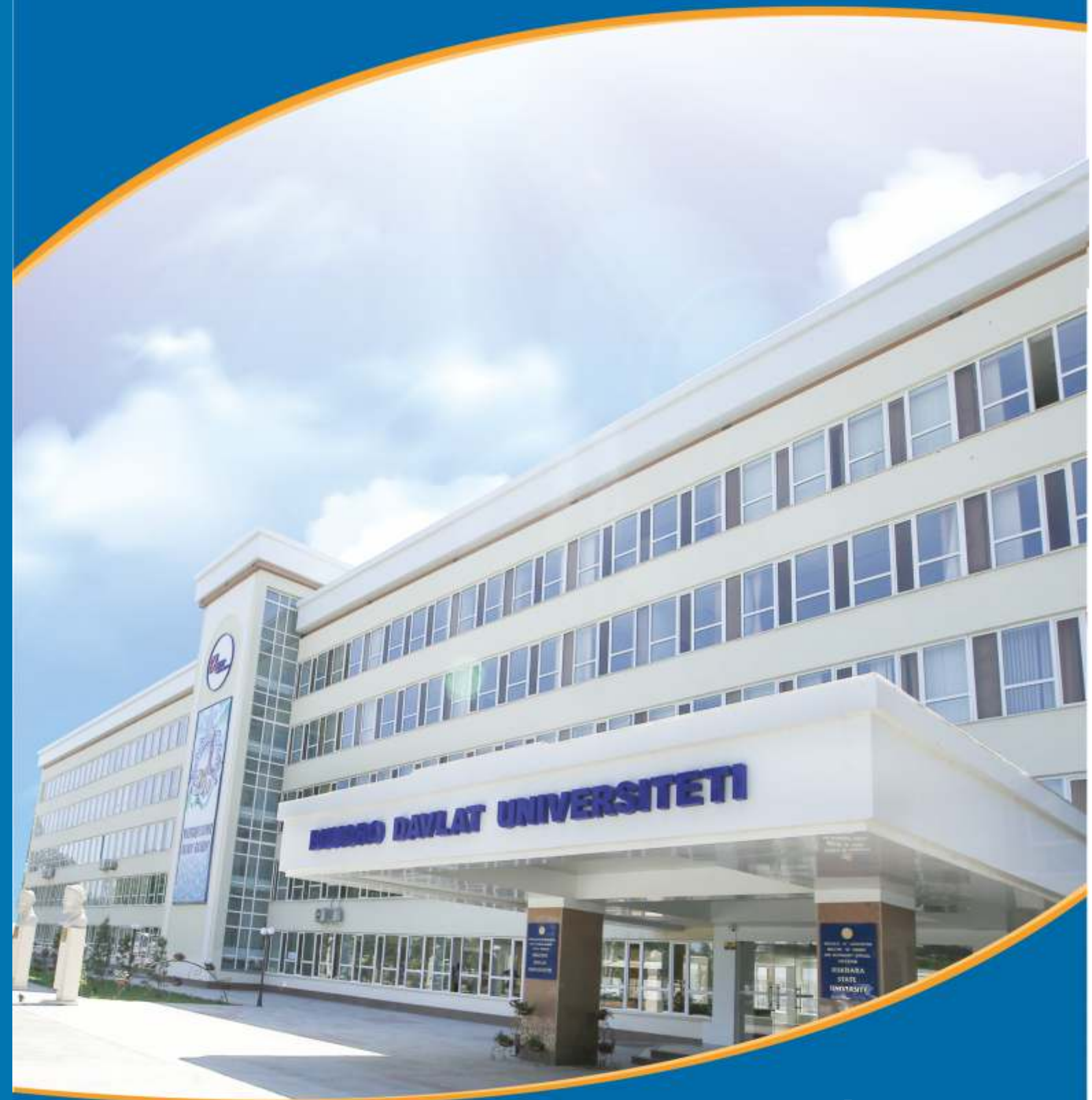




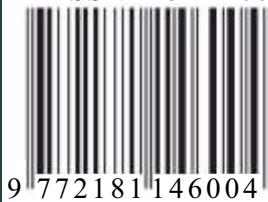
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THE INVERSE PROBLEM FOR SYSTEMS OF INCOMPRESSIBLE VISCOELASTIC POLYMERIC FLUID AT REST

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Abstract:

Introduction. Many physical processes are described by a system of equations of the hyperbolic type of the first order. For example, systems of an incompressible viscoelastic polymeric fluid, etc. It is well known that second-order equations are derived from them with the help of a number of additional restrictions. The solution of inverse problems leads directly to the solution of these systems. Systematic research in this area was carried out in the 1970s by L.P. Nizhnik, S.P. Belinsky, V.G. Romanov and L.I. Slinyuchev began in the work of scientists.

Methods. In this work we will use the differential equations, functional analysis, algebraic methods and also the principle of contraction mappings.

Results. The article checks the inverse problem for hyperbolic systems of 4 first-order integro-differential equations with an integral member of the convolution type. The direct problem is the initial-boundary value problem for this system on the finite interval $[0, 1]$. When certain data matching conditions are fully met, the inverse problem is reduced to solving a system of Volterra-type integral equations with respect to the unknowns. In addition, a theorem on the local unique solvability of the problem for sufficiently small.

Discussions. The study of direct and inverse problems posed to a mixed type equation is one of the advanced critical and rapidly emerging areas of world science. Their numerical implementation provides an applied application for the study of these problems. In this paper, we numerically study the boundary value problem posed to a model equation of mixed type. To do this, you need to know the concept of approximation and stability. The stability of the difference scheme has been proven. The order of approximation is calculated in the work. Further, when the stability and approximation are proved, it is possible to show the approximation of the numerical solution to the exact solution.

Conclusion. To sum up, we look the kernel is 4×4 dimensional diagonal matrix that depends on time. To define that function, we put initial-boundary conditions on characteristic lines. Proved the theorem of unique solvability. We get the following results, firstly consider the inverse problem of the determination kernel in hyperbolic system of n number first-order integro-differential equations, which is

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of the form of 4×4 matrices depending on variable t , next obtain the theorem of exists unique solution, finally proved local theorem in a small interval.

Keywords: Hyperbolic system, diagonal and inverse quadratic matrices, vector functions, convolution kernel, integral equations of Volterra type, principle of contraction mappings.

Introduction. First-order hyperbolic systems of equations describe many physical processes associated with the motion of a polymer fluid in a flat channel. As an example, we can point out systems of equations for an incompressible viscoelastic polymer fluid.

The Pokrovsky–Vinogradov rheological model is used as a model for the hydrodynamics of a polymeric fluid [1, 2].

Polymeric liquids are fluid media consisting of long macromolecules entangled with each other. In flows with nonzero velocity gradients, such molecules interact in a complex way, resting against each other, catching and releasing with time. This feature of the molecular structure of a fluid leads to a number of features like the strain memory effect, pseudoplasticity (change in fluid viscosity with shear rate) and spatial anisotropy.

The mathematical description of such a complex behavior of the medium is a difficult task, in the process of solving which one has to make a large number of assumptions and assumptions, often not obvious and controversial, not always well argued from a physical point of view. Apparently, it is not worth counting on the appearance of a certain universal model of the dynamics of polymeric materials, since it is hardly possible to take into account all the various features of the behavior of these media within the framework of one model. The result of this is a large number of different rheological models for the dynamics of liquid polymers, differing in approaches and, as a result, in the relationships and properties obtained. In addition, even geometrically simple flows within the framework of such models have unusual features that are often unique for individual models and require careful analysis. By themselves, these models are quite complex mathematically, and the properties of problem solutions for them are often poorly understood.

One way or another, any rheological model of liquid polymers is based on a constitutive relation connecting the stress tensor of the medium with the velocity gradient tensor. The form of this ratio depends from the generalizing assumptions made to obtain it and differ from model to model. In general, we can single out two main approaches, or if you like, two main ideas that make it possible to obtain this ratio. The first approach is focused on the analysis of experimental measurements of fluid properties obtained in the study of viscometric flows of real polymers. Using experimental data, within the framework of this approach, one can make a number of general assumptions regarding conservation laws and obtain constitutive relations by selecting the values of one or more of the introduced parameters, achieving correspondence solutions of equations with empirical data.

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The second approach focuses on modeling the dynamics of the medium macromolecules themselves and their interaction with each other. Since the motion of molecules in itself is random, to model their dynamics one has to involve stochastic equations, which in one way or another take into account the Brownian component of the dynamics of microscopic particles. Accordingly, to obtain macroscopic relationships, the liquid characteristics are averaged over the statistical ensemble. Models that mainly adhere to the first approach are called phenomenological [3, 4], and the second – statistical [6, 5]. Models that somehow combine these approaches are commonly referred to as mesoscopic. The latter include and the Pokrovsky–Vinogradov model used in this work.

One of the classical fluid flows is a stationary flow in a straight cylindrical or flat channel. Its implementation for a viscous fluid in the stationary case is the well-known Poiseuille flow, which is one of the examples of exact analytical solutions of the Navier–Stokes equations. A natural desire is to analyze a flow of a viscoelastic fluid similar in geometry. In addition to its relative simplicity, this type of flow can be considered one of the most interesting from a practical point of view, since the study of the flow of polymer melts through pipes is important for the production of polymer materials, additive technologies, and related industries. Similar flows, among other models, have also been studied for the Pokrovsky–Vinogradov model, but, unlike the Poiseuille flow for the Navier–Stokes equations, cases that allow one to find analytical solutions have not yet been considered.

Analysis of dynamic equations describing such processes, show that Volterrod operators of the convolution type of some function are added to the right-hand side of the systems of hyperbolic equations, depending on time and the elliptic part of the corresponding hyperbolic operators on the left side.

Following [1], we formulate the generalized rheological model of Vinogradov – Pokrovsky, which describes the flows of an incompressible viscoelastic polymeric fluid (for example,

in a flat channel). In dimensionless form (the process of nondimensionalization is described in detail in [2]), this mathematical model has the following in

$$\begin{aligned} u_x + v_y &= 0, \\ \frac{d\mathbf{u}}{dt} + \nabla p &= \frac{1}{Re} \operatorname{div} \Pi, \\ \frac{da_{11}}{dt} - 2A_1 u_x - 2a_{12} u_y + K_I a_{11} + \beta \|\sigma_1\|^2 &= 0, \\ \frac{da_{12}}{dt} - A_1 v_x - A_2 u_y + K_I a_{12} + \beta(\sigma_1, \sigma_2) &= 0, \\ \frac{da_{22}}{dt} - 2a_{12} v_x - 2A_2 v_y + K_I a_{22} + \beta \|\sigma_2\|^2 &= 0, \end{aligned} \quad (1)$$

here: t - time; u, v - components of the velocity vector \mathbf{u} in Cartesian coordinates x, y ; p - pressure; $a_{ij}, i, j = 1, 2$ - components of the symmetric anisotropy tensor Π of the second rank; σ_1, σ_2 - columns of the symmetric matrix $\Pi = (a_{ij}) = (\sigma_1, \sigma_2)$;

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$$\|\sigma_i\|^2 = (\sigma_i, \sigma_i), i = 1, 2;$$

$$\operatorname{div} \Pi = (\operatorname{div} \sigma_1, \operatorname{div} \sigma_2)^T,$$

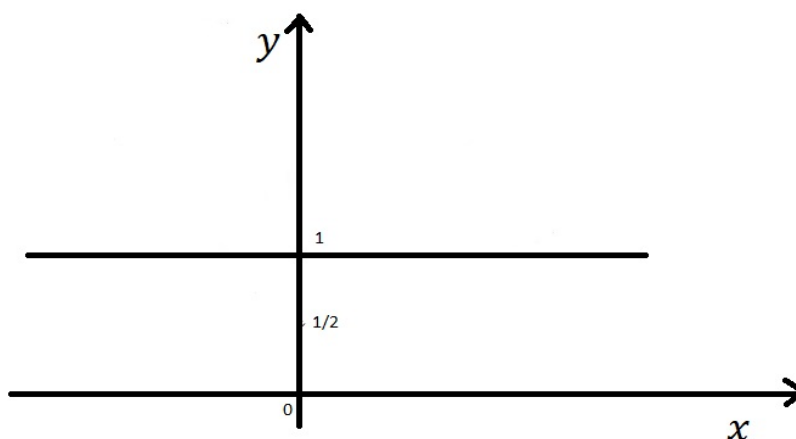
$K_I = W^{-1} + \frac{\bar{k}}{3} I, I = a_{11} + a_{22}, \bar{k} = k - \beta$ the constants $k, \beta (0 < \beta < 1)$ – phenomenological parameters do not depend on the molecular weight of the polymer and its concentration, characterizing, respectively, the dimensions and orientation of the molecular coils of the polymer associated with anisotropy; $Re = \frac{\rho u_H l}{\eta_0}$ – Reynolds number; $\rho (= \text{const})$ – medium density; $W = \frac{\tau_0 u_H}{l}$ – Weissenberg number; η_0, τ_0 – initial values of shear viscosity and relaxation time; l – characteristic length (see figure); u_H – characteristic speed;

$$A_i = W^{-1} + a_{ii}, \quad i = 1, 2;$$

$$\frac{d}{dt} = \frac{\partial}{\partial t} + (\mathbf{u}, \nabla).$$

In the (1) frame, time t , coordinates x, y , velocity vector components u, v , pressure p are related to $\frac{l}{u_H}, l, u_H, \rho u_H^2$. As we have already noted, the stationary solutions of the mathematical model (1) were studied in detail in [2]. Stationary solutions were constructed there, similar to the Poiseuille and Couette solutions for the Navier–Stokes system of equations. Questions related with linear stability of such solutions were considered in [3; 4]. In this work as the initial stationary flow, we take the state of rest (mechanical equilibrium):

$$u = v = a_{11} = a_{12} = a_{22} = 0, p = \text{const}. \quad (2)$$



1. Flat channel.

In [2], a linear system was constructed, obtained by linearizing equations of an incompressible viscoelastic polymeric fluid (1). Linearization was carried out with respect to stationary solutions similar to the Poiseuille solutions for the system of Navier-Stokes equations. If we take the state of rest (2) in the channel (see figure) as a stationary solution, then the linear system will have the following view:

$$U_t + A_1 U_y + A_2 U_x + A_3 U + F_0 = 0, \quad (3)$$

$$t > 0, x \in \mathbb{R}^1, \quad 0 < y < 1,$$

$$U = \begin{pmatrix} u \\ v \\ \alpha_{12} \\ \alpha_{22} \end{pmatrix}, A_1 = \begin{pmatrix} 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 \\ -\kappa_0^2 & 0 & 0 & 0 \\ 0 & -2\kappa_0^2 & 0 & 0 \end{pmatrix}, A_2 = \begin{pmatrix} 0 & 0 & 0 & 2 \\ 0 & 0 & -1 & 0 \\ 0 & -\kappa_0^2 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix},$$

$$A_3 = W^{-1} \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 \end{pmatrix}, \quad F_0 = \begin{pmatrix} \Omega_x \\ \Omega_y \\ 0 \\ 0 \end{pmatrix}; \quad (4)$$

u, v are small perturbations of the velocity vector components; $a_{11} (= -a_{22}), a_{12}, a_{22}$ - small perturbations of the components of the symmetric anisotropy tensor; $\alpha_{ij} = \frac{a_{ij}}{Re}, i, j = 1, 2; \Omega = p - \alpha_{22}, p$ - small pressure perturbation; $\kappa_0^2 = \frac{1}{WRe}$.

Equation (3) will be considered with integral terms of the convolution type on the right side:

$$U_t + A_1 U_y + A_2 U_x + A_3 U + F_0 = \int_0^t \Psi(\tau) U(y, t - \tau) d\tau,$$

$$t > 0, x \in \mathbb{R}^1, \quad 0 < y < 1,$$

where $\Psi(t) = \text{diag}(\psi_1, \psi_2, \psi_3, \psi_4)(t)$ -diagonal matrix, characterizing the viscous properties of the medium.

Now, applying the Fourier transform with respect to the variable x , we rewrite this system in the form:

$$\tilde{U}_t + A_1 \tilde{U}_y + B_1 \tilde{U} = \int_0^t \Psi(t - \tau) \tilde{U}(y, \tau) d\tau - \tilde{F}_0(y, t), \quad 0 < y < 1, \quad (5)$$

where $\tilde{U} = (\tilde{u}, \tilde{v}, \tilde{\alpha}_{12}, \tilde{\alpha}_{22})$ -column vector, $\tilde{\Omega} = \tilde{p} - \tilde{\alpha}_{22}$,

$$A_1 = \begin{pmatrix} 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \\ -\kappa_0^2 & 0 & 0 & 0 \\ 0 & -2\kappa_0^2 & 0 & 0 \end{pmatrix}, \quad (6)$$

$$B_1 = (i\xi A_2 + A_3) = \begin{pmatrix} 0 & 0 & 0 & i\xi \\ 0 & 0 & -i\xi & 0 \\ 0 & -i\xi\kappa_0^2 & \frac{1}{W} & \frac{1}{W} \\ 0 & 0 & \frac{1}{W} & \frac{1}{W} \end{pmatrix}, \tilde{F}_0 = \begin{pmatrix} i\xi\tilde{p} \\ \tilde{p}_y \\ 0 \\ 0 \end{pmatrix}.$$

Let us reduce system (5) to the canonical form.

In the case under consideration, there exists a nonsingular matrix T such that $T^{-1}A_1T = \Lambda$, where Λ – is a diagonal matrix with eigenvalues of the matrix A_1 ,

$$T = \begin{pmatrix} 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 \\ -\kappa_0 & \kappa_0 & 0 & 0 \\ 0 & 0 & -\sqrt{2}\kappa_0 & \sqrt{2}\kappa_0 \end{pmatrix}. \quad (7)$$

The inverse matrix to T is defined by the following formula

$$T^{-1} = \begin{pmatrix} \frac{1}{2} & 0 & -\frac{1}{2\kappa_0} & 0 \\ \frac{1}{2} & 0 & \frac{1}{2\kappa_0} & 0 \\ 0 & \frac{1}{2} & 0 & -\frac{1}{2\sqrt{2}\kappa_0} \\ 0 & \frac{1}{2} & 0 & \frac{1}{2\sqrt{2}\kappa_0} \end{pmatrix}. \quad (8)$$

Now, in equation (5), we introduce a new function using the equality

$$\tilde{U} = TV \quad (9)$$

and multiply this equation on the left by the matrix T^{-1} . Then for the function V we obtain the equation

$$\left(I_4 \frac{\partial}{\partial t} + \Lambda \frac{\partial}{\partial y} + C\right)V = \int_0^t R(t-\tau)V(y,\tau)d\tau + F \quad (10)$$

where I_4 – means the identity matrix of order 4, $\Lambda = \text{diag}(\kappa_0, -\kappa_0, \sqrt{2}\kappa_0, -\sqrt{2}\kappa_0)$, $C = T^{-1}B_1T$, $R(t) = T^{-1}\Psi(t)T$, $F = -T^{-1}\tilde{F}_0(y, t)$.

Formulation of the problem

In the direct problem, given matrices R, C and vector functions F , it is required to determine in the domain $\Pi = \{(y, t): 0 < y < 1, t > 0\}$ the vector function $V(y, t)$, matching equation (10) under the following initial and boundary conditions:

$$V_i(y, t)|_{t=0} = \varphi_i(y), i = \overline{1,4}; \quad (11)$$

$$V_i(y, t)|_{y=0} = g_i(t), i = 1,3; \quad V_i(y, t)|_{y=1} = g_i(t), i = 2,4; \quad (12)$$

here $\varphi(y) = (\varphi_1, \varphi_2, \varphi_3, \varphi_4)(y)$, $g(t) = (g_1, g_2, g_3, g_4)(t)$ given functions.

In the inverse problem, the matrix function $R(t) > 0, t > 0$ is assumed to be unknown it is required to find it if, with respect to the solution of problem (10) (12), additional conditions are known that are specified on the side boundaries of the domain Π ,

$$\begin{aligned} V_i(t)|_{y=1} &= h_i(t), i = 1,3; \\ V_i(t)|_{y=0} &= h_i(t), i = 2,4; \end{aligned} \quad (13)$$

in this case, $R(0)$ are assumed to be given.

To date, the problems of determining kernels from one second-order integro-differential equation [6]-[23] have been widely studied. The numerical solution of direct and inverse problems for such equations was studied in [24]-[38]. As a rule, second-order equations are derived from systems of first-order partial differential equations under some additional assumptions.

The inverse problem of determining the kernels of the integral terms from a system of general first-order integro-differential equations with two independent variables was studied in [39]. A theorem of local existence and global uniqueness is obtained.

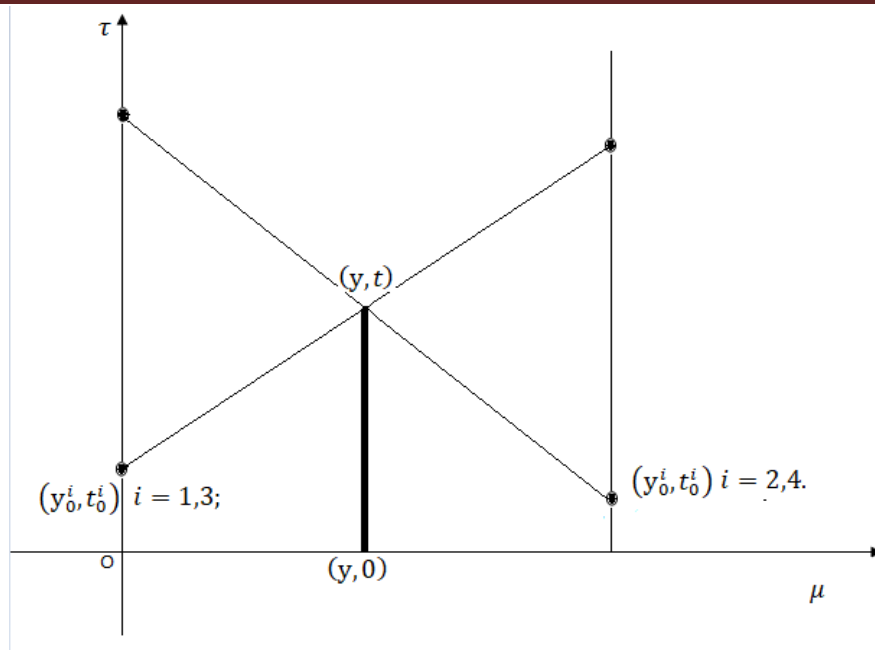
It seems quite natural to study inverse problems of determining the kernels of the integral terms of a system of integro-differential equations directly in terms of the system itself. This article is a natural continuation of this circle of problems and to a certain extent generalizes the results of [39] to the case of a system of equations for an incompressible viscoelastic polymer fluid (1).

Study of the direct problem

Consider an arbitrary point $(y, t) \in \Pi$ on the plane of variables μ, τ and characterize the equation of system (10) through it until it intersects the boundary Π in the region $\tau < t$. Its equation has the form

$$\mu = y + \lambda_i(\tau - t), \quad (14)$$

at $\lambda_i > 0$ (that is $i = 1,3$) this point lies either on the segment $[0,1]$ of the axis $t = 0$, or on the line $y = 0$, and for $\lambda_i < 0$, (that is $i = 2,4$) either on the segment $[0,1]$ or on the line $y = 1$ (Rice 2).



2. Characteristic lines.

Integrating the i -th component of equality (10) with respect to characteristic (14) from the point (y_0^i, t_0^i) to the point (y, t) , we find

$$V_i^1(y, t) = V_i^1(y_0^i, t_0^i) + \int_0^t \left[F_i(\mu, \tau) - \sum_{j=1}^4 c_{ij} V_j^1(\mu, \tau) \right] \Big|_{\mu=y+\lambda_i(\tau-t)} d\tau + \\ + \int_{t_0^i}^t \int_0^\tau \sum_{j=1}^4 R(\tau)_{ij} V_j^1(\mu, \tau - \eta) d\eta \Big|_{\mu=y+\lambda_i(\tau-t)} d\tau, i = \overline{1,4}. \quad (15)$$

Let us first define in (15) t_0^i . It depends on the coordinates of the point (y, t) . It is easy to see that $t_0^i(y, t)$ has view,

$$t_0^i(y, t) = \begin{cases} \begin{cases} t - \frac{y}{\lambda_i}, & t \geq \frac{y}{\lambda_i}, \\ 0, & 0 < t < \frac{y}{\lambda_i}, \end{cases} & i = 1,3; \\ \begin{cases} t + \frac{1-y}{\lambda_i}, & t \geq \frac{y-1}{\lambda_i}, \\ 0, & 0 < t < \frac{y-1}{\lambda_i} \end{cases} & i = 2,4. \end{cases} \quad (16)$$

Then, from the condition that the pair (y_0^i, t_0^i) satisfies equation (15) it follows

$$y_0^i(y, t) = \begin{cases} \begin{cases} 0, & t \geq \frac{y}{\lambda_i}, \\ y - \lambda_i t, & 0 < t < \frac{y}{\lambda_i}, \end{cases} & i = 1, 3; \\ \begin{cases} 1, & t \geq \frac{y-1}{\lambda_i}, \\ y - \lambda_i t, & 0 < t < \frac{y-1}{\lambda_i} \end{cases} & i = 2, 4. \end{cases}$$

The free terms of the integral equations (15) are determined through the initial and boundary conditions (11) and (12) as follows:

$$V_i(y_0^i, t_0^i) = \begin{cases} \begin{cases} g_i\left(t - \frac{y}{\lambda_i}\right), & t \geq \frac{y}{\lambda_i}, \\ \varphi_i(y - \lambda_i t), & 0 \leq t < \frac{y}{\lambda_i}, \end{cases} & i = 1, 3; \\ \begin{cases} g_i\left(t + \frac{1-y}{\lambda_i}\right), & t \geq \frac{y-1}{\lambda_i}, \\ \varphi_i(y - \lambda_i t), & 0 \leq t < \frac{y-1}{\lambda_i}, \end{cases} & i = 2, 4. \end{cases} \quad (17)$$

We require that the functions $V_i(y_0^i, t_0^i)$ be continuous in the domain Π . Note that in order to fulfill these conditions, the given functions φ_i and g_i must satisfy the matching conditions at the corner points of the domain Π :

$$\varphi_i(0) = g_i(0), \quad i = 1, 3; \quad \varphi_i(1) = g_i(0), \quad i = 2, 4. \quad (18)$$

Here the values of functions g_i at $t = 0$ and functions φ_i at $y = 0, 1$; are understood as the limit at these points as the argument tends from the side of the point where these functions are defined.

Let us assume that all given functions included in (15) are continuous functions of their arguments in Π . Then this system of equations is a closed system of Voltaire-type integral equations of the second kind with continuous kernels and free terms. As usual, such a system has a unique solution in the bounded subdomain $\Pi_T = \{(y, t): 0 \leq y \leq 1, 0 \leq t \leq T\}$, $T > 0$ is some fixed number, area Π .

Let us introduce the vector function $w(y, t) = \frac{\partial}{\partial t} V(y, t)$. To obtain a problem for a function $w(y, t)$ similar to (10)-(12), we differentiate equations (10) and boundary conditions (12) with respect to the variable t , and conventionally for $t = 0$ we find using the equation (10) and initial conditions (11). In doing so, we get

$$\frac{\partial w_i}{\partial t} + \gamma_i \frac{\partial w_i}{\partial y} = - \sum_{j=1}^4 c_{ij} w_j(y, t) + \sum_{j=1}^4 R_{ij}(t) \varphi_j(y) +$$

$$+ \int_0^t \sum_{j=1}^4 R_{ij}(\tau) w_j(y, t - \tau) d\tau + \frac{\partial}{\partial t} F_i(y, t), i = \overline{1,4}; \quad (19)$$

$$w_i(y, t)|_{t=0} = \Phi_i(y), i = \overline{1,4}; \quad (20)$$

$$\begin{aligned} w_i(y, t)|_{y=0} &= \frac{d}{dt} g_i(t), i = 1,3; \\ w_i(y, t)|_{y=1} &= \frac{d}{dt} g_i(t), i = 2,4; \end{aligned} \quad (21)$$

where

$$\Phi_i(y) = F_i(y, 0) - \lambda_i \frac{\partial}{\partial y} \varphi_i(y) - \sum_{j=1}^4 c_{ij} \varphi_j(y), i = \overline{1,4}. \quad (22)$$

Again, integration along the corresponding characteristics will lead problem (19)-(21) to the integral equations

$$\begin{aligned} w_i(y, t) &= w_i(y_0^i, t_0^i) + \int_{t_0^i}^t \sum_{j=1}^4 R_{ij}(\tau) \varphi_j(\mu) \Big|_{\mu=y+\lambda_i(\tau-t)} d\tau + \\ &+ \int_{t_0^i}^t \left[\frac{\partial}{\partial t} F_i(\mu, \tau) - \sum_{j=1}^4 c_{ij} w_j(\mu, \tau) \right] \Big|_{\mu=y+\lambda_i(\tau-t)} d\tau + \\ &+ \int_{t_0^i}^t \int_0^\tau \sum_{j=1}^4 R_{ij}(\eta) w_j(\mu, \tau - \eta) d\eta \Big|_{\mu=y+\lambda_i(\tau-t)} d\tau. \quad i = \overline{1,4} \end{aligned} \quad (23)$$

For functions w_i additional conditions (13) conditions look like

$$w_i(0, t) = \frac{d}{dt} h_i(t), i = 2,4; \quad w_i(1, t) = \frac{d}{dt} h_i(t), i = 1,3. \quad (24)$$

In equations (23) $w_i(y_0^i, t_0^i)$ are defined as follows:

$$\begin{aligned} w_i(y_0^i, t_0^i) &= \begin{cases} \frac{d}{dt} g_i\left(t - \frac{y}{\lambda_i}\right), & t \geq \frac{y}{\lambda_i} \\ \Phi_i(y - \lambda_i t), & 0 \leq t < \frac{y}{\lambda_i}, \end{cases} \quad i = 1,3; \\ w_i(y_0^i, t_0^i) &= \begin{cases} \frac{d}{dt} g_i\left(t + \frac{1-y}{\lambda_i}\right), & t \geq \frac{y-1}{\lambda_i} \\ \Phi_i(y - \lambda_i t), & 0 \leq t < \frac{y-1}{\lambda_i}, \end{cases} \quad i = 2,4; \end{aligned}$$

Let the conditions

$$F_i(0,0) - \gamma_i \left[\frac{\partial}{\partial y} \varphi_i(y) \right]_{y=0} - \sum_{j=1}^4 c_{ij} \varphi_j(0) = \left[\frac{d}{dt} g_i(t) \right]_{t=0}, i = 1,3; \quad (25)$$

$$F_i(1,0) - \gamma_i \left[\frac{\partial}{\partial y} \varphi_i(y) \right]_{y=1} - \sum_{j=1}^4 c_{ij} \varphi_j(1) = \left[\frac{d}{dt} g_i(t) \right]_{t=0}, i = 2,4; \quad (26)$$

It is not difficult to see that the conditions for matching the initial (20) and boundary (21) data at the corner points of the domain Π coincide with relations (25) and (26). From here it is clear that if the same equalities (25) and (26) hold, equations (19) will have unique continuous solutions $w_i(y,t)$ or the same $(\partial/\partial t)V_i(y,t)$. So, we have proved the following statement:

Theorem 1. Let be $\varphi(y) \in C^1[0,1]$, $g(t) \in C^1[0,1]$, $\Psi(t) \in C[0,T]$,

$\varphi(y) \in C^1[0,1]$, $F(y,t)$ and $F_t(y,t) \in C(\Pi_T)$ the conditions are met (18), (25) и (26). Then there is a unique continuous solution to problem (19)-(21) in the domain Π .

Study of the inverse problem. Derivation of an equivalent system of integral equations

Consider an arbitrary point $(y,0) \in \Pi$ and draw characteristic (14) through it until it intersects with the side boundaries of the region Π . Integrating the i -th component of equation (19), using the data (22), we find

$$\begin{aligned} w_i(y,0) = \frac{d}{dt} h_i(t_i(y)) - \int_0^{t_i(y)} \left[\sum_{j=1}^4 R_{ij}(\tau) \varphi_j(\mu) - \sum_{j=1}^4 c_{ij} w_j(\mu, \tau) \right]_{\mu=y+\lambda_i \tau} d\tau - \\ - \int_0^{t_i(y)} \frac{\partial}{\partial t} F_i(\mu, \tau) \Big|_{\mu=y+\lambda_i \tau} d\tau - \int_0^{t_i(y)} \int_0^{\tau} \sum_{j=1}^4 R_{ij}(\alpha) w_j(\mu, \tau - \alpha) d\alpha \Big|_{\mu=y+\lambda_i \tau} d\tau, \end{aligned} \quad (27)$$

where

$$t_i(y) = \frac{1}{\lambda_i} \begin{cases} -y, & i = 1,3, \\ 1-y, & i = 2,4. \end{cases}$$

Taking into account the initial conditions (21), we rewrite equations (27) in the form

$$\begin{aligned}
& \int_0^{t_i(y)} \sum_{j=1}^4 c_{ij} w_j(y + \lambda_i \tau, \tau) d\tau - \int_0^{t_i(y)} \int_0^{\tau} \sum_{j=1}^4 R_{ij}(\alpha) w_j(y + \lambda_i \tau, \tau - \alpha) d\alpha d\tau = \\
& = \Phi_i(y) - \frac{d}{dt} h_i(t_i(y)) + \int_0^{t_i(y)} \left[\sum_{j=1}^4 R_{ij}(\tau) \varphi_j(y + \lambda_i \tau) + \frac{\partial}{\partial t} F_i(y + \lambda_i \tau, \tau) \right] d\tau, i = \overline{1,4}.
\end{aligned}
\tag{28}$$

We differentiate the equations with respect to the variables y . Then we have

$$\begin{aligned}
& - \sum_{j=1}^4 c_{ij} w_j(y + \lambda_i t_i(y), t_i(y)) + \lambda_i \int_0^{t_i(y)} \sum_{j=1}^4 c_{ij} \frac{\partial}{\partial y} w_j(y + \lambda_i \tau, \tau) d\tau + \\
& + \int_0^{t_i(y)} \sum_{j=1}^4 R_{ij}(\tau) w_j(y + \lambda_i t_i(y), t_i(y) - \tau) d\tau - \\
& - \lambda_i \int_0^{t_i(y)} \int_0^{\tau} \sum_{j=1}^4 R_{ij}(\alpha) \frac{\partial}{\partial y} w_i(y + \lambda_i \tau, \tau - \alpha) d\alpha d\tau \\
& = \lambda_i \frac{d}{dy} \Phi_i(y) + \frac{\partial^2}{\partial t^2} h_i(t_i(y)) - \\
& - \left[\sum_{j=1}^4 R_{ij}(t_i(y)) \varphi_j(y + \lambda_i t_i(y)) + \frac{\partial}{\partial t} F_i(y + \lambda_i t_i(y), t_i(y)) \right] + \\
& + \lambda_i \int_0^{t_i(y)} \left[\sum_{j=1}^4 R_{ij}(\tau) \frac{\partial}{\partial y} \varphi_j(y + \lambda_i \tau) + \frac{\partial^2}{\partial t \partial y} F_i(y + \lambda_i \tau, \tau) \right] d\tau, i = \overline{1,4}.
\end{aligned}
\tag{29}$$

Next, in equations (29), we replace $t_j(y)$ by t , and obtain the following equalities

$$\begin{aligned}
& - \sum_{j=1}^4 c_{ij} w_j(0, t) + \lambda_i \int_0^t \sum_{j=1}^4 c_{ij} \frac{\partial}{\partial y} w_j(y + \lambda_i \tau, \tau) d\tau + \\
& + \sum_{j=1}^4 R_{ij}(t) \varphi_j(0) + \int_0^t \sum_{j=1}^4 R_{ij}(\tau) w_j(0, t - \tau) d\tau - \\
& - \lambda_i \int_0^t \int_0^{\tau} \sum_{j=1}^4 R_{ij}(\alpha) \frac{\partial}{\partial y} w_i(y + \lambda_i \tau, \tau - \alpha) d\alpha d\tau = \lambda_i \frac{d}{dy} \Phi_i(y) +
\end{aligned}$$

$$+ \frac{\partial^2}{\partial t^2} h_i(t) - \frac{\partial}{\partial t} F_i(0, t) + \quad (30)$$

$$\begin{aligned}
& + \lambda_i \int_0^t \left[\sum_{j=1}^4 R_{ij}(\tau) \frac{\partial}{\partial y} \varphi_j(y + \lambda_i \tau) + \frac{\partial^2}{\partial t \partial y} F_i(y + \lambda_i \tau, \tau) \right] d\tau, i = 1, 3; \\
& - \sum_{j=1}^4 c_{ij} w_j(1, t) + \lambda_i \int_0^t \sum_{j=1}^4 c_{ij} \frac{\partial}{\partial y} w_j(y + \lambda_i \tau, \tau) d\tau + \\
& + \sum_{j=1}^4 R_{ij}(t) \varphi_j(1) + \int_0^t \sum_{j=1}^4 R_{ij}(\tau) w_j(1, t - \tau) d\tau - \\
& - \lambda_i \int_0^t \int_0^\tau \sum_{j=1}^4 R_{ij}(\alpha) \frac{\partial}{\partial y} w_i(y + \lambda_i \tau, \tau - \alpha) d\alpha d\tau = \lambda_i \frac{d}{dy} \Phi_i(y) + \\
& + \frac{\partial^2}{\partial t^2} h_i(t) - \frac{\partial}{\partial t} F_i(1, t) + \quad (31) \\
& + \lambda_i \int_0^t \left[\sum_{j=1}^4 R_{ij}(\tau) \frac{\partial}{\partial y} \varphi_j(y + \lambda_i \tau) + \frac{\partial^2}{\partial t \partial y} F_i(y + \lambda_i \tau, \tau) \right] d\tau, i = 2, 4;
\end{aligned}$$

We write equalities (30)-(31) in the following compact form

$$\begin{aligned}
& - \sum_{j=1}^4 c_{ij} w_j(\theta_i, t) + \lambda_i \int_0^t \sum_{j=1}^4 c_{ij} \frac{\partial}{\partial y} w_j(y + \lambda_i \tau, \tau) d\tau + \\
& + \sum_{j=1}^4 R_{ij}(t) \varphi_j(\theta_i) + \int_0^t \sum_{j=1}^4 R_{ij}(\tau) w_j(\theta_i, t - \tau) d\tau - \\
& - \lambda_i \int_0^t \int_0^\tau \sum_{j=1}^4 R_{ij}(\alpha) \frac{\partial}{\partial y} w_i(y + \lambda_i \tau, \tau - \alpha) d\alpha d\tau = \lambda_i \frac{d}{dy} \Phi_i(y) + \\
& + \frac{\partial^2}{\partial t^2} h_i(t) - \frac{\partial}{\partial t} F_i(\theta_i, t) + \quad (32) \\
& + \lambda_i \int_0^t \left[\sum_{j=1}^4 R_{ij}(\tau) \frac{\partial}{\partial y} \varphi_j(y + \lambda_i \tau) + \frac{\partial^2}{\partial t \partial y} F_i(y + \lambda_i \tau, \tau) \right] d\tau, i = \overline{1, 4};
\end{aligned}$$

here

$$\theta_i = \begin{cases} 0, & i = 1,3; \\ 1, & i = 2,4; \end{cases} \quad \lambda_i = \begin{cases} 1, \sqrt{2}, & i = 1,3; \\ -1, -\sqrt{2}, & i = 2,4. \end{cases}$$

Let us introduce the following notation

$$\begin{aligned} Y = (\theta_i; \varphi(\theta_i)) &:= (Y_{il}(\theta_i; \varphi(\theta_i)))_{i,l=1}^4 = \\ &= \frac{1}{2} \begin{pmatrix} \varphi_1(\theta_1) + \varphi_2(\theta_1) & 0 & \varphi_1(\theta_1) - \varphi_2(\theta_1) & 0 \\ \varphi_1(\theta_2) + \varphi_2(\theta_2) & 0 & -\varphi_1(\theta_2) + \varphi_2(\theta_2) & 0 \\ 0 & \varphi_3(\theta_3) + \varphi_4(\theta_3) & 0 & \varphi_3(\theta_3) - \varphi_4(\theta_3) \\ 0 & \varphi_3(\theta_4) + \varphi_4(\theta_4) & 0 & -\varphi_3(\theta_4) + \varphi_4(\theta_4) \end{pmatrix}, \\ Y = (y; \omega(y, t)) &:= (Y_{il}(y; \omega(y, t)))_{i,l=1}^4 = \\ &= \frac{1}{2} \begin{pmatrix} \omega_1(y, t) + \omega_2(y, t) & 0 & \omega_1 - \omega_2 & 0 \\ \omega_1(y, t) + \omega_2(y, t) & 0 & -\omega_1 + \omega_2 & 0 \\ 0 & \omega_3(y, t) + \omega_4 & 0 & \omega_3 - \omega_4 \\ 0 & \omega_3(y, t) + \omega_4 & 0 & -\omega_3 + \omega_4 \end{pmatrix}. \end{aligned} \quad (33)$$

Taking into account (33), we write equations (23) in the following form:

$$\begin{aligned} w_i(y, t) &= w_i(y_0^i, t_0^i) + \int_{t_0^i}^t [\sum_{j=1}^4 Y_{ij}(\mu; \varphi(\mu)) \psi_j(\tau) - \sum_{j=1}^4 c_{ij} w_i(\mu, \tau)]_{\mu=y+\lambda_i(\tau-t)} d\tau + \\ &+ \int_{t_0^i}^t \int_0^\tau \sum_{j=1}^4 Y_{ij}(\mu; w_i(\mu, \tau - \eta)) \psi_j(\eta) d\eta \Big|_{\mu=y+\lambda_i(\tau-t)} d\tau + \int_{t_0^i}^t \frac{\partial}{\partial t} F_i(\mu, \tau) \Big|_{\mu=y+\lambda_i(\tau-t)} d\tau. \end{aligned} \quad (34)$$

Also using (33) system (32), we rewrite in the form:

$$\begin{aligned} \sum_{j=1}^4 Y_{ij}(\theta_i; \varphi(\theta_i)) \psi_j(t) &= \lambda_i \int_0^t \frac{\partial}{\partial y} \sum_{j=1}^4 Y_{ij} \left(\tau; \frac{\partial}{\partial y} \varphi_j(y + \lambda_i \tau) \right) \psi_j(\tau) d\tau - \\ &- \int_0^t \sum_{j=1}^4 Y_{ij}(\theta_i; w_j(\theta_i, t - \tau)) \psi_j(\tau) d\tau + \\ &+ \lambda_i \int_0^t \int_0^\tau \sum_{j=1}^4 Y_{ij} \left(y; \frac{\partial}{\partial y} w_j(y, \tau - \alpha) \right) \psi_j(\alpha) \Big|_{y=\theta_i+\lambda_i(\tau-t)} d\alpha d\tau - \\ &- \lambda_i \int_0^t \sum_{j=1}^4 c_{ij} \frac{\partial}{\partial y} w_j(y + \lambda_i \tau, \tau) d\tau + \lambda_i \frac{d}{dy} \Phi_i(y) + \frac{\partial^2}{\partial t^2} h_i(t) - - \frac{\partial}{\partial t} F_i(\theta_i, t) \\ &+ \sum_{j=1}^4 c_{ij} w_j(\theta_i, t) + \lambda_i \int_0^t \frac{\partial^2}{\partial t \partial y} F_i(y + \lambda_i \tau, \tau) d\tau, i = \overline{1,4}. \end{aligned} \quad (35)$$

In what follows, we will assume that the conditions

$$\det Y(\theta_j; \varphi(\theta_j)) = D_0 \neq 0,$$

$$\varphi_1(0)\varphi_1(1) \neq \varphi_2(0)\varphi_2(1) \quad \varphi_3(0)\varphi_3(1) \neq \varphi_4(0)\varphi_4(1). \quad (36)$$

Now solving system (35) with respect to $\psi_j(t)$, we obtain

$$\begin{aligned} \psi_j(t) = & \frac{1}{D_0} \sum_{k=1}^4 \left[\lambda_k \int_0^t \sum_{l=1}^4 \Upsilon_{kl} \left(\tau; \frac{\partial}{\partial y} \varphi_l(y + \lambda_k \tau) \psi_l(\tau) d\tau \right] A_{kj} \left(\theta_j; \varphi(\theta_j) \right) - \\ & - \frac{1}{D_0} \sum_{k=1}^4 \left[\lambda_k \int_0^t \sum_{l=1}^4 \Upsilon_{kj}(\theta_k; \omega_l(\theta_k, t - \tau)) \psi_l(\tau) d\tau \right] A_{kj} \left(\theta_j; \varphi(\theta_j) \right) + \\ & + \frac{1}{D_0} \sum_{k=1}^4 \left[\lambda_k \int_0^t \int_0^\tau \sum_{l=1}^4 \Upsilon_{kl} \left(y; \frac{\partial}{\partial y} \omega_l(y, \tau - \alpha) \right) \psi_l(\Phi) \right]_{y=\theta_j - \lambda_k(t-\tau)} d\alpha d\tau A_{kj} - \\ & - \frac{1}{D_0} \sum_{k=1}^4 \left[\lambda_k \int_0^t \sum_{l=1}^4 c_{kl} \frac{\partial}{\partial y} \omega_l(y + \lambda_k t, \tau) \psi_l d\tau \right] A_{kj} \left(\theta_j; \varphi(\theta_j) \right) + \\ & + \frac{1}{D_0} \sum_{k=1}^4 \left[\lambda_k \frac{\partial}{\partial y} \Phi_k(y) + \frac{\partial^2}{\partial t^2} h_k(t) - \frac{\partial}{\partial y} F_k(\theta_k, t) \right] A_{kj} \left(\theta_j; \varphi(\theta_j) \right) + \\ & + \frac{1}{D_0} \sum_{k=1}^4 \left[\sum_{l=1}^4 c_{kl} \frac{\partial}{\partial y} \omega_l(\theta_j, t) + \lambda_k \int_0^t \frac{\partial^2}{\partial t \partial y} F_k(y + \lambda_k t, \tau) d\tau \right] A_{kj} \left(\theta_j; \varphi(\theta_j) \right), \end{aligned} \quad (37)$$

where A_{kj} are algebraic complements of elements Υ_{ij} -matrices. Equations (37) include unknown functions $\frac{\partial}{\partial y} w_j$, $j = \overline{1,4}$. For them we find the integral equations from (34) by differentiating them with respect to the variable y . At the same time, we have

$$\begin{aligned} \frac{\partial}{\partial y} w_i(y, t) = & \frac{\partial}{\partial y} w_i(y_0^i, t_0^i) - \frac{\partial}{\partial y} t_0^i \left[\frac{\partial}{\partial t} F_i(y_0^i, t_0^i) - \sum_{j=1}^4 c_{ij} w_j(y_0^i, t_0^i) + \right. \\ & + \left. \sum_{j=1}^4 \Upsilon_{ij}(y_0^i; \varphi) \psi_j(t_0^i) \right] + \int_{t_0^i}^t \left[\frac{\partial}{\partial t \partial y} F_i(\mu, \tau) - \sum_{j=1}^4 c_{ij} \frac{\partial}{\partial y} w_j(\mu, \tau) + \right. \\ & + \left. \frac{\partial}{\partial y} t_0^i \int_0^{t_0^i} \sum_{j=1}^4 \Upsilon_{ij} \left(y_0^i; G_j(y_0^i, t_0^i - \tau) \right) \psi_j(\tau) d\tau + \right. \end{aligned} \quad (38)$$

$$+ \int_{t_0^i}^t \int_0^\tau \sum_{j=1}^4 \frac{\partial}{\partial y} \Upsilon_{ij}(\mu; w_j(\mu, \tau - \eta)) \psi_j(\eta) d\eta \bigg|_{\mu=y+\lambda_i(\tau-t)} d\tau, i = \overline{1,4}$$

where

$$G_j(y_0^i, t_0^i - \tau) = \begin{cases} \frac{d}{dt} h_j \left(\frac{1-y}{\lambda_i} - \tau \right), j = 2,4, \\ \frac{d}{dt} g_j \left(\frac{1-y}{\lambda_i} - \tau \right), j = 1,3. \end{cases}$$

We require compliance with the conditions of agreement

$$\left[\frac{d}{dt} h_i(t) \right]_{t=0} = F_i(0,0) - \lambda_i \frac{\partial}{\partial y} \varphi_i(y) \bigg|_{y=0} - \sum_{j=1}^4 c_{ij} \varphi_j(0), i = 2,4, \quad (39)$$

$$\left[\frac{d}{dt} h_i(t) \right]_{t=0} = F_i(1,0) - \lambda_i \frac{\partial}{\partial y} \varphi_i(y) \bigg|_{y=1} - \sum_{j=1}^4 c_{ij} \varphi_j(1), i = 1,3. \quad (40)$$

Main result and its proof

The main result of this work is the following assertion:

Theorem 2. Let the conditions of Theorem 1 be satisfied, besides $\varphi(y) \in C^2[0,1]$, $g(t) \in C^2[0,T]$, $h(t) \in C^2[0,T]$, and condition (36) and matching conditions (39), (40) are satisfied. Then on the interval $[0,1]$ there is a unique solution of the inverse problem (19)-(22), from the class $\Psi(t) \in C[0,1]$, and each component $\psi_i \in C[0,1]$ is defined by specifying $h_i(t)$ for $t \in [0,1]$, $i = \overline{1,4}$.

Proof. Consider now the square

$$\Pi_0 := \{(y, t): 0 \leq y \leq 1, 0 \leq t \leq 1\}.$$

Equations (34), (37) and (38), supplemented by the initial and boundary conditions from equality (19), form in Π_0 a closed system of equations with respect to the unknowns $w_i(y, t), \psi_i(t), \frac{\partial}{\partial y} w_i(y, t), i = \overline{1,4}$.

Equations (34), (37) and (38) show that the values of the functions $w_i(y, t), \psi_i(t), \frac{\partial}{\partial y} w_i(y, t), i = \overline{1,4}$ at $(y, t) \in \Pi_0$ are expressed in terms of integrals of some combinations of the same functions over segments lying in Π_0 .

We write equations (34), (37), and (38) as a closed system of Voltaire-type integral equations of the second kind. To do this, we introduce into consideration the vector function $v(y, t) = (v_i^1, v_i^2, v_i^3), i = \overline{1,4}$ defining their components by equalities

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$$v_i^1(y, t) = w_i(y, t), v_i^2(y, t) = \psi_i(t),$$

$$v_i^3(y, t) = \frac{\partial}{\partial y} w_i(y, t) + \frac{\partial}{\partial y} t_0^i \sum_{j=1}^4 \Upsilon_{ij} \left(y_0^i; \varphi(y_0^i) \right) \psi_j(t_0^i).$$

Then the system of equations (34), (37) and (38) takes the operator form

$$v = Lv \quad (41)$$

where operator $L = (L_i^1, L_i^2, L_i^3)$, $i = \overline{1, 4}$ in accordance with the right-hand sides of equations (34), (37) and (38) is defined by the equalities

$$\begin{aligned} L_i^1 v = v_i^{01}(y, t) + \int_{t_0^i}^t \left[\sum_{j=1}^4 \Upsilon_{ij}(\mu; \varphi(\mu)) v_j^2(\tau) - \sum_{j=1}^4 c_{ij} v_j^1(\mu, \tau) \right]_{\mu=y+\lambda_i(\tau-t)} d\tau + \\ + \int_{t_0^i}^t \int_0^\tau \sum_{j=1}^4 \Upsilon_{ij}(\mu; v_j^1(\mu, \tau - \eta)) v_j^2(\eta) d\eta \Big|_{\mu=y+\lambda_i(\tau-t)} d\tau, \quad i = \overline{1, 4}. \end{aligned} \quad (42)$$

$$\begin{aligned} L_i^2 v = v_i^{02}(y, t) + \frac{1}{Y_0} \int_0^t \sum_{k=1}^4 \sum_{l=1}^4 \lambda_k \Upsilon_{kl} \left(\tau; \frac{\partial}{\partial y} \varphi_l(y + \lambda_k \tau) \right) v_l^1(\tau) d\tau A_{ki}(\theta_i; \varphi(\theta_i)) \\ - \frac{1}{Y_0} \int_0^t \sum_{k=1}^4 \sum_{l=1}^4 \lambda_k \Upsilon_{kl} \left(\theta_k; \frac{d}{dt} h_l(\theta_k, t - \tau) \right) v_l^2(\tau) d\tau A_{ki}(\theta_i; \varphi(\theta_i)) + \\ + \frac{1}{Y_0} \int_0^t \int_0^\tau \sum_{k=1}^4 \sum_{l=1}^4 \lambda_k \Upsilon_{kl} \left(y; \frac{\partial}{\partial y} v_l^1(y, \tau - \alpha) \right) v_l^2(\tau) \Big|_{y=\theta_i-\lambda_k(t-\tau)} d\alpha d\tau A_{ki}(\theta_i; \varphi(\theta_i)) - \\ - \frac{1}{Y_0} \sum_{k=1}^4 \left[\int_0^t \sum_{l=1}^4 \lambda_k c_{kl} \frac{\partial}{\partial y} v_l^1(y + \lambda_k t, \tau) v_l^2(\tau) d\tau \right] A_{ki}(\theta_i; \varphi(\theta_i)), \quad i = \overline{1, 4}. \end{aligned} \quad (43)$$

$$\begin{aligned} L_i^3 v = v_i^{03}(y, t) \\ + \int_{t_0^i}^t \left[\sum_{j=1}^4 \frac{\partial}{\partial y} \Upsilon_{ij}(\mu; \varphi(\mu)) v_j^2(\tau) - \sum_{j=1}^4 c_{ij} \frac{\partial}{\partial y} v_j^1(\mu, \tau) \right] \Big|_{\mu=y+\lambda_i(\tau-t)} d\tau \end{aligned}$$

$$\begin{aligned}
& -\frac{\partial}{\partial y} t_0^i \int_0^{t_0^i} \sum_{j=1}^4 \Upsilon_{ij} \left(y_0^i; G(y_0^i, t_0^i - \tau) \right) v_j^2(\tau) d\tau + \\
& + \int_{t_0^i}^t \int_0^\tau \sum_{j=1}^4 \frac{\partial}{\partial y} \Upsilon_{ij}(\mu; w_j(\mu, \tau - \eta)) v_j^2(\eta) d\eta \Big|_{\mu=y+\lambda_i(\tau-t)} d\tau, \quad i = \overline{1,4}.
\end{aligned} \tag{44}$$

The following notations are introduced in these formulas:

$$\begin{aligned}
v_i^{01}(y, t) &= w_i(y_0^i, t_0^i) + \int_{t_0^i}^t \frac{\partial}{\partial t} F_i(\mu, \tau) \Big|_{\mu=y+\lambda_i(y-t)} d\tau, \\
v_i^{02}(y, t) &= \frac{1}{Y_0} \sum_{k=1}^4 \left[\lambda_k \frac{\partial}{\partial y} \Phi_k(y) + \frac{\partial^2}{\partial t^2} h_k(t) - \frac{\partial}{\partial y} F_k(\theta_k, t) \right] A_{ki}(\theta_i; \mathfrak{U}(\theta_i)) + \\
& + \frac{1}{Y_0} \sum_{k=1}^4 \left[\sum_{l=1}^4 c_k \frac{\partial}{\partial y} h_l(\theta_i, t) + \lambda_k \int_0^t \frac{\partial^2}{\partial t \partial y} F_k(y + \lambda_k t, \tau) d\tau \right] A_{ki}(\theta_i; \varphi(\theta_i)), \\
v_i^{03}(y, t) &= \frac{\partial}{\partial y} w_i(y_0^i, t_0^i) - \frac{\partial}{\partial y} t_0^i \left[\frac{\partial}{\partial t} F_i(y_0^i, t_0^i) - \sum_{j=1}^4 c_{ij} w_j(y_0^i, t_0^i) + \right. \\
& \left. + \sum_{j=1}^4 \Upsilon_{ij} \left(y_0^i; \mathfrak{U}(y_0^i) \right) \psi_j(t_0^i) \right] + \int_{t_0^i}^t \frac{\partial}{\partial t \partial y} F_i(\mu, \tau) \Big|_{\mu=y+\lambda_i(\tau-t)} d\tau.
\end{aligned}$$

On the set of continuous functions $C_\sigma(\Pi_0)$, we define the norm

$$\|v\|_\sigma = \max_{1 \leq i \leq 4, 1 \leq l \leq 3} \sup_{(y,t) \in \Pi_0} |v_i^l(y, t) e^{-\sigma t}|,$$

$\sigma \geq 0$ -some number to be chosen later.

Obviously, for $\sigma = 0$ this space coincides with the space of continuous functions with the usual norm $\|v\|_\sigma$. Because of the inequality

$$e^{-\sigma} \|v\| \leq \|v\|_\sigma \leq \|v\|,$$

norm $\|v\|_\sigma$ and $\|v\|$ equivalent.

Next, consider the set of functions $S(v^0, r) \subset C_\sigma(\Pi_0)$, satisfying the inequality

$$\|v - v^0\|_\sigma \leq r, \tag{45}$$

where is a vector function $v^0(y, t) = (v_i^{01}(y, t), v_i^{02}(t), v_i^{03}(y, t))$, $i = \overline{1, 4}$ is determined by the free terms of the operator equation (43). It is easy to see that $v \in S(v^0, r)$ satisfies the estimate $\|v\|_\sigma \leq \|v^0\|_\sigma + r \leq \|v^0\| + r =: r_0$. So r_0 is a known number.

Let us introduce the following notation:

$$\varphi_0 := \max_{1 \leq i \leq 4} \|\varphi_i\|_{C^2[0,1]}, g_0 := \max_{1 \leq i \leq 4} \|g_i\|_{C^2[0,1]}, F_0 := \max_{1 \leq i \leq 4} \|F_i\|_{C^2[\Pi_0]}, h_0 := \max_{1 \leq i \leq 4} \|h_i\|_{C^2[0,1]},$$

$$Y_0 \varphi_0 = \max_{1 \leq i, j \leq 4} \|Y_{ij}(y + \lambda_i(\tau - t); \varphi)\|_{C^1(\Pi_0)}, A_0 := \max_{1 \leq i, j \leq 4} \{|A_{ij}(\theta_i; \varphi(\theta_i))|\}.$$

The operator A takes the space $C_\sigma(\Pi_0)$ into itself. Let us show that, given an appropriate choice of σ , it is a contraction operator on the set $S(v^0, r)$. Let us first verify that the operator A maps the set $S(v^0, r)$ into itself, i.e. it follows from the condition $v(y, t) \in S(v^0, r)$ that $Av \in S(v^0, r)$, if σ satisfies some restrictions. Indeed, for any $(y, t) \in \Pi_0$ and any $v \in S(v^0, r)$ the inequalities hold:

$$\begin{aligned} |(L_i^1 v - v_i^{01})e^{-\sigma t}| &= \left| \int_{t_0}^t \sum_{j=1}^4 Y_{ij}(\mu; \varphi(\mu)) e^{-\sigma(t-\tau)} v_j^2(\tau) e^{-\sigma \tau} d\tau - \right. \\ &\quad \left. - \int_{t_0}^t \sum_{j=1}^4 c_{ij} e^{-\sigma(t-\tau)} v_j^1(\mu, \tau) e^{-\sigma \tau} d\tau + \right. \\ &\quad \left. + \int_{t_0}^t \int_0^\tau \sum_{j=1}^4 Y_{ij}(\mu; v_i^1(\mu, \tau - \eta)) e^{-\sigma(\tau-\eta)} v_j^2(\eta) e^{-\sigma \eta} d\eta d\tau \right|_{\mu=y+\lambda_i(\tau-t)} \leq \\ &\leq 4[(Y_0 \varphi_0 + c_0) \|v\|_y + Y_0 \|v\|_\sigma^2] \int_0^t e^{-\sigma(t-\tau)} d\tau \leq \\ &\leq \frac{4}{\sigma} ((Y_0 \varphi_0 + c_0) + Y_0 r_0) r_0 =: \frac{1}{\sigma} \alpha_{11}, \\ |(L_i^2 v - v_i^{02}(y, t))e^{-\sigma t}| &= \left| \frac{1}{D_0} \int_0^t \sum_{k=1}^4 \sum_{l=1}^4 \lambda_k Y_{kl} \left(y + \lambda_k \tau; \frac{\partial}{\partial y} \varphi_l(y + \lambda_k \tau) \right) e^{-\sigma(t-\tau)} \times \right. \\ &\quad \times v_l^2(\tau) e^{-\sigma \tau} d\tau A_{ki}(\theta_i; \varphi(\theta_i)) \\ &\quad \left. - \frac{1}{D_0} \int_0^t \sum_{k=1}^4 \sum_{l=1}^4 \lambda_k Y_{kl} \left(\theta_k; \frac{d}{dt} h_l(\theta_k, t - \tau) \right) e^{-\sigma(t-\tau)} \times \right. \end{aligned}$$

$$\begin{aligned}
& \times v_l^2(\tau) e^{-\sigma\tau} d\tau A_{ki}(\theta_i; \varphi(\theta_i)) \\
& + \frac{1}{D_0} \int_0^t \int_0^\tau \sum_{k=1}^4 \sum_{l=1}^4 \lambda_k \Upsilon_{kl} \left(y; \frac{\partial}{\partial y} v_l^1(y, \tau - \alpha) \right) e^{-\sigma(t-\tau)} \times \\
& \times v_l^2(\tau) e^{-\sigma\tau} \Big|_{y=\theta_i - \lambda_k(t-\tau)} d\alpha d\tau A_{ki} \left(\theta_i; \varphi(\theta_i) - \frac{1}{D_0} \int_0^t \sum_{k=1}^4 \sum_{l=1}^4 \lambda_k c_{kl} e^{-\sigma(t-\phi)} \times \right. \\
& \times \left[v_l^3(y + \lambda_k t, \tau) - \frac{\partial}{\partial y} t_0^i \sum_{p=1}^4 \Upsilon_{lp} \left(y_0^i; \varphi(y_0^i) \right) v_p^2(t_0^i) \right] e^{-\sigma\tau} d\tau A_{ki}(\theta_i; \varphi(\theta_i)) \Big| \leq \\
& \leq \frac{16A_0}{D_0} [\Upsilon_0(\varphi_0 + h_0 + \|v\|_\sigma) + c_0(1 + \Upsilon_0\varphi_0)] \|v\|_\sigma \int_0^t e^{-\sigma(t-\tau)} d\tau \leq \\
& \leq \frac{16A_0}{\sigma D_0} [\Upsilon_0(\varphi_0 + h_0 + r_0) + c_0(1 + \Upsilon_0\varphi_0)] r_0 := \frac{1}{\sigma} \alpha_{12}, \\
& |(L_i^3 v - v_i^{03}) e^{-\sigma t}| = \left| \int_{t_0^i}^t \sum_{j=1}^4 \frac{\partial}{\partial y} \Upsilon_{ij}(\mu; \varphi(\mu)) e^{-\sigma(t-\tau)} v_j^2(\tau) e^{-\sigma\tau} \Big|_{\mu=y+\lambda_i(\tau-t)} d\tau - \right. \\
& - \int_{t_0^i}^t \sum_{j=1}^4 c_{ij} e^{-\sigma(t-\tau)} \left(v_j^3 \right. \\
& \left. - \frac{\partial}{\partial y} t_0^i \int_0^{t_0^i} \sum_{p=1}^4 \Upsilon_{jp} \left(y_0^j; \varphi(y_0^j) \right) v_p^2(t_0^i) \right) e^{-\sigma\tau} \Big|_{\mu=y+\lambda_i(\tau-t)} \\
& \times d\tau - \frac{\partial}{\partial y} t_0^i \int_0^{t_0^i} \sum_{j=1}^4 \Upsilon_{ij} \left(y_0^i; G(y_0^i, t_0^i - \tau) \right) e^{-\sigma(t-\tau)} v_j^2(\tau) e^{-\sigma\tau} d\tau + \\
& + \int_{t_0^i}^t \int_0^\tau \sum_{j=1}^4 \frac{\partial}{\partial y} \Upsilon_{ij}(\mu; v_j^1(\mu, \tau - \eta)) e^{-\sigma(\tau-\eta)} v_j^2(\eta) e^{-\sigma\eta} d\eta \Big|_{\mu=y+\lambda_i(\tau-t)} d\tau \Big| \leq \\
& \leq 4[\Upsilon_0(\varphi_0 + h_0 + \|v\|_\sigma) + c_0(1 + \Upsilon_0\varphi_0)] \|v\|_\sigma \int_0^t e^{-\sigma(t-\tau)} d\tau \leq
\end{aligned}$$

$$\leq \frac{4}{\sigma} [\Upsilon_0(\varphi_0 + h_0 + r_0) + c_0(1 + \Upsilon_0\varphi_0)]r_0 = \frac{1}{\sigma} \alpha_{13}.$$

From here and from formulas (41) and (42)-(44) it follows that

$$\|Lv - v^0\|_\sigma = \max \left\{ \max_{1 \leq i \leq 4} \sup_{(y,t) \in \Pi_0} |(L_i^1 v - v_i^{01})e^{-\sigma t}|, \max_{1 \leq i \leq 4} \sup_{t \in [0,1]} |(L_i^2 v - v_i^{02})e^{-\sigma t}|, \right. \\ \left. \max_{1 \leq i \leq 4} \sup_{t \in [0,1]} |(L_i^3 v - v_i^{03})e^{-\sigma t}| \right\} \leq \frac{1}{\sigma} \alpha_0,$$

where $\alpha_0 := \max(\alpha_1, \alpha_2, \alpha_3)$. Choosing $\sigma > (1/r)\alpha_0$, we obtain that the operator L takes the set $S(v^0, \rho)$ into itself.

Let us now take any functions $v, \tilde{v} \in S(v^0, r)$ and estimate the norm of the difference $Uv - U\tilde{v}$. Using the obvious inequality

$$|v_i^k v_i^l - \tilde{v}_i^k \tilde{v}_i^l| e^{-\sigma t} \leq |v_i^k - \tilde{v}_i^k| |v_i^l| e^{-\sigma t} + |\tilde{v}_i^k| |v_i^l - \tilde{v}_i^l| e^{-\sigma t} \leq 2r_0 \|v - \tilde{v}\|_\sigma,$$

and estimates for the integrals similar to those given above, we obtain

$$\begin{aligned} |(L_i^1 v - L_i^1 \tilde{v})e^{-\sigma t}| &= \\ &= \left| \int_{t_0^i}^t \sum_{j=1}^4 \Upsilon_{ij}(\mu; \varphi(\mu)) e^{-\sigma(t-\tau)} (v_j^2(\tau) - \tilde{v}_j^2(\tau)) e^{-\sigma \tau} \right|_{\mu=y+\lambda_i(\tau-t)} d\tau - \\ &- \int_{t_0^i}^t \sum_{j=1}^4 c_{ij} e^{-\sigma(t-\tau)} (v_j^1(\mu, \tau) - \tilde{v}_j^1(\mu, \tau)) e^{-\sigma \tau} \Big|_{\mu=y+\lambda_i(\tau-t)} d\tau + \\ &+ \left| \int_{t_0^i}^t \int_0^\tau \sum_{j=1}^4 \Upsilon_{ij}(\mu; v_i^1(\mu, \tau - \eta)) e^{-\sigma(\tau-\eta)} (v_j^2(\eta) - \tilde{v}_j^2(\eta)) e^{-\sigma \eta} d\eta \right|_{\mu=y+\lambda_i(\tau-t)} d\tau \leq \\ &\leq 4[(\Upsilon_0\varphi_0 + c_0) \|v - \tilde{v}\|_\sigma + 2r_0\Upsilon_0 \|v - \tilde{v}\|_\sigma] \int_0^t e^{-\sigma(t-\tau)} d\tau \leq \\ &\leq \frac{4}{\sigma} ((\Upsilon_0\varphi_0 + c_0) + 2\Upsilon_0 r_0) \|v - \tilde{v}\|_\sigma = \frac{1}{\sigma} \alpha_{21} \|v - \tilde{v}\|_\sigma. \end{aligned}$$

Similarly, we obtain the following estimates

$$\begin{aligned} |(L_i^2 v - L_i^2 \tilde{v})e^{-\sigma t}| &\leq \frac{16A_0}{\sigma D_0} [\Upsilon_0(\varphi_0 + h_0 + 2r_0) + c_0(1 + \Upsilon_0\varphi_0)] \|v - \tilde{v}\|_\sigma: \\ &= \frac{1}{\sigma} \alpha_{22} \|v - \tilde{v}\|_\sigma, \end{aligned}$$

$$\begin{aligned}
|(L_i^3 v - L_i^3 \tilde{v})e^{-\sigma t}| &\leq \frac{4}{\sigma} [\Upsilon_0(\varphi_0 + h_0 + 2r_0) + c_0(1 + \Upsilon_0 \varphi_0)] \|v - \tilde{v}\|_{\sigma} = \\
&= \frac{1}{\sigma} \alpha_{2_3} \|v - \tilde{v}\|_{\sigma}.
\end{aligned}$$

Hence we have

$$\begin{aligned}
\|Lv - L\tilde{v}\|_{\sigma} &= \max \left\{ \max_{1 \leq i \leq 4} \sup_{(y,t) \in \Pi_0} |(L_i^1 v - L_i^1 \tilde{v})e^{-\sigma t}|, \max_{1 \leq i \leq 4} \sup_{t \in [0,1]} |(L_i^2 v - L_i^2 \tilde{v})e^{-yt}|, \right. \\
&\quad \left. \max_{1 \leq i \leq 4} \sup_{t \in [0,1]} |(L_i^3 v - L_i^3 \tilde{v})e^{-\sigma t}| \right\} \leq \frac{1}{\sigma} \beta_0 \|v - \tilde{v}\|_{\sigma},
\end{aligned}$$

Where $\beta_0 := \max(\beta_1, \beta_2, \beta_3)$. Choosing now $\sigma > \beta_0$, we get that the operator L shrinks the distance between elements v, \tilde{v} by $S(v^0, \rho)$.

As follows from the above estimates, if the number σ is chosen from the condition $\sigma > \sigma^* := \max\{\alpha_0, \beta_0\}$, then the operator L is contractive on $S(v^0, \rho)$. In this case, according to the Banach principle [40, pp. 87-97], equation (41) has a unique solution in $S(v^0, \rho)$. Theorem 2 is proved.

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TWO-DIMENSIONAL INVERSE PROBLEM OF DETERMINING THE KERNEL OF THE INTEGRO-DIFFERENTIAL HEAT EQUATION

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Abstract:

Introduction. The two-dimensional integro-differential equation of temperature transmission with the time-convolution integral on the correct lateral is deliberated. The straight problematic is the initial-boundary problematic for this integro-differential equivalence. Inverse problem is premeditated for this uninterrupted problematic containing in defining of a kernel of the fundamental member on given supplementary circumstance with reverence to the clarification of the straight issues, correspondingly.

Research methods. The object was applied approaches of well-designed examination, mathematical physical science and clarification of degree of difference calculations, second type of nonlinear locked essential calculations of the Volterra kind, standard of sequence estimate, narrowing charting.

Results. Before we continue to considering the converse issue, examined that the coordinate issue had a special arrangement. We diminished the issue (1)-(3) by an proportionate necessarily condition and the special solvability of this indispensably condition was demonstrated with the utilize of the strategy of progressive approximation. At that point an assistant issue, which is identical to the initial issue is presented and prove its proportionality to the first issue. The assistant issue is diminished to an identical closed framework of Volterra-type necessarily conditions with regard to obscure functions. Applying the strategy of withdrawal mappings to this system within the continuous class of capacities, we demonstrate the most result of the article, which may be a worldwide presence and uniqueness hypothesis of reverse issue solutions.

Discussions. The assurance of the indispensably administrator from the perceptible data around the arrangements of the comparing conditions could be an unused course of reverse issues that has not however been adequately examined. In see of a wide extend of applications, the hypothesis of in problems for integro-differential conditions are one of the foremost critical and quickly creating areas of world science. It ought to moreover be famous that the articulation of the issue and the confirmation procedure utilized in this paper differ from those of the other investigates, and the conditions within the problems are altogether diverse from those in them. A particular include of this article is the inverse problem of deciding kernel in an integro-differential heat condition within the two dimensional space are investigated.

Conclusion. In the work, the classical solvability of reverse issue for a second-order figurative condition with initial-boundary conditions was examined. The

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considered issue was decreased to an assistant reverse issue in a certain sense and its comparability to the first issue is appeared. At that point utilizing the Fourier method and principle Banach, the existence and uniqueness hypothesis for assistant issue is demonstrated.

Keywords: integro-differential equation, initial-boundary problem, inverse problem, Green function.

Introduction. Scientific material science ordinarily considers redress issues, that's, the issues that have arrangements which are presence, uniqueness and soundness within the information in appropriate utilitarian spaces. Such issues are called coordinate issues. In this case, it is accepted that a differential condition is given starting or initial-boundary conditions. But, in applications there are curiously issues, where the integro-differential, differential condition is as it were in part indicated, to be specific, a few capacities that are part of the differential condition (a few within the right-hand side, integrant in integro-differential conditions, the introductory or initial-boundary conditions) stay obscure. The issues are to be decided on extra conditions almost the arrangements of coordinate issues for differential conditions, are called reverse issues.

Reverse issues are broadly utilized to unravel connected issues in various areas of science and building. The consider of reverse bit assurance issues for hyperbolic, illustrative, psevdaparabolic and elliptic integro-differential conditions with an fundamentally term of convolution sort is curiously from both the viable and hypothetical perspective. Such conditions within the case of a illustrative condition emerge in issues of heat conduction medium whose state at a given time moment depends on their state at all past time moments.

Part assurance issues in integro-differential condition have a place to the field of converse issues of numerical material science. Illustrative integro-differential conditions with an necessarily of convolution sort demonstrate primarily direct dissemination forms with heat memory. In these conditions the part of an indispensably term can depend on time- and time-spatial factors. For numerous cases, within the hone these parts are obscure capacities and it is required to discover them on a estimation of physical areas in open places available places. The converse issues of the assurance of part in one- and multidimensional integro-differential heat condition in different settings particular, were considered in taking after works.

Inverse issues in this course can be found in papers [1]-[17](see moreover references in them) and the issues examined in them are near to the issue considered in this article. Within the over papers, the presence and uniqueness hypotheses were demonstrated for the arrangement of the issue of finding the coefficient or part for different overdetermination conditions. The works [1]-[5] are committed to inverse

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problems of deciding the correct side or one of the coefficients of a extended condition with extra data of different types.

In [11], it is considered converse issue of reconstructing time autonomous coefficient of an integro-differential condition from the ultimate time over indicated information. The recreation of the parameter is changed to a minimization issue through ideal control outline work. The stability assess for the coefficient with the upper bound in terms of the ultimate estimation determined through the minimization of the accepteda toll functional.

In [12] and [13], it is considered converse issue of deciding the part of the indispensably term in a illustrative condition of moment arrange. Coordinate issue is the Cauchy issue approximately deciding the tempereture of medium given a known beginning heat distrimution. As extra data, the arrangement of the coordinate issue is given on the hyperplane $x_n = 0$. Demonstrated a nearby presence and uniqueness hypothesis for the converse problem.

In [14], the converse issue of recognizable proof of memory parts in one-dimensional heat stream are managed with where the part is spoken to by a limited entirety of items of known spatially-dependent capacities and obscure time-dependent capacities. As extra conditions for the reverse issues perceptions of both heat flux and temperature are endorsed. Utilizing the Laplace change strategy, demonstrated an presence and uniqueness hypothesis for the memory kernel.

In [15] and [17], It is examined the converse issue of deciding the multidimensional part of the indispensably term in a illustrative condition of moment arrange. As extra data, the arrangement of the coordinate issue is given on the hyperplane $x_n = 0$. It was demonstrated a nearby presence and uniqueness hypothesis for the converse problem.

In the [16] article is studed the issue of deciding the bit of the necessarily term within the one-dimensional integro-differential condition of heat conduction from the known arrangement of the Cauchy issue for this condition. To begin with, the initial issue is supplanted by the identical issue where an extra condition contains the obscure bit without necessarily. At that point consider the address of the uniqueness of the deciding of the part. Next, assuming that there are two solutions $k_1(x; t)$ and $k_2(x; t)$; integro-differential equations, Cauchy and additional conditions for the difference of solutions of the Cauchy problem corresponding to the functions $k_1(x; t)$; $k_2(x; t)$ are obtained. Further research was being conducted for the difference $k_1(x; t) - k_2(x; t)$ of solutions of the problem and using the techniques of integral equations estimates it is shown that if the unknown kernel $k(x; t)$ can be represented as $k_j(x; t) = \sum_{i=0}^N a_i(x)b_i(t)$, $j = 1; 2$; then $k_1(x; t) \equiv k_2(x; t)$: Thus, the theorem on the uniqueness of the solution of the problem is proved.

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The reverse issues of deciding the energy–temperature connection $\alpha(t)$ and the heat conduction connection $k(t)$ capacities within the one-dimensional integro-differential heat condition were explored in [19]. The coordinate issue is the initial-boundary issue for this condition. The indispensably terms have the time convolution frame of obscure parts and coordinate issue arrangement. As extra data for tackling reverse issues, the arrangement of the coordinate issue for $x = x_0$ is given. At the starting, an assistant issue, which was identical to the first issue, was included. At that point the assistant issue was decreased to an proportionate closed framework of Volterra-type necessarily conditions with regard to obscure capacities. Applying the strategy of contraction mappings to this framework within the nonstop course of capacities with weighted norms, it was demonstrated the most result of the article, which could be a worldwide presence and uniqueness hypothesis of converse issue arrangements.

This paper explored the inverse issue of deciding a time-dependent part in two dimensional heat condition with initial-boundary and necessarily overdetermination conditions.

Consider the problem of determining the unknown functions $u(x, y, t)$ and $k(t)$ in the space $D_T = \{(x, y, t) | x \in (0, p), y \in (0, q), t \in (0, T), 0 < T < +\infty\}$ such that the pair u, k satisfies the following integro-differential equation for parabolic type of second order

$$u_t - a^2 \Delta u = \int_0^t k(\tau) u(x, y, t - \tau) d\tau, (x, y, t) \in D_T, \quad (1)$$

with the initial condition

$$u|_{t=0} = \varphi(x, y), x \in [0, p], y \in [0, q] \quad (2)$$

the boundary conditions

$$u|_{x=0} = 0, u|_{x=p} = 0, u|_{y=0} = 0, u|_{y=q} = 0, \quad (3)$$

and additional condition

$$\int_0^p \int_0^q u(x, y, t) dy dx = f(t), \quad (4)$$

in which a is a positive constant, p, q and T are arbitrary positive numbers and $\varphi(x, y), f(t)$ are given functions.

Definition. A function $u(x, y, t)$ is said to be a classical solution of problem (1)-(3) if all four of the following conditions are satisfied:

1. The function $u(x, y, t)$ with the derivatives $u_{xx}(x, y, t)$, $u_{yy}(x, y, t)$ and $u_t(x, y, t)$ are continuous in the domain D_T .
2. The function $k(t)$ is continuous on the interval $[0, T]$.

3. The equation (1) and conditions (2)-(3) are satisfied in the classical sense.

4. The matching conditions $\varphi(0, y) = \varphi(x, 0) = \varphi(p, y) = \varphi(x, q) = 0$ are met.

This article is based on ideas close to those used in [see [12]] and summarizes previous our results.

Methods: In this chapter, we provide observations into the methods used in the article.

Successive Approximations Method.

The method of successive approximations, It will be implemented here to solve Volterra integral equations . In this method, we replace the unknown function $u(x)$ under the integral sign of the Volterra equation

$$u(x) = f(x) + \lambda \int_0^x K(x, t)u(t)dt, \quad (a)$$

by any selective real valued continuous function $u_0(x)$, called the zeroth approximation. This substitution will give the first approximation $u_1(x)$ by

$$u_1(x) = f(x) + \lambda \int_0^x K(x, t)u_0(t)dt. \quad (b)$$

It is obvious that $u_1(x)$ is continuous whenever $f(x), K(x, t)$ and $u_0(x)$ are continuous. The second approximation $u_2(x)$ of $u(x)$ can be obtained similarly by replacing $u_0(x)$ in (b) by $u_1(x)$ obtained above, hence we find

$$u_2(x) = f(x) + \lambda \int_0^x K(x, t)u_1(t)dt, \quad (c)$$

This process can be continued in the same manner to obtain the n th approximation. In other words, the various approximations of the solution $u(x)$ of (a) can be obtained in a recursive scheme given by

$$\begin{cases} u_0(x) = \text{any selective real valued function} \\ u_n(x) = f(x) + \lambda \int_0^x K(x, t)u_{n-1}(t)dt, n \geq 1, \end{cases} \quad (d)$$

The most commonly selected functions for $u_0(x)$ are 0, 1 or x . At the limit, the solution $u(x)$ of the equation (a) is obtained by

$$u(x) = \lim_{n \rightarrow \infty} u_n(x), \quad (e)$$

where the zeroth component $u_0(x)$ is defined and given by all terms that are out of the integral sign. However, in the successive approximations method, we apply the above recursive scheme (d) to determine various approximations of the solution $u(x)$ it self, and not components of $u(x)$, noting that the zeroth approximation is not defined but rather given by a selective real valued function, and as a result the solution $u(x)$ is given by the formula (e).

Definition. Let A be an operator defined on a closed set B which is a subset of a Banach space. A is called a contraction mapping operator in B if it satisfies the following two properties:

1. If $g(x, t) \in B(g_0, \rho)$, then $Ag \in B(g_0, \rho)$;
2. If g^1, g^2 are arbitrary two elements of $B(g_0, \rho)$, then the inequality $\|Ag^1 - Ag^2\|_\sigma \leq \mu \|g^1 - g^2\|_\sigma$ is valid with $\mu \in (0, 1)$.

Lemma. (contraction mapping principle [20, pp. 87-97]). If A is a contraction mapping operator from B to B , then the equation

$$g = Ag$$

has a unique solution $g_0 \in B$.

Lemma (Gronuolla-Bellman). Let $u(x)$ and $v(x)$ nonnegative piecewise continuous functions on $[x_0, x]$ for which the inequality

$$u(x) = D + \left| \int_{x_0}^x u(t)v(t)dt \right|,$$

holds, where D and x_0 are nonnegative constants. Then,

$$u(x) \leq De^{\left| \int_{x_0}^x v(t)dt \right|}.$$

Results. Investigation of direct problem

Before we proceed to studying the inverse problem, let us show that the direct problem has a unique solution.

Lemma 1. If $\varphi(x, y) \in C([0, p] \times [0, q])$, $k(t) \in C([0, T])$, then there is the unique classical solution $u(x, y, t)$ to the problem (1)-(3) of the class $C^{2,1}(D_T)$ ($C^{2,1}(D_T)$ is the class of twice continuously differentiable with respect to x, y and once continuously differentiable with respect to t in the domain D_T functions). In what follows we also use the usual class $C(D_T)$ of continuous in D_T functions.

Proof. A solution to the problem (1)-(3) satisfies the integral equation [see [19], [pp. 180-219]]:

$$u(x, t) = \int_0^p \int_0^q G(x, y, \xi, \eta, t - \tau) \varphi(\xi, \eta) d\eta d\xi + \\ + \int_0^t \int_0^p \int_0^q G(x, y, \xi, \eta, t - \tau) \int_0^\tau k(\tau) u(\xi, \eta, \alpha) d\alpha d\eta d\xi d\tau, \quad (5)$$

where

$$G(x, y, \xi, \eta, t - \tau) = \frac{4}{pq} \sum_{n,m=1}^{\infty} e^{-(a\pi)^2 \left(\frac{n^2}{p^2} + \frac{m^2}{q^2} \right) (t-\tau)} \sin\left(\frac{\pi n}{p} \xi\right) \sin\left(\frac{\pi m}{q} \eta\right) \sin\left(\frac{\pi n}{p} x\right) \sin\left(\frac{\pi m}{q} y\right)$$

is the Green function of the initial-boundary problem for two-dimensional parabolic equation.

Let us denote the first summand on the right-hand side of (5) by $F(x, y, t)$, for this equation, we consider in the domain D_T the sequence of functions

$$u_n(x, y, t) = F(x, y, t) + \int_0^t \int_0^p \int_0^q G(x, y, \xi, \eta, t - \tau) \int_0^\tau k(\tau) u_{n-1}(\xi, \eta, \alpha) d\alpha d\eta d\xi d\tau, \quad n = 1, 2, \dots, \quad (6)$$

where $u_0(x, y, t) = 0$ for $(x, y, t) \in D_T$. If the conditions of Lemma 1 are fulfilled, we have that $F(x, y, t) \in C^{2,1}(D_T)$. Then, it follows from (6) that all $u_n(x, y, t)$ in D_T possess the same property.

Denote $Z_n(x, y, t) = u_n(x, y, t) - u_{n-1}(x, y, t)$ and $F_0 = \|F\|_{C(D_T)}$. According to the formula (6), we estimate $Z_n(x, y, t)$ in the domain D_T :

$$\begin{aligned} |Z_1(x, y, t)| &\leq F_0, \\ |Z_2(x, y, t)| &\leq \int_0^t d\tau \int_0^p \int_0^q G(x, y, \xi, \eta, t - \tau) \int_0^\tau |k(\alpha)| |Z_1(\xi, \eta, \alpha)| d\alpha d\eta d\xi \leq \\ &\leq F_0 k_0 \frac{t^2}{2!}, \quad k = \max_{t \in [0, T]} |k(t)|, \\ |Z_3(x, y, t)| &\leq \int_0^t d\tau \int_0^p \int_0^q G(x, y, \xi, \eta, t - \tau) \int_0^\tau |k(\alpha)| |Z_2(\xi, \eta, \alpha)| d\alpha d\eta d\xi \leq \\ &\leq F_0 k_0^2 \frac{t^4}{4!}. \end{aligned}$$

Thus, for arbitrary $n = j$, we have

$$|Z_j(x, y, t)| \leq F_0 k_0^{j-1} \frac{t^{2(j-1)}}{2(j-1)!}.$$

It follows from the above estimates that the series

$$\sum_{n=1}^{\infty} [u_n(x, y, t) - u_{n-1}(x, y, t)]$$

converges in D_T , and its sum $u(x, y, t)$ belongs to the functional space $C^{2,1}(D_T)$. Since the sequence $u_n(x, y, t)$, determined by equality (6) converges to $u(x, y, t)$ uniformly in D_T , then $u(x, y, t)$ is a solution of equation (5).

Now show that this solution is the only one. Suppose that there are two solutions $u^1(x, y, t)$ and $u^2(x, y, t)$. Then their difference $Z(x, y, t) = u^2(x, y, t) - u^1(x, y, t)$ is a solution to the equation

$$Z(x, y, t) = \int_0^t \int_0^p \int_0^q G(x, y, \xi, \eta, t - \tau) \int_0^\tau k(\alpha) Z(\xi, \eta, \alpha) d\alpha d\eta d\xi d\tau.$$

Let $\tilde{Z}(t)$ denote the supremum of the module of the function $Z(x, y, t)$ for $(x, y) \in (0, q) \times (0, q)$ at each fixed $t \in (0, T)$. Then we have the inequality

$$\tilde{Z}(t) \leq kT \int_0^t \tilde{Z}(\tau) d\tau, \quad t \in [0, T].$$

Applying the Gronwall lemma here, we obtain that $\tilde{Z}(t) = 0$ for $t \in [0, T]$, which means that $Z(x, y, t) = 0$ in D_T , i.e. $u^1(x, y, t) = u^2(x, y, t)$ in D_T . Therefore, equation (0.5) has a unique solution in D_T . The lemma is proved.

Inverse problem transformation

Lemma 2. *Problem (1)-(4) are equivalent to the auxiliary problem of determining the functions $\omega(x, y, t)$, $k(t)$ from the following equations:*

$$\omega_t - a^2 \Delta \omega = k(t) \varphi(x, y) + \int_0^t k(\tau) \omega(x, y, t - \tau) d\tau, \quad (7)$$

$$\omega|_{t=0} = a^2 \Delta \varphi(x, y), \quad (8)$$

$$\omega|_{x=0} = 0, \omega|_{x=p} = 0, \omega|_{y=0} = 0, \omega|_{y=q} = 0, \quad (9)$$

$$\int_0^p \int_0^q \omega(x, y, t) dy dx = f'(t). \quad (10)$$

Proof. We find $u(x, y, t)$ from the designation $u_t(x, y, t) = \omega(x, y, t)$

$$u(x, y, t) = \int_0^t \omega(x, y, \tau) d\tau + \mu(x, y).$$

Find the unknown function $\mu(x, y)$ so that equalities (1)-(3) hold. Then from condition (2), we obtain that $\mu(x, y) = \varphi(x, y)$.

Differentiate the equalities equation (1) with respect to t , and using the condition (2), we obtain:

$$\omega_t - a^2 \Delta \omega = k(t) \varphi(x, y) + \int_0^t k(\tau) \omega(x, y, t - \tau) d\tau.$$

The initial condition for ω is obtained by setting $t = 0$ in equality (1) and using equality (2):

$$\omega|_{t=0} = a^2 \Delta \varphi(x, y).$$

To get the boundary conditions for ω differentiate the equality (3) with respect to t :

$$\omega|_{x=0} = 0, \omega|_{x=p} = 0, \omega|_{y=0} = 0, \omega|_{y=q} = 0.$$

The additional condition for ω is the following relation:

$$\int_0^p \int_0^q \omega(x, y, t) dy dx = f'(t), t > 0.$$

The **lemma** is proved.

Discussions. Formulation of main result and its proof.

In this section existence and uniqueness for the problem (7)-(10) is proved using the contraction mapping principle. The idea is to write the integral equations for unknown functions $\omega(x, t)$, $k(t)$ as a system with a nonlinear operator, and prove that this operator is a contraction mapping operator. The existence and uniqueness then follow immediately. From problem (7)-(10), we obtain

$$\begin{aligned} \omega(x, y, t) = & \omega_0(x, y, t) + \int_0^t \int_0^p \int_0^q G(x, y, \xi, \eta, t - \tau) k(\tau) \varphi(\xi, \eta) d\eta d\xi d\tau + \\ & + \int_0^t \int_0^p \int_0^q G(x, y, \xi, \eta, t - \tau) \int_0^\tau k(\alpha) \omega(\xi, \eta, \tau - \alpha) d\alpha d\eta d\xi d\tau, \end{aligned} \quad (11)$$

where

$$\omega_0(x, y, t) = \int_0^t \int_0^p \int_0^q G(x, y, \xi, \eta, t - \tau) a^2 \Delta \varphi(\xi, \eta) d\eta d\xi d\tau.$$

Now we write two properties of Green function [see [19]. pp. 200-221] which will be needed in the future.

Remark 1. The integral of the Green function does not exceed 1:

$$\int_0^p \int_0^q G(x, y, \xi, \eta, t) d\eta d\xi \leq 1, x \in (0, p), y \in (0, q), t \in (0, T].$$

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Remark 2. The function $G(x, y, \xi, \eta, t)$ is infinitely continuously differentiable with respect to x, y, ξ, η, t and $G_t(x, y, \xi, \eta, t)$ is bounded for $x, \xi \in (0, p)$, $y, \eta \in (0, q)$, $t \in (0, T]$ i.e.

$$|G_t(x, y, \xi, \eta, t - \tau)| \leq \frac{4}{pq}.$$

Using the additional condition, from (5) we have

$$\begin{aligned} f'(t) = & \int_0^p \int_0^q \omega_0(x, y, t) dy dx + \\ & + \int_0^p \int_0^q \int_0^t \int_0^p \int_0^q G(x, y, \xi, \eta, t - \tau) k(\tau) \varphi(\xi, \eta) d\eta d\xi d\tau dy dx + \\ & + \int_0^p \int_0^q \int_0^t \int_0^p \int_0^q G(x, y, \xi, \eta, t - \tau) \int_0^\tau k(\alpha) \omega(\xi, \eta, \tau - \alpha) d\alpha d\eta d\xi d\tau dy dx, \end{aligned}$$

Differentiating this equality with respect to t , we arrive at equation:

$$\begin{aligned} f''(t) = & \int_0^p \int_0^q \omega_{0t}(x, y, t) dy dx + \\ & + \int_0^p \int_0^q \int_0^p \int_0^q G(x, y, \xi, \eta, 0) k(t) \varphi(\xi, \eta) d\eta d\xi dy dx + \\ & + \int_0^p \int_0^q \int_0^t \int_0^p \int_0^q G_t(x, y, \xi, \eta, t - \tau) k(\tau) \varphi(\xi, \eta) d\eta d\xi d\tau dy dx + \\ & + \int_0^p \int_0^q \int_0^p \int_0^q G(x, y, \xi, \eta, 0) \int_0^t k(\alpha) \omega(\xi, \eta, t - \alpha) d\alpha d\eta d\xi dy dx + \\ & + \int_0^p \int_0^q \int_0^t \int_0^p \int_0^q G_t(x, y, \xi, \eta, t - \tau) \int_0^\tau k(\alpha) \omega(\xi, \eta, \tau - \alpha) d\alpha d\eta d\xi d\tau dy dx, \end{aligned}$$

Since $G(x, y, \xi, \eta, 0) = \delta(x - \xi, y - \eta)$, where $\delta(\cdot)$ is the Dirac's delta function, and taking into account the following relations:

$$\int_0^p \int_0^q g(\xi, \eta) \delta(x - \xi, y - \eta) d\eta d\xi = g(x, y),$$

$$\int_0^p \int_0^q G(x, y, \xi, \eta, 0) \int_0^t k(\alpha) \omega(\xi, \eta, t - \alpha) d\alpha d\eta d\xi = \int_0^t k(\alpha) \omega(x, y, t - \alpha) d\alpha$$

we rewrite the last equation in the form

$$\begin{aligned}
 f''(t) = & \int_0^p \int_0^q \omega_{0t}(x, y, t) dy dx + k(t) \int_0^p \int_0^q \varphi(\xi, \eta) dy dx + \\
 & + \int_0^p \int_0^q \int_0^t \int_0^p \int_0^q G_t(x, y, \xi, \eta, t - \tau) k(\tau) \varphi(\xi, \eta) d\eta d\xi d\tau dy dx + \\
 & + \int_0^p \int_0^q \int_0^t k(\alpha) \omega(x, y, t - \alpha) d\alpha dy dx + \\
 & + \int_0^p \int_0^q \int_0^t \int_0^p \int_0^q G_t(x, y, \xi, \eta, t - \tau) \int_0^\tau k(\alpha) \omega(\xi, \eta, \tau - \alpha) d\alpha d\eta d\xi d\tau dy dx, \quad (12)
 \end{aligned}$$

In what follows we denote

$$\varphi_0 = \int_0^p \int_0^q \varphi(\xi, \eta) dy dx.$$

Next we write the equality (12) as the integral equation of the second order with respect to unknown function $k(t)$

$$\begin{aligned}
 k(t) = & \frac{1}{\varphi_0} [f''(t) - \int_0^p \int_0^q \omega_{0t}(x, y, t) dy dx - \\
 & + \int_0^p \int_0^q \int_0^t \int_0^p \int_0^q G_t(x, y, \xi, \eta, t - \tau) k(\tau) \varphi(\xi, \eta) d\eta d\xi d\tau dy dx - \\
 & - \int_0^p \int_0^q \int_0^t k(\alpha) \omega(x, y, t - \alpha) d\alpha dy dx - \\
 & - \int_0^p \int_0^q \int_0^t \int_0^p \int_0^q G_t(x, y, \xi, \eta, t - \tau) \int_0^\tau k(\alpha) \omega(\xi, \eta, \tau - \alpha) d\alpha d\eta d\xi d\tau dy dx]. \quad (13)
 \end{aligned}$$

We represent the system of equations (11), (13) in the form

$$Ag = g, \quad (14)$$

where $g = (g_1, g_2) = (\omega(x, y, t), k(t))$ is the vector-function and $A = (A_1, A_2)$ is defined by the right sides of equations (11) and (13):

$$\begin{aligned}
 A_1 g = & g_{01}(x, t) + \int_0^t \int_0^p \int_0^q G(x, y, \xi, \eta, t - \tau) g_2(\tau) \varphi(\xi, \eta) d\eta d\xi d\tau + \\
 & + \int_0^t \int_0^p \int_0^q G(x, y, \xi, \eta, t - \tau) \int_0^\tau g_2(\alpha) g_1(\xi, \eta, \tau - \alpha) d\alpha d\eta d\xi d\tau, \quad (15) \\
 A_2 g = & g_{02}(t) -
 \end{aligned}$$

$$\begin{aligned}
& -\frac{1}{\varphi_0} \left[\int_0^p \int_0^q \int_0^t \int_0^p \int_0^q G_t(x, y, \xi, \eta, t - \tau) g_2(\tau) \varphi(\xi, \eta) d\eta d\xi d\tau dy dx - \right. \\
& \quad - \int_0^p \int_0^q \int_0^t g_2(\alpha) g_1(x, y, t - \alpha) d\alpha dy dx - \\
& \quad - \int_0^p \int_0^q \int_0^t \int_0^p \int_0^q G_t(x, y, \xi, \eta, t - \tau) \times \\
& \quad \times \int_0^\tau g_2(\alpha) g_1(\xi, \eta, \tau - \alpha) d\alpha d\eta d\xi d\tau dy dx.
\end{aligned} \tag{16}$$

The following notations were introduced in the equalities (15) and (16):

$$\begin{aligned}
g_0(x, t) &= (g_{01}(x, t), g_{02}(t)) = \\
&= \left(\omega_0(x, y, t), \frac{1}{\varphi_0} \left[f''(t) - \int_0^p \int_0^q \omega_{0t}(x, y, t) dy dx \right] \right).
\end{aligned}$$

Theorem 1. Assume the conditions $f(t) \in C^2[0, T]$, $\varphi(x, y) \in C^2([0, p] \times [0, q])$, $\Delta\varphi(0, 0) = 0$, $\varphi_0 \neq 0$, $\varphi(0, y) = \varphi(x, 0) = \varphi(p, y) = \varphi(x, q) = 0$, $\int_0^p \int_0^q \varphi(x, y) dy dx = f(0)$, $a^2 \int_0^p \int_0^q \Delta\varphi(x, y) dy dx = f'(0)$, $\Delta\varphi(0, y) = \Delta\varphi(x, 0) = \Delta\varphi(p, y) = \Delta\varphi(x, q) = 0$ are hold. Then there exists sufficiently small number $T^* \in (0, T)$ that the solution to the integral equations (11), (13) in the class of functions $\omega(x, y, t) \in C^{2,1}(D_{T^*})$, $k(t) \in C[0; T^*]$ exist and unique.

Proof. We define for the unknown vector-function $g(x, t) \in C(D_T)$ the following weight norm:

$$\begin{aligned}
\|g\|_\sigma &= \max \left\{ \sup_{(x, y, t) \in \overline{D}_T} |g_1(x, y, t) e^{-\sigma t}|, \sup_{t \in [0, T]} |g_2(t) e^{-\sigma t}| \right\} = \\
&= \max \{ \|g_1\|_\sigma, \|g_2\|_\sigma \}, \quad \sigma \geq 0.
\end{aligned}$$

At $\sigma = 0$ this norm coincides with the usual norm

$$\|g\| = \max \left\{ \sup_{(x, y, t) \in \overline{D}_T} |g_1(x, y, t)|, \sup_{t \in [0, T]} |g_2(t)| \right\}.$$

The number $\sigma \geq 0$ will be chosen later. Denote by $B(g_0, \rho)$ the ball of vector-functions g with center at the point g_0 and radius $\rho > 0$, i.e. $B(g_0, \rho) = \{g: \|g - g_0\|_\sigma \leq \rho\}$. The number $\rho > 0$ will be also chosen later.

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Obviously, $\|g\| \leq \rho + \|g_0\|$ for $g(x, t) \in B(g_0, \rho)$. We prove that the operator A is contracting in the Banach space $B(g_0, \rho)$ if the numbers σ and ρ will be chosen in suitable way. Remind that operator A is contractive if the following two conditions are met:

1. If $g(x, t) \in B(g_0, \rho)$, then $Ag \in B(g_0, \rho)$;
2. If g^1, g^2 are arbitrary two elements of $B(g_0, \rho)$, then the inequality $\|Ag^1 - Ag^2\|_y \leq \mu \|g^1 - g^2\|_\sigma$ is valid with $\mu \in (0, 1)$.

Note that the weight norm $\|\cdot\|_\sigma$ is equivalent to the usual norm $\|\cdot\|$:

$$\|\cdot\|_\sigma \leq \|\cdot\| \leq e^{\sigma T} \|\cdot\|_\sigma, \quad \sigma > 0. \quad (17)$$

The convolution operator is commutative and invariant with respect to multiplication by $e^{-\sigma t}$:

$$\begin{aligned} (h_1 * h_2)(t) &= \int_0^t h_1(t-s)h_2(s)ds = \\ &= \int_0^t h_1(s)h_2(t-s)ds = (h_2 * h_1)(t), \end{aligned} \quad (18)$$

$$e^{-\sigma t}(h_1 * h_2)(t) = (e^{-\sigma t}h_1(t)) * (e^{-\sigma t}h_2(t)). \quad (19)$$

The last formula implies the estimation

$$\|h_1 * h_2\|_\sigma \leq \|h_1\|_\sigma \|h_2\|_\sigma T. \quad (20)$$

Moreover, since

$$\int_0^t e^{-\sigma s} ds = \int_0^t e^{-\sigma(t-s)} ds \leq \frac{1}{\sigma}, \quad \sigma > 0 \quad (21)$$

we have

$$\|h_1 * h_2\|_\sigma \leq \frac{1}{\sigma} \|h_1\| \|h_2\|_\sigma \leq \frac{1}{\sigma} \|h_1\| \|h_2\|, \quad \sigma > 0 \quad (22)$$

using (17) and the results of [9].

First, we check the first condition of contractive mapping. For simplicity, we denote $\varphi_1 = \max_{(x,y) \in ([0,p] \times [0,q])} |\varphi(x, y)|$. Let $g(x, t)$ be an element of $B(g_0, \rho)$, i.e. $g \in B(g_0, \rho)$. Then for $(x, y, t) \in D_T$ we have

$$\|A_1 g - g_{01}\|_\sigma = \sup_{(x,y,t) \in D_T} |(A_1 g - g_{01})e^{-\sigma t}| =$$

$$\begin{aligned}
&= \sup_{(x,y,t) \in D_T} e^{-\sigma t} \left| \int_0^t \int_0^p \int_0^q G(x,y,\xi,\eta,t-\tau) g_2(\tau) \varphi(\xi,\eta) d\eta d\xi d\tau + \right. \\
&\quad \left. + \int_0^t \int_0^p \int_0^q G(x,y,\xi,\eta,t-\tau) \int_0^\tau g_2(\alpha) g_1(\xi,\eta,\tau-\alpha) d\alpha d\eta d\xi d\tau \right| \leq \\
&\leq \frac{(\rho + \|g_0\|)}{\sigma} (\varphi_1 + (\rho + \|g_0\|)T).
\end{aligned}$$

If we choose σ as

$$\sigma \geq \sigma_1 = \frac{\rho}{(\rho + g_0)(\varphi_1 + (\rho + \|g_0\|)T)},$$

then $\|A_1 g - g_{01}\|_\sigma \leq \rho$, i.e. it is satisfied the first condition of contractive mapping for A_1 .

Now we carry out the estimations for A_2 :

$$\begin{aligned}
&\|A_2 g - g_{02}\|_\sigma = \sup_{t \in (0,T)} |(A_2 g - g_{02})e^{-\sigma t}| = \\
&= \sup_{t \in (0,T)} \frac{1}{\varphi_0} e^{-\sigma t} \left| \int_0^p \int_0^q \int_0^t \int_0^p \int_0^q G_t(x,y,\xi,\eta,t-\tau) g_2(\tau) \varphi(\xi,\eta) d\eta d\xi d\tau dy dx - \right. \\
&\quad \left. - \int_0^p \int_0^q \int_0^t g_2(\alpha) g_1(x,y,t-\alpha) d\alpha dy dx - \int_0^p \int_0^q \int_0^t \int_0^p \int_0^q G_t(x,y,\xi,\eta,t-\tau) \right. \\
&\quad \left. \times \int_0^\tau g_2(\alpha) g_1(\xi,\eta,\tau-\alpha) d\alpha d\eta d\xi d\tau dy dx \right| \leq \\
&\leq \sup_{t \in (0,T)} \frac{1}{\varphi_0} \left| \int_0^p \int_0^q \int_0^t g_2(\tau) e^{-\sigma \tau} e^{-\sigma(t-\tau)} \times \right. \\
&\quad \left. \times \int_0^p \int_0^q G_t(x,y,\xi,\eta,t-\tau) \varphi(\xi,\eta) d\eta d\xi d\tau dy dx \right| + \\
&+ \sup_{t \in (0,T)} \frac{1}{\varphi_0} \left| \int_0^p \int_0^q \int_0^t g_2(\alpha) e^{-\sigma \alpha} g_1(x,y,t-\alpha) e^{-\sigma(t-\alpha)} d\alpha dy dx \right| + \\
&+ \sup_{t \in (0,T)} \frac{1}{\varphi_0} \left| \int_0^p \int_0^q \int_0^t e^{-\sigma(t-\tau)} \int_0^p \int_0^q G_t(x,y,\xi,\eta,t-\tau) \times \right. \\
&\quad \left. \times \int_0^\tau g_2(\alpha) e^{-\sigma \alpha} g_1(\xi,\eta,\tau-\alpha) e^{-\sigma(\tau-\alpha)} d\alpha d\eta d\xi d\tau dy dx \right|.
\end{aligned}$$

Denoting each summand in last formula by I_i , $i = 1, 2, 3$, we estimate them. For the expression I_1 we obtain

$$\begin{aligned} I_1 &= \sup_{t \in (0, T)} \frac{1}{\varphi_0} \left| \int_0^p \int_0^q \int_0^t g_2(\tau) e^{-\sigma\tau} e^{-\sigma(t-\tau)} \times \right. \\ &\quad \times \left. \int_0^p \int_0^q G_t(x, y, \xi, \eta, t - \tau) \varphi(\xi, \eta) d\eta d\xi d\tau dy dx \right| \leq \\ &\leq \frac{\varphi_1}{\varphi_0} \|g_2\|_\sigma \sup_{t \in (0, T)} \left| \int_0^t e^{-\sigma(t-\tau)} \int_0^p \int_0^q \int_0^p \int_0^q G_t(x, y, \xi, \eta, t - \tau) d\eta d\xi d\tau dy dx \right| \\ &\leq \frac{4pq\varphi_1(\rho + \|g_0\|)}{\varphi_0} \frac{1}{\sigma}. \end{aligned}$$

Using relations (17)-(22), we estimate I_2 as follows:

$$\begin{aligned} I_2 &= \sup_{t \in (0, T)} \frac{1}{\varphi_0} \left| \int_0^p \int_0^q \int_0^t g_2(\alpha) g_1(x, y, t - \alpha) e^{-\sigma t} d\alpha dy dx \right| = \\ &= \sup_{t \in (0, T)} \frac{1}{\varphi_0} \left| \int_0^p \int_0^q (g_2 * g_1)(t) e^{-\sigma t} dy dx \right| = \\ &= \frac{1}{\varphi_0} \sup_{t \in (0, T)} \left| \int_0^p \int_0^q - (g_{02} * g_{01})(t) \} e^{-\sigma t} dy dx \right| \leq \\ &\leq \frac{1}{\varphi_0} \int_0^p \int_0^q \left(\|g_2 - g_{02}\|_\sigma \|g_1 - g_{01}\|_\sigma T + \frac{1}{\sigma} \|g_2\|_\sigma \|g_{01}\| + \right. \\ &\quad \left. + \frac{1}{\sigma} \|g_1\|_\sigma \|g_{01}\| + \frac{1}{\sigma} \|g_{01}\|_\sigma \|g_{02}\| \right) dy dx \leq \\ &\leq \frac{pq}{\varphi_0} \left(\rho^2 T + \frac{2}{\sigma} (\rho + \|g_0\|) \|g_0\| + \frac{1}{\sigma} \|g_0\|^2 \right), \end{aligned}$$

Conducting the similar estimates alike as for the case I_1 we have for I_3

$$\begin{aligned} I_3 &= \sup_{t \in (0, T)} \frac{1}{\varphi_0} \left| \int_0^p \int_0^q \int_0^t e^{-\sigma(t-\tau)} \int_0^p \int_0^q G_t(x, y, \xi, \eta, t - \tau) \times \right. \\ &\quad \times \left. \int_0^\tau g_2(\alpha) e^{-\sigma\alpha} g_1(\xi, \eta, \tau - \alpha) e^{-\sigma(\tau-\alpha)} d\alpha d\eta d\xi d\tau dy dx \right| \leq \end{aligned}$$

$$\leq \frac{1}{\varphi_0} \|g_1\|_\sigma \|g_2\|_\sigma \sup_{t \in (0, T)} \left| \int_0^p \int_0^q \int_0^t e^{-\sigma(t-\tau)} \times \right. \\ \left. \times \int_0^p \int_0^q G_t(x, y, \xi, \eta, t - \tau) d\eta d\xi d\tau dy dx \right| \leq \frac{4pqT(\rho + \|g_0\|)^2}{\varphi_0} \frac{1}{\sigma}.$$

Accordingly, we get

$$\|A_2 g - g_{02}\|_\sigma \leq I_1 + I_2 + I_3 = \frac{4pq\varphi_1(\rho + \|g_0\|)}{\varphi_0} \frac{1}{\sigma} + \frac{\rho^2 pqT}{\varphi_0} + \\ + \frac{2pq(\rho + \|g_0\|) \|g_0\|}{\varphi_0} \frac{1}{\sigma} + \frac{pq \|g_0\|^2}{\varphi_0} \frac{1}{\sigma} + \frac{4pqT(\rho + \|g_0\|)^2}{\varphi_0} \frac{1}{\sigma}.$$

Now we can choose ρ, σ such that there hold the inequalities:

$$\begin{cases} \frac{\rho^2 pqT}{\varphi_0} < \frac{1}{3} \rho, \\ \frac{pq \|g_0\|^2}{\varphi_0 \sigma} < \frac{1}{3} \rho, \\ \frac{4pq(\rho + \|g_0\|)(\varphi_1 + \|g_0\| + T(\rho + \|g_0\|))}{\varphi_0 \sigma} < \frac{1}{3} \rho. \end{cases}$$

It follows that if

$$\begin{cases} \rho < \frac{\varphi_0}{3Tpq} = \rho_1, \\ \beta_1 = \frac{(3pq)^2 \|g_0\|^2 T}{\varphi_0^2} < \sigma, \\ \beta_2 = \frac{36T(pq)^2}{\varphi_0^2} \left(\frac{\varphi_0}{3Tpq} + \|g_0\| \right) (\varphi_1 + \|g_0\| + T(\frac{\varphi_0}{3Tpq} + \|g_0\|)) < \sigma, \end{cases}$$

then $A_2 g \in B(g_0, \rho)$.

So, if the inequality

$$\sigma > \sigma_2 = \max\{\beta_1, \beta_2\}$$

and $\rho \in (0, \rho_1)$ holds, then the operator A_2 maps $B(g_0, \rho)$ into itself, i.e. $A_2 g \in B(g_0, \rho)$.

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As a result, we conclude that if σ, ρ satisfy the conditions $\sigma > \max\{\sigma_1, \sigma_2\}$, $\rho \in (0, \rho_1)$, then operator A maps $B(g_0, \rho)$ into itself, i.e. $Ag \in B(g_0, \rho)$.

Second, we check the second condition of contractive mapping. In accordance with (15) for the first component of operator A we get

$$\begin{aligned} & \| (Ag^1 - Ag^2)_1 \|_\sigma \leq \\ & \leq \sup_{(x,t) \in D_T} \left| \int_0^t \int_0^p \int_0^q G(x, y, \xi, \eta, t - \tau) [g_2^1(\tau) - g_2^2(\tau)] \varphi(\xi, \eta) d\eta d\xi d\tau e^{-\sigma t} \right| + \\ & \quad + \sup_{(x,t) \in D_T} \left| \int_0^t \int_0^p \int_0^q G(x, y, \xi, \eta, t - \tau) \times \right. \\ & \quad \left. \times \int_0^\tau [g_2^1(\alpha) g_1^1(\xi, \eta, \tau - \alpha) - g_2^2(\alpha) g_1^2(\xi, \eta, \tau - \alpha)] d\alpha d\eta d\xi d\tau e^{-\sigma t} \right|. \end{aligned}$$

Here the integrand in the last integral can be estimated as follows

$$\begin{aligned} & \| g_2^1 g_1^1 - g_2^2 g_1^2 \|_\sigma = \| (g_2^1 - g_2^2) g_1^1 + g_2^2 (g_1^1 - g_1^2) \|_\sigma \leq \\ & \leq 2 \| g^1 - g^2 \|_\sigma \max(\| g_1^1 \|_\sigma, \| g_2^2 \|_\sigma) \leq 2(\| g_0 \| + \rho) \| g^1 - g^2 \|_\sigma. \end{aligned}$$

Therefore

$$\| (Ag^1 - Ag^2)_1 \|_\sigma \leq \frac{1}{\sigma} (\varphi_1 + 2(\rho + \| g_0 \|)T) \| g^1 - g^2 \|_\sigma.$$

It is obviously, if we choose σ as $\sigma > \sigma_3 = \varphi_1 + 2(\rho + \| g_0 \|)T$, then $\| (Ag^1 - Ag^2)_1 \|_\sigma \leq \frac{\sigma_3}{\sigma} \| g^1 - g^2 \|_\sigma$, i.e. it is satisfied the second condition of contractive mapping for A_1 .

The second component of A can be estimated in the following form:

$$\begin{aligned} & \| (Ag^1 - Ag^2)_2 \|_\sigma = \sup_{t \in (0, T)} \frac{1}{\varphi_0} \left| \int_0^p \int_0^q \int_0^t [g_2^1 - g_2^2](\tau) \times \right. \\ & \quad \times \int_0^p \int_0^q G_t(x, y, \xi, \eta, t - \tau) \varphi(\xi, \eta) d\eta d\xi d\tau dy dx e^{-\sigma t} \Big| + \\ & \quad + \sup_{t \in (0, T)} \frac{1}{\varphi_0} \left| \int_0^p \int_0^q \int_0^t [g_2^1 g_1^1 - g_2^2 g_1^2] e^{-\sigma t} d\alpha dy dx \right| + \\ & \quad + \sup_{t \in (0, T)} \frac{1}{\varphi_0} \left| \int_0^p \int_0^q \int_0^t \int_0^p \int_0^q G_t(x, y, \xi, \eta, t - \tau) \times \right. \end{aligned}$$

$$\begin{aligned} & \times \int_0^\tau [g_2^1 g_1^1 - g_2^2 g_1^2] e^{-\sigma t} d\alpha d\eta d\xi d\tau dy dx \Big| \leq \\ & \leq \frac{4pq}{\varphi_0} \left(\rho T + \frac{\varphi_1}{\sigma} + \frac{\|g_0\|}{\sigma} + \frac{2(\rho + \|g_0\|)T}{\sigma} \right) \|g^1 - g^2\|_\sigma. \end{aligned}$$

Now we choose numbers σ, ρ so that the expression at $\|g^1 - g^2\|_\sigma$ becomes less than 1, i.e., the inequality

$$\frac{4pq}{\varphi_0} \left(\frac{\varphi_1}{\sigma} + \rho T + \frac{\|g_0\|}{\sigma} + \frac{2(\rho + \|g_0\|)T}{\sigma} \right) < 1$$

is fulfilled. This inequality is valid if numbers σ, ρ will be chosen from conditions

$$\begin{cases} \frac{4pq\rho T}{\varphi_0} < \frac{1}{3}, \\ \frac{4pq}{\varphi_0\sigma} (\varphi_1 + \|g_0\|) < \frac{1}{3}, \\ \frac{8pqT}{\varphi_0\sigma} (\rho + \|g_0\|) < \frac{1}{3}. \end{cases}$$

Solving these inequalities with respect to σ, ρ we obtain

$$\begin{cases} \rho < \frac{\varphi_0}{12pqT} = \rho_2, \\ \sigma_4 = \frac{12pq}{\varphi_0} (\varphi_1 + \|g_0\|) < \sigma, \\ \sigma_5 = \frac{2\varphi_0 + 24pqT \|g_0\|}{\varphi_0} < \sigma. \end{cases}$$

From these estimates it is clear that if σ and ρ are chosen from condition $\sigma > \sigma_4$ and $\rho < (0, \rho_2)$, then the operator A_2 satisfies the second condition of contracting mapping.

As result, we conclude that if σ and ρ are taken from conditions $\sigma > \max(\sigma_1, \sigma_2, \sigma_3, \sigma_4, \sigma_5)$ and $\rho \in (0, \min(\rho_1, \rho_2)) = (0, \rho_2)$, then the operator A carries out contracting mapping the ball $B(g_0, \rho)$ into itself and according to Banach theorem in this ball it has a unique fixed point, i.e., there exists a unique solution of operator equation (14). By found function $\omega(x; y; t); k(t)$, the function $u(x; t)$ is found by virtue of the formula from which follows $u(x, y, t) = \int_0^t \omega(x, y, t) d\tau + \varphi(x, y)$.

The Theorem 1 is proved.

Conclusion. In the work, the solvability of inverse problem for integro-differential second-order parabolic equation with initial-boundary conditions was studied. The considered problem was reduced to an auxiliary problem in a certain sense and its equivalence to the original problem was shown. Then the auxiliary problem was reduced to an equivalent closed system of Volterra-type integral equations with respect to unknown functions. Applying the method of contraction mappings to this system in the continuous class of functions with weighted norms, we proved the main result of the article, which is a global existence and uniqueness theorem of inverse problem solutions. We note that global solvability of this kind of n dimensional problem is open issue.

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NUMERICAL STUDY OF THE FIRST AND SECOND BOUNDARY VALUE PROBLEMS POSED FOR A MODEL EQUATION OF MIXED TYPE IN SPACE, AND THE CALCULATION OF THE APPROXIMATION OF A STABLE FINITE-DIFFERENCE SCHEME OF THESE PROBLEMS

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Abstract:

Introduction. When analyzing difference schemes for partial differential equations, we always carry out research, dividing it into two stages. The first step is to check the approximation. The second stage is to test the so-called sustainability. In this article, stable difference schemes are constructed for the multidimensional case, and the order of approximation of the stable difference scheme in the one-dimensional case is determined.

Research methods. To solve a given boundary value problem, we will use an approximate (numerical) method. Among the approximate methods for solving differential ones used now, "finite-difference schemes" are widely used. In this method we discretize the considered area where the problem is solved, i.e. build a difference network; we approximate the initial differential problem by a finite-difference scheme on the constructed network; prove stability; we find a numerical solution to the differential problem using a finite difference scheme.

Results. Today, the use of modern electronic computers plays an important role in the development of the theory of differential equations. When studying differential equations, computational experiments to determine one or another property of solutions can then be theoretically justified and serve as the basis for further theoretical research.

Discussions. The study of direct and inverse problems posed to a mixed type equation is one of the advanced critical and rapidly emerging areas of world science. Their numerical implementation provides an applied application for the study of these problems. In this paper, we numerically study the boundary value problem posed to a model equation of mixed type. To do this, you need to know the concept of approximation and stability. The stability of the difference scheme has been proven. The order of approximation is calculated in the work. Further, when the stability and approximation are proved, it is possible to show the approximation of the numerical solution to the exact solution.

Conclusion. Conclusion. A priori estimates have been obtained for the solutions of equations of mixed type. The analytical solution of nonclassical equations in mathematical physics is a very complex process, so the boundary value problems in these equations are approximated by differential schemes and the stability is checked, which allows to solve a number of boundary value problems for mixed type equations.

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Keywords: *mixed type equations, stability, approximation, difference scheme.*

Introduction. The theory of differential equations is one of the largest branches of modern mathematics. To illustrate its place in modern mathematical science, it is worth noting the peculiarities of two major branches of the theory of differential equations: ordinary differential equations and the theory of partial differential equations.

The first peculiarity is the widespread application of the theory of differential equations in life. If we consider mathematics as a science that reveals the secrets of nature, its main purpose is to build mathematical models of real life. When a researcher studies a physical phenomenon, he constructs its mathematical ideal, in other words, he sees a mathematical model. In most cases, this model takes the form of a differential equation. Models of phenomena in the mechanics of contiguous media, chemical reactions, electrical, magnetic, and other phenomena take the form of differential equations.

By studying the obtained differential equations with additional, i.e., initial and boundary conditions, the mathematician can obtain information about the event that is taking place, and sometimes be aware of the past and future of the event.

Mathematically, the study of a model by mathematical methods allows not only to obtain qualitative characteristics of physical phenomena, but also to know the basis of a physical phenomenon, sometimes to discover new physical phenomena. Mathematically, the criterion for determining the correct choice of the model is the comparison of the results obtained with the help of mathematical research with experimental data.

As A. Poincare said: "Mathematics is the art of calling different things by one name," that is, mathematics studies various phenomena of real life in one way - a mathematical model.

In order to construct a mathematical model in the form of differential equations, it is not necessary to have complete knowledge of the whole physical phenomenon, but only to know the necessary connections.

The study of the basic equations of mathematical physics led to the classification of equations and systems of partial differential equations. In the first 30s of the last century I.G. Petrovsky classified partial differential equations. Today, hyperbolic, parabolic and elliptic types of equations are widely studied. Mixed-type partial differential equations are considered unstudied by the class of partial differential equations.

Hence, a distinctive feature of the theory of differential equations is its wide application. The second distinctive aspect is the relationship of the theory of differential equations with other branches of mathematics: functional analysis, algebra, and probability theory.

The theory of differential equations, mainly the theory of special derivative differential equations, makes extensive use of basic concepts, ideas, and methods in various fields of mathematics and also influences their problems and the nature of research.

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Many sections of the theory of differential equations have developed in such a way that as a result they have been formed as separate directions. One such direction is mixed type equations. The classical equations of mathematical physics and the problems posed to them are studied.

Today's time is the use of computers, i.e. computers in the study of differential equations is considered relevant. When studying differential equations, and when finding certain properties of a solution, computational experiments are conducted, and this will become the basis for further theoretical research.

Computational experiments are also used in physics and in theoretical research. This is done using a mathematical model of a physical process. The purpose of a computational experiment using a computer is the right accuracy, spending little computer time to express the physical process. On the basis of such experiments lies in many cases partial differential equations. This leads to the connection between theories of differential equations and computational mathematics, mainly with the sections of the finite difference method, the finite element method, etc. It means that their widespread use is characteristic of differential equations.

Physics and other natural sciences provide the theory of differential equations with unsolved problems, but it can also happen that mathematical studies over time find their exact life applications. Tricomi's task is an example of this. After a quarter century, the solution to this problem has found its application in gas dynamics.

The sections of differential equations have developed so much that they are formed as separate directions. One such direction of the partial differential equation.

The relevance of the work. The classical equations of mathematical physics and the problems posed by him have been studied sufficiently. There are enough experimental and theoretical works on the analytical and numerical solution of classical equations. The study of mixed equations, called non-classical problems of mathematical physics, began at the beginning of the last century.

The study of equations of mixed and composite type from the mathematical side is very important because they are used in different branches of mechanics and physics. For example, the problem of motion in gas dynamics, where there are subsonic and post-sound areas. Usually such free waves are called mixed, subsonic or transonic waves.

In today's time of existence and uniqueness of the solution of a mixed type equation, it has been proved in a functional way, and much has been done. One can say that a theory of mixed type equations has been created. There are enough works done to prove in a functional way the existence and uniqueness of a solution to a mixed type equation, we can say how the theory of mixed type equations was formulated. The next task is to create a theory of numerical methods for a mixed type equation. Enough work has been done in this area today. Now the task is to solve these types of equations by numerical methods and create a theory of numerical calculations of mixed types. Currently, a lot of work has been done in this direction. Basically, replacing mixed type equations with finite division schemes can prove that these schemes are elastic, which proves the validity of the boundary value problem of the mixed type equation, as well as the existence and uniqueness of the solution.

A priori estimates were obtained for solving mixed equations, and many scientists devoted and devoted their research to this field. The study of a discrete model of boundary value problems for mixed equations today has not lost its relevance. In our opinion, if we study the discrete model of boundary value problems for mixed equations, then we first obtain numerical analogues of the a priori estimates obtained for solving these equations and prove that these problems can be solved numerically. The main task here is to demonstrate the adequacy of the considered new discrete models or the original differential problem.

The scope of the studied problem. Mixed flows are usually determined by equations of a mixed-type elliptic-hyperbolic type, therefore, the study of the dynamics of a transition gas is closely connected with the development of mixed-type equations. First of all, the importance of studying mixed type equations was emphasized by S. A. Chaplygin in his 1902 work, Gas Flows. The study of systematically mixed types of equations began in the 1920s. The Italian scientist F. Tricomi began to study equations of various kinds and generalized them to S. Gellerstend. For the first time, they introduced boundary conditions for mixed equations and began to study them. These equations are now called by their names.

M. V. Keldysh, M. A. Lavrentiev, A. V. Bitsadze, K. I. Babenko, F. I. Frankel, A new stage in the development of differential equations with differential equations, equations of a mixed type and the theory of nonlinear classical equations. L.V. Ossyannikov, L.D. Kudryavtsev and a number of their students.

Further development of the theory of equations of mixed type A.V. Bitsadze, O.A. Alynik, E.V. Radkevich, M.M. Smirnov, G. Fiker, T. Dzhuraev, D.G. Karatoprakliev, M.S. Salakhitdinov, V.P. Glushko, T.S. Kalmenov, A.I. Kiprianova, V.K. The names of N. Vragov, B. A. Bubnov and other authors are connected.

Scientific and practical significance of the work.

The analytical solution of nonlinear equations of mathematical physics is a very complex process, therefore, stable boundary schemes for boundary value problems for these equations are constructed, which allow solving a finite number of boundary value problems for mixed equations.

Formulation of the problem: Let be $\Omega \subset R^n$ - limited area $\gamma \in C^2$ the boundary of a given region, a simply connected region.

Let be $Q = \Omega \times (-T, T)$, $S = \gamma \times (-T, T)$, where Γ - Q border of a given area. $Q^+ = Q \cap \{t > 0\}$, $Q^- = Q / Q^+$.

In the field, consider the following differential equation:

$$Lu \equiv K(x, t) \cdot u_{tt} - \sum_{i,j=1}^n a_{ij}(x, t) \cdot u_{x_i x_j} + a(x, t) \cdot u_t + \sum_{i=1}^n a_i(x, t) \cdot u_{x_i} + c(x, t) \cdot u = f(x, t) \quad (1)$$

where, $K(x, t), a_{i,j}(x, t) \in C^2(\overline{Q})$, $i, j = \overline{1, n}$; $a(x, t), a_i(x, t) \in C^1(\overline{Q})$, $c(x, t) \in C(Q)$,

$a_{ij}(x, t) = a_{ji}(x, t)$, $i, j = \overline{1, n}$; $t \cdot K(x, t) > 0$, $t \neq 0$; $K(x, 0) = 0$, $x \in \overline{\Omega}$; $\sum_{i,j=1}^n a_{ij} \cdot \xi_i \cdot \xi_j > 0$, $x \in \Omega$,

$\forall \xi \in R^n, |\xi| \neq 0; \sum_{i,j=1}^n a_{ij}(x,t) \cdot n_i \cdot n_j = 0, (x,t) \in S; n = (n_1, n_2, \dots, n_n, n_t)$ - vector inner normals to. $\beta(x) \equiv a(x,0) - K_t(x,0) > 0, x \in \bar{\Omega}$.

Note that in the region Q equation (1) is a mixed type equation. Namely, when $t > 0$ - hyperbolic-parabolic type, with $t < 0$ - elliptic-parabolic type.

The first boundary value problem. Find solutions to the equation:

$$Lu = f(x,t) \quad \text{B } Q \quad (1)$$

such that

$$u(x, -T) = 0, \quad x \in \bar{\Omega} \quad (2)$$

Suppose in equation (1) given in a cylindrical region Q :

$$\sum_{i,j=1}^n a_{ij}(x,t) \cdot u_{x_i x_j} = h(x,t) \cdot \Delta_x u,$$

when

$$\Delta_x u = \sum_{i,j=1}^n u_{x_i x_j}, \quad h(x,t) \in C^\infty(\bar{Q}), \quad a(x, -T) = 0; \quad h(x,t) > 0, \quad (x,t) \in Q; \quad h(x,t) = 0, \quad (x,t) \in S;$$

$$\beta(x) \equiv a(x,0) - K_t(x,0) < 0, \quad x \in \bar{\Omega}.$$

And then we get the following equation:

$$Lu \equiv K(x,t) \cdot u_{tt} - h(x,t) \cdot \Delta_x u + a(x,t) \cdot u_t + \sum_{i=1}^n a_i(x,t) \cdot u_{x_i} + c(x,t) \cdot u = f(x,t) \quad (1')$$

We assume that the coefficients of an equation from the class $C^\infty(Q)$.

Second boundary value problem: Find in the field of solution of the equation:

$$Lu = f(x,t) \quad (1')$$

satisfying condition

$$u(x, -T) = u(x, T) = u_t(x, T) = 0 \quad x \in \bar{\Omega}. \quad (3)$$

Numerical solution of assigned tasks. The numerical solution of the boundary value problems (1) - (2) and - (3) is not an easy task because a stable difference scheme is not constructed for them.

In this paper, we propose stable difference schemes and numerically solve (1) - (2) and - (3) the first and second boundary value problems for an equation of mixed type.

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Using the functional approach in [1], the following inequalities were proved for the first boundary-value problem:

$$\int_Q e^{-\lambda_0 t} u_t L u dQ + \mu_0 \int_Q u L u dQ \geq m \|u\|_{H_1}^2 \quad (4.a)$$

$$\|Lu\|_0 \geq m \|u\|_{H_1}, \quad (4.b)$$

and for the second boundary-value problem, the following estimates:

$$-\int_{Q^+} e^{\lambda_0 t} u_t L u dQ^+ \geq m \cdot \int_{Q^+} (u_t^2 + h(x,t) \cdot u_x^2 + u^2) dQ^+ \quad (5.a)$$

$$\|Lu\|_{0,Q^+} \geq m \cdot \|u\|_{H_1(Q^+)}, \quad \forall u \in C_Q \quad (5.b)$$

$$\int_{Q^-} u L u dQ^- \geq m_1 \cdot \int_{Q^-} (K(x,t) \cdot u_t^2 + h(x,t) \cdot u_x^2 + u^2) dQ^- \quad (5.c)$$

where are the constants m, m_1 independent of function $u(x,t)$ and the uniqueness theorem for solving problems is proved (1)-(2) и (1')-(3).

Difference schemes. For the numerical solution of the mixed problem (1) - (2) we offer the following scheme:

$$\left\{ \begin{array}{l} L^- u \equiv K \left(\frac{\tau \bar{\tau} u}{\Delta^2} \right) - \sum_{i,j=1}^n \frac{1}{\Delta \chi_i^2} \cdot a_{ij} \xi_i \bar{\xi}_j u + \frac{a \tau u}{\Delta} + \sum_{i=1}^n \frac{1}{\Delta \chi_i} \cdot a_i \bar{\xi}_i u + cu = f \\ k = \overline{-m+1, 0}; \quad l_i = \overline{0, N_i}, i = \overline{1, n} \end{array} \right. \quad (6)$$

$$\left\{ \begin{array}{l} L^+ u \equiv K \left(\frac{\tau \bar{\tau} u}{\Delta^2} \right) - \sum_{i,j=1}^n \frac{1}{\Delta \chi_i^2} \cdot a_{ij} \xi_i \bar{\xi}_j u + \frac{a \tau u}{\Delta} + \sum_{i=1}^n \frac{1}{\Delta \chi_i} \cdot a_i \bar{\xi}_i u + cu = f \\ k = \overline{1, m}; \quad l_i = \overline{0, N_i}, i = \overline{1, n} \end{array} \right. \quad (6')$$

$$\left\{ \begin{array}{l} u_{l_1, l_2, \dots, l_n}^{-m} = 0, \quad l_i = \overline{0, N_i}, i = \overline{1, n} \end{array} \right. \quad (7)$$

and for the numerical solution of the problem - (3) we offer the following difference scheme:

$$\left\{ \begin{array}{l} L^- u \equiv K \left(\frac{\tau \bar{\tau} u}{\Delta^2} \right) - h \cdot \sum_{i,j=1}^n \frac{1}{\Delta \chi_i^2} \cdot \xi_i \bar{\xi}_j u + \frac{a \tau u}{\Delta} + \sum_{i=1}^n \frac{1}{\Delta \chi_i} \cdot a_i \bar{\xi}_i u + cu = f \\ k = \overline{-m+1, 0}; \quad l_i = \overline{0, N_i}, i = \overline{1, n} \end{array} \right. \quad (8)$$

$$\left\{ \begin{array}{l} L^+ u \equiv K \left(\frac{\tau \bar{\tau} u}{\Delta^2} \right) - h \cdot \sum_{i,j=1}^n \frac{1}{\Delta \chi_i^2} \cdot \xi_i \bar{\xi}_j u + \frac{a \tau u}{\Delta} + \sum_{i=1}^n \frac{1}{\Delta \chi_i} \cdot a_i \bar{\xi}_i u + cu = f \\ k = \overline{1, m}; \quad l_i = \overline{0, N_i}, i = \overline{1, n} \end{array} \right. \quad (8')$$

$$\left\{ \begin{array}{l} u^{-m} = u^m = \frac{1}{\Delta} \tau u^m = 0, \quad l_i = \overline{0, N_i}, i = \overline{1, n} \end{array} \right. \quad (9)$$

Here $u = u(t^k, x_{1,l_1}, x_{2,l_2}, \dots, x_{n,l_n}) = u_{l_1, l_2, \dots, l_n}^k, i = \overline{1, n},$

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$\varphi, \varphi^{-1}, \psi_i, \psi_i^{-1}$ - shift operators. $\varphi u = u_{l_i}^{k+1} = u^{k+1}$, $\varphi^{-1} u = u_{l_i}^{k+1} = u^{k+1}$,

$\psi_i u = u_{l_i+1}^k = u_{l_i+1}^k$, $\psi_i^{-1} u = u_{l_i-1}^k = u_{l_i-1}^k$,

а также $\tau, \bar{\tau}, \xi_i, \bar{\xi}_i$ - difference operators:

$\tau = \varphi - 1$, $\bar{\tau} = 1 - \varphi^{-1}$, $\xi_i = \psi_i - 1$, $\bar{\xi}_i = 1 - \psi_i^{-1}$,

Δ - step by t , a Δx_i - step by x_i , $i = \overline{1, n}$.

System of linear algebraic equations (6)-(6')-(7) and (8)-(8')-(9) relatively unknown $\{u_{l_1, l_2, \dots, l_n}^k\}_{l_i = \overline{0, N_i}, i = \overline{1, n}}^{k = \overline{-m, m}}$, forms a complete system.

Here, using some examples, we will show the unique solvability of the difference scheme and present the results of a numerical calculation.

When $n=1$ in work [25], that is, for the equation given on the plane R^2 The solvability of the first boundary value problem was proved numerically.

Now let us show how to calculate the order of approximation of these schemes for the one-dimensional case.

When analyzing difference schemes for partial differential equations, we always conduct research, dividing it into two stages.

First stage consists in checking that the solution u of the differential equation

$$Lu = f \quad (10)$$

of interest to us, after substitution in the approximating difference equation $L_h u = f$, almost exactly satisfies this equation. As a rule, the validity of equalities of the type

$$L_h u - Lu = O(h),$$

$$L_h u - Lu = O(h^2 + \tau^2) \text{ etc.}$$

(h, τ are the steps of the difference scheme). Testing the validity of this kind of statement is called an approximation test.

At the beginning, we give the exact meaning of the approximation of the differential boundary value problem.

Let problem (1) be given. A difference scheme was constructed for a numerical solution:

$$L_h u^{(h)} = f^{(h)}, \quad (11)$$

which approximates problem (10) on the solution u for some of order h^k . This means the residual $\delta f^{(h)}$

$$L_h[u]_h = f^{(h)} + \delta f^{(h)}, \quad (12)$$

arising from the substitution of the grid function $[u]_h$ -table of the desired solution u - in equation (11), satisfies an estimate of the form:

$$\|\delta f^{(h)}\|_{F_h} \leq C_1 h^k. \quad (13)$$

where C_1 is some constant independent of h .

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The tendency of the residual value $\delta f^{(h)}$ to zero as $h \rightarrow 0$ is taken as the definition of an approximation [2]. The approximation is insufficient for convergence. We also need stability.

Second stage consists in checking the so-called stability. Stability is understood as the fulfillment of the inequality for solutions of the difference equations $L_h u_h = f_h$.

$$\|u_h\| \leq M \|f_h\|.$$

Here $\|u_h\|$, $\|f_h\|$ are any norms in which the "value" of the difference solution u_h and the right-hand side of f_h is measured; M is a constant independent of the steps of the difference scheme [1].

Definition 1 [2]. Difference scheme (2) will be called stable if there exist numbers $h_0 > 0$ and $\delta > 0$ such that for any $h < h_0$ and any $\varepsilon^h \in F_h$, $\|\varepsilon^h\|_{F_h} < \delta$, difference problem (12) obtained from problem (11) by adding to the right-hand side of the perturbation $\varepsilon^{(h)}$, has one and only one solution $z^{(h)}$, and this solution deviates from the solution $u^{(h)}$ unperturbed problem (11) on the grid function $z^{(h)} - u^{(h)}$ satisfying the estimate

$$\|z^{(h)} - u^{(h)}\|_{U_h} \leq C \|\varepsilon^{(h)}\|_{F_h} \quad (14)$$

where C is some constant independent of h , F_h and U_h are linear, normed spaces consisting, respectively, of the elements $f^{(h)}$ or $\delta f^{(h)}$ initially given and $u^{(h)}$ of the sought elements.

Let the operator L_h mapping U_h to F_h be linear. Then the above definition of stability is equivalent to the following:

Definition 2 [2]. We call difference scheme (11) with linear operator L_h stable if, for any $f^{(h)} \in F_h$, equation (11) has a unique solution $u^{(h)} \in U_h$, and

$$\|u^{(h)}\|_{U_h} \leq C \|f^{(h)}\|_{F_h} \quad (15)$$

where C is some constant independent of h .

If the difference equations approximate the differential equations and if the difference equations are stable, then it is easy to prove the closeness of the exact and approximate solutions [1,2]. One of the important problems in the theory of difference schemes is the construction of stable and exact schemes for second-order differential equations containing terms with first derivatives. The problem becomes much more complicated if the equations are of mixed type.

A number of methods for constructing difference schemes for partial differential equations were indicated by Godunov, Ryabenky, Samarsky and other authors (see, for example, [1-4]).

Much work has been done to prove the existence and uniqueness of solutions of equations of mixed type, and it can be said that the theory of equations of mixed type has been developed. The task now is to solve this type of equation by numerical

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methods and to create a theory of numerical calculation of mixed type equations. Much work is currently being done in this regard. Basically, by substituting mixed-type equations with finite-difference schemes, it is possible to prove the stability of these schemes, and on this basis to prove the correctness of the boundary value problem and the solution of the problem that exists and is unique.

A priori estimates have been obtained for the solutions of equations of mixed type, and many scientists have devoted and continue to dedicate their scientific work in this direction. The study of the differential model of boundary value problems for mixed-type equations has not lost its relevance to this day. In our view, if a differential model of boundary value problems for mixed-type equations is studied, first, a numerical analogue of the a priori estimates obtained for the solutions of these equations is obtained, and it is proved that these problems can be solved numerically. The main task is to show the adequacy of the new discrete models under consideration or construction to the initial differential problem.

Mixed flows are usually defined by equations of the elliptic-hyperbolic type of the mixed type, so the study of transistor gas dynamics is closely related to the development of the theory of mixed-type equations. The importance of studying equations of mixed type was first emphasized by S.A. Chaplygin in his 1902 work *On Gas Flows*. The study of systemically mixed type equations dates back to the 1920s. The Italian scientist F. Tricomi began to study equations of mixed type, which were generalized by S. Gellerstend [5-8]. They were the first to set boundary conditions for mixed-type equations and to study them. These equations are now called by their name.

A new stage in the development of the theory of differential equations of variable type, equations of mixed type and equations of nonclassical type is M.V Keldysh, M.A. Lavrentev, AV Bitsadze, K.I. Babenko, F.I. There were a number of works by LV Ovsiyannikov, LD Kudryavtsev and their students.

Further development of the theory of equations of mixed type was carried out by A.V. Bitsadze, O.A. Oleynik, E.V. Radkevich, M.M.Smirnov, G.Fiker, T.D.Djuraev, D.G.Karatoprakliev, M.S.Salaxitdinov, V.P.Glushko, T.Sh.Kalmenov, A.I.Kipriyanova, V. Associated with the names of N. Vragov, B.A. Bubnov and other authors [7-11],[14-16].

Consider the following boundary value problem for equations of mixed type in the one-dimensional case.

In the $D = \{(x, t) : 0 < x < l, -T < t < T\}$ domain, we consider the following equation:

$$Lu \equiv K(t) \cdot u_{tt} - h(x) \cdot u_{xx} + a(x, t) \cdot u_t + b(x, t) \cdot u_x + c(x, t) \cdot u = f(x, t), \quad (16)$$

where L through we have defined a linear partial differential operator of the second order.

$K(t)$, $h(x)$, $a(x, t)$, $b(x, t)$, $c(x, t)$ are given functions that satisfy the following conditions:

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$$1) K(t) \in C^2([-T, T]), \quad \text{at } t \neq 0 \quad t \cdot K(t) > 0 \text{ and } K(0) = 0.$$

$$2) h(x) \in C^2([0, l]), \quad h(x) > 0, \quad \text{if } x \in (0, l) \text{ and } h(0) = h(l) = 0.$$

$$3) a(x, t), b(x, t) \in C^1(\bar{D}), \quad c(x, t) \in C(\bar{D}).$$

$$4) \beta(x) = a(x, 0) - K_t(0) > 0, \quad x \in [0, l].$$

C - space of continuous functions, \bar{D} - closure D . We divide the area D into three areas: $D = D^+ \cup D^- \cup \{t = 0\}$, where

$$D^+ = D \cap \{t > 0\} = \{(x, t) : 0 < x < l, 0 < t < T\},$$

$$D^- = D \cap \{t < 0\} = \{(x, t) : 0 < x < l, -T < t < 0\},$$

$\Gamma = \partial D$ - the border of the area D . $\vec{n} = (n_x, n_t)$ is the internal normal drawn to the boundary.

According to the classification of second-order partial differential equations, equation (16) in the domain is a mixed-type equation. The study of the basic equations of mathematical physics made it possible to conduct a classification of differential equations and systems of equations with special derivatives. In the 1930s, a class of elliptic, parabolic, and hyperbolic equations was first studied by I.G. Petrovsky. And now these classes are a class of equations that have been studied enough. A class of mixed-type equations can be considered as an unstudied class.

For equation (16) we consider the following boundary value problem:

Boundary value problem: Find a function $u(x, t)$ that satisfies equation (16) in the domain D , and under the condition

$$t = -T$$

$$u(x, -T) = 0, \quad x \in [0, l] \tag{17}$$

Let the space C_2 - of functions lying in the class $C^2(\bar{D})$ and satisfying condition (17).

Boundary value problems for an equation of mixed type were studied in the works of Tricomi [5], Fiker [6], Vragov [14-16], Nakhushhev [10-11], Dzshuraev [8], Salakhitdinov [7] and many other researchers (see, for example, [18-20]). Mixed type equations are of an applied nature. Today, the use of modern electronic computers plays an important role in the development of differential equations. In the study of differential equations, it is possible to show computational experiments in the determination of solutions or these properties, to prove them further theoretically, and to lay the groundwork for the next attractions.

The analytical solution of such problems is difficult, and one has to solve them by numerical methods.

To solve the boundary value problem (16) - (17), we use an approximate (numerical) method.

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To solve boundary value problems posed to differential equations, he uses different approximate methods (see, for example, [2, 4, 17, 18, 22]).

Among the approximate methods for solving differential equations, "finite-difference schemes" are now widely used.

This method can be divided into the following steps:

- 1) Discretization of the considered area where the problem is solved, i.e. building a difference network;
- 2) Approximation of the original differential problem by a finite-difference scheme on the constructed network;
- 3) Substantiate the constructed finite-difference scheme, i.e. show its correctness, i.e. check the existence, uniqueness and stability of the solution;
- 4) Find a numerical solution to the differential problem using a finite-difference scheme.

Now let us check the approximation of the difference scheme for the following problem.

Let us apply the method of finite-difference schemes to the boundary value problem (16) - (17).

In the area $\bar{D} = \{(x, t) : 0 \leq x \leq l, -T \leq t \leq T\}$, construct a difference grid with steps $\Delta t = \Delta$, $\Delta x = \Delta_x$, $(T = m \cdot \Delta, l = n \cdot \Delta_x)$.

We denote by u_i^k the approximate solution of the boundary value problem at a (t^k, x_i) point.

Here (t^k, x_i) is the anchor point formed by the intersection of straight lines $t = t^k = k \cdot \Delta$, $x = x_i = i \cdot \Delta_x$. We introduce $\varphi, \psi, \tau, \bar{\tau}, \xi, \bar{\xi}$ shift and difference operators as follows:

$$\varphi u_i^k = u_i^{k+1} = u^{k+1} = \hat{u}, \quad \varphi^{-1} u_i^k = u_i^{k-1} = u^{k-1} = \bar{u}, \quad \psi^{\pm 1} u_i^k = u_{i \pm 1}^k = u_{i \pm 1}$$

$$\tau = \varphi - 1 \text{ - right difference operator on a variable } t,$$

$$\bar{\tau} = 1 - \varphi^{-1} \text{ - left difference operator on a variable } t,$$

$$\xi = \psi - 1 \text{ - right difference operator on a variable } x,$$

$$\bar{\xi} = 1 - \psi^{-1} \text{ - left difference operator on a variable } x,$$

$$r = \frac{\Delta}{\Delta_x} \text{ - step ratio.}$$

In this case, we approximate the boundary value problem (16) - (17) by the following finite-difference scheme [23-25], the stability of which was proved in [25]:

$$\begin{cases}
L^- u \equiv \left[K^k \frac{\bar{\tau}\bar{\tau}}{\Delta^2} - h_i \frac{\bar{\xi}\bar{\xi}}{\Delta_x^2} + a_i^k \frac{\bar{\tau}}{\Delta} + b_i^k \frac{\bar{\xi}}{\Delta_x} + c_i^k \right] u = f_i^k \\
\qquad\qquad\qquad k = \overline{-m+1, 0}; \quad i = \overline{0, n} \\
L^+ u \equiv \left[K^k \frac{\bar{\tau}\bar{\tau}}{\Delta^2} - h_i \frac{\bar{\xi}\bar{\xi}}{\Delta_x^2} + a_i^k \frac{\bar{\tau}}{\Delta} + b_i^k \frac{\bar{\xi}}{\Delta_x} + c_i^k \right] u = f_i^k \\
\qquad\qquad\qquad k = \overline{1, m}; \quad i = \overline{0, n} \\
u_i^{-m} = 0, \quad i = \overline{0, n}
\end{cases} \quad (18)$$

This scheme has a first order approximation with respect to Δ, Δ_x .

Results and discussions. Let us check the order of approximation of this scheme with respect to Δ, Δ_x . To do this, we first analyze the difference operators, i.e. let's open them:

$$\bar{\tau}u = (1 - \varphi^{-1})u = u - \varphi^{-1}u = u_i^k - u_i^{k-1},$$

$$\tau\bar{\tau}u = \tau(1 - \varphi^{-1})u = u_i^{k+1} - 2u_i^k + u_i^{k-1},$$

$$\tau\tau u = \tau(1 - \varphi^{-1})u = u_i^k - 2u_i^{k-1} + u_i^{k-2},$$

$$\bar{\xi}u = (1 - \psi^{-1})u = u - \psi^{-1}u = u_i^k - u_{i-1}^k,$$

$$\xi\bar{\xi}u = \xi(1 - \psi^{-1})u = u_{i+1}^k - 2u_i^k + u_{i-1}^k,$$

$$\bar{\xi}\xi u = \bar{\xi}(1 - \psi^{-1})u = u_i^k - 2u_{i-1}^k + u_{i-2}^k.$$

Here,

$$u_i^k = u(x_i, t_k), \quad u_i^{k+1} = u(x_i, t_{k+1}) = u(x_i, t_k + \Delta), \quad u_i^{k-1} = u(x_i, t_{k-1}) = u(x_i, t_k - \Delta),$$

$$u_{i+1}^k = u(x_{i+1}, t_k) = u(x_i + \Delta_x, t_k), \quad u_{i-1}^k = u(x_{i-1}, t_k) = u(x_i - \Delta_x, t_k).$$

Now, to study the approximation, we will use, as usual, the Taylor formula. Let us first recall the definition of a Taylor series. The Taylor series is an expansion of a function into an infinite sum of power functions.

The Taylor series was known long before Taylor's publications [13] - it was used in the 14th century in India, as well as in the 17th century by Gregory and Newton.

Taylor series are used to approximate a function by polynomials. In particular, the equations are linearized by expanding into a Taylor series and cutting off all terms above the first order.

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The Taylor polynomial of a function $f(x)$ of a real variable x differentiable k times at a point a is the finite sum

$$f(x) = \sum_{n=0}^k \frac{f^{(n)}(a)}{n!} (x - a)^n$$

used in approximate calculations as a generalization of the corollary of Lagrange's theorem on the mean value of a differentiable function:

for $x - a = h \rightarrow 0$ it is true

$$f(x) = f(a + h) = f(a) + f'(a)h + O(h^2) \approx f(a) + f'(a)h = f(a) + f'(a)(x - a) .$$

When writing the sum, we used the notation $f^{(0)}(x) = f(x)$ and the product convention over the empty set: $0! = 1$, $(x - a)^0 = 1$.

The Taylor series at a point a of a function $f(x)$ real x , infinitely differentiable in a neighborhood of a point a , is a formal power series

$$f(x) = \sum_{n=0}^{+\infty} \frac{f^{(n)}(a)}{n!} (x - a)^n$$

with a common term $\frac{f^{(n)}(a)}{n!} (x - a)^n$, depending on the design a .

In other words, the Taylor series of the function $f(x)$ at the point a is the series of the expansion of the function in positive powers of the binomial $(x - a)$.

The presence of infinite differentiability of the function $f(x)$ in a neighborhood of the point a is not enough for the Taylor series to converge to the function itself anywhere, except for the point a itself.

Suppose that the function $f(x)$ has all derivatives up to order $n + 1$ inclusive in some interval, containing the point $x = a$. Find a polynomial $P_n(x)$ of degree at most n , the value of which at the point $x = a$ is equal to the value of the function $f(x)$ at this point, and the values of its derivatives up to the n th order inclusive at the point $x = a$ are equal to the values of the corresponding derivatives of the function $f(x)$ at this point.

It is easy enough to prove that such a polynomial has the form

$$P_n(x) = \sum_{k=0}^n \frac{f^{(k)}(a)}{k!} (x - a)^k , \text{ that is, this is the } n\text{th partial sum of the Taylor}$$

series of the function $f(x)$.

Definition 3[26]. The difference between the function $f(x)$ and the polynomial $P_n(x)$ is called the remainder and is denoted by $R_n(x) = f(x) - P_n(x)$.

Definition 4[26]. The formula $f(x) = P_n(x) + R_n(x)$ is called the Taylor formula.

The remainder is differentiable $n + 1$ times in the considered neighborhood of the point a . Taylor's formula is used to prove a large number of theorems in

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differential calculus. Loosely speaking, Taylor's formula shows the behavior of a function in a neighborhood of some point.

There are various forms of residual members.

Schloumilch-Roche form: $R_n(x) = \left(\frac{x-a}{x-\xi}\right)^p \frac{(x-\xi)^{n+1}}{n!p} f^{(n+1)}(\xi);$

Lagrange form: $R_n(x) = \frac{(x-a)^{n+1}}{(n+1)!} f^{(n+1)}(a + \theta(x-a)), p = n+1; 0 < \theta < 1;$

Cauchy form: $R_n(x) = \frac{(x-a)^{n+1}(1-\theta)^n}{n!p} f^{(n+1)}(a + \theta(x-a)), p = 1; 0 < \theta < 1;$

Integral form: $R_n(x) = \frac{1}{n!} \int_a^x (x-a)^n f^{(n+1)}(t) dt.$

We will now use these notions in our research.

$$\begin{aligned} u_i^{k+1} &= u(x_i, t_{k+1}) = u(x_i, t_k + \Delta) = u(x, t + \Delta) = u(x, t) + \frac{\Delta}{1!} u_t + \frac{\Delta^2}{2!} u_{tt} + \frac{\Delta^3}{3!} u_{ttt} + \dots = \\ &= u(x, t) + \frac{\Delta}{1!} u_t + \frac{\Delta^2}{2!} u_{tt} + \frac{\Delta^3}{3!} u_{ttt}(\xi, \tau) \end{aligned}$$

$$\begin{aligned} u_i^{k-1} &= u(x_i, t_{k-1}) = u(x_i, t_k - \Delta) = u(x, t - \Delta) = u(x, t) - \frac{\Delta}{1!} u_t + \frac{\Delta^2}{2!} u_{tt} - \frac{\Delta^3}{3!} u_{ttt} + \dots = \\ &= u(x, t) - \frac{\Delta}{1!} u_t + \frac{\Delta^2}{2!} u_{tt} - \frac{\Delta^3}{3!} u_{ttt}(\xi, \tau) \end{aligned}$$

$$\begin{aligned} u_{i+1}^k &= u(x_{i+1}, t_k) = u(x_i + \Delta_x, t_k) = u(x + \Delta_x, t) = u(x, t) + \frac{\Delta_x}{1!} u_x + \frac{\Delta_x^2}{2!} u_{xx} + \frac{\Delta_x^3}{3!} u_{xxx} + \dots = \\ &= u(x, t) + \frac{\Delta_x}{1!} u_x + \frac{\Delta_x^2}{2!} u_{xx} + \frac{\Delta_x^3}{3!} u_{xxx}(\xi, \tau) \end{aligned}$$

$$\begin{aligned} u_{i-1}^k &= u(x_{i-1}, t_k) = u(x_i - \Delta_x, t_k) = u(x - \Delta_x, t) = u(x, t) - \frac{\Delta_x}{1!} u_x + \frac{\Delta_x^2}{2!} u_{xx} - \frac{\Delta_x^3}{3!} u_{xxx} + \dots = \\ &= u(x, t) - \frac{\Delta_x}{1!} u_x + \frac{\Delta_x^2}{2!} u_{xx} - \frac{\Delta_x^3}{3!} u_{xxx}(\xi, \tau) \end{aligned}$$

Here, (ξ, τ) some intermediate point.

We insert these calculations into the difference scheme (12) and get:

At $k = \overline{-m+1, 0}; \quad i = \overline{0, n}$

$k = \overline{-m+1, 0}; \quad i = \overline{0, n}$

$$\left[K^k \frac{\tau \bar{\tau}}{\Delta^2} - h_i \frac{\xi \bar{\xi}}{\Delta_x^2} + a_i^k \frac{\bar{\tau}}{\Delta} + b_i^k \frac{\bar{\xi}}{\Delta_x} + c_i^k \right] u = \frac{K^k}{\Delta^2} \tau \bar{\tau} u - \frac{h_i}{\Delta_x^2} \xi \bar{\xi} u + \frac{a_i^k}{\Delta} \bar{\tau} u + \frac{b_i^k}{\Delta_x} \bar{\xi} u + c_i^k u =$$

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$$\begin{aligned}
&= \frac{K^k}{\Delta^2} \left(u_i^{k+1} - 2u_i^k + u_i^{k-1} \right) - \frac{h_i}{\Delta_x^2} \left(u_{i+1}^k - 2u_i^k + u_{i-1}^k \right) + \frac{a_i^k}{\Delta} \left(u_i^k - u_i^{k-1} \right) + \frac{b_i^k}{\Delta_x} \left(u_i^k - u_{i-1}^k \right) + c_i^k u_i^k = \\
&= \frac{K(t)}{\Delta^2} \left(u(x, t) + \frac{\Delta}{1!} u_t + \frac{\Delta^2}{2!} u_{tt} + \frac{\Delta^3}{3!} u_{ttt} + \dots - 2u(x, t) + u(x, t) - \frac{\Delta}{1!} u_t + \frac{\Delta^2}{2!} u_{tt} - \frac{\Delta^3}{3!} u_{ttt} + \dots \right) - \\
&- \frac{h(x)}{\Delta_x^2} \left(u(x, t) + \frac{\Delta_x}{1!} u_x + \frac{\Delta_x^2}{2!} u_{xx} + \frac{\Delta_x^3}{3!} u_{xxx} + \dots - 2u(x, t) + u(x, t) - \frac{\Delta_x}{1!} u_x + \frac{\Delta_x^2}{2!} u_{xx} - \frac{\Delta_x^3}{3!} u_{xxx} + \dots \right) + \\
&+ \frac{a(x, t)}{\Delta} \left(u(x, t) - \left(u(x, t) - \frac{\Delta}{1!} u_t + \frac{\Delta^2}{2!} u_{tt} - \frac{\Delta^3}{3!} u_{ttt} + \dots \right) \right) + \\
&\frac{b(x, t)}{\Delta_x} \left(u(x, t) - \left(u(x, t) - \frac{\Delta_x}{1!} u_x + \frac{\Delta_x^2}{2!} u_{xx} - \frac{\Delta_x^3}{3!} u_{xxx} + \dots \right) \right) + c(x, t)u(x, t) = \\
&= 2 \frac{K(t)}{\Delta^2} \left(\frac{\Delta^2}{2!} u_{tt} + \frac{\Delta^4}{4!} u_{tttt} + \dots \right) - 2 \frac{h(x)}{\Delta_x^2} \left(\frac{\Delta_x^2}{2!} u_{xx} + \frac{\Delta_x^4}{4!} u_{xxxx} + \dots \right) + \\
&+ \frac{a(x, t)}{\Delta} \left(u(x, t) - \left(u(x, t) - \frac{\Delta}{1!} u_t + \frac{\Delta^2}{2!} u_{tt} - \frac{\Delta^3}{3!} u_{ttt} + \dots \right) \right) + \\
&+ \frac{b(x, t)}{\Delta_x} \left(u(x, t) - \left(u(x, t) - \frac{\Delta_x}{1!} u_x + \frac{\Delta_x^2}{2!} u_{xx} - \frac{\Delta_x^3}{3!} u_{xxx} + \dots \right) \right) + c(x, t)u(x, t) = \\
&= K(t)u_{tt} - h(x)u_{xx} + a(x, t)u_t + b(x, t)u_x + c(x, t)u + K^k \frac{\Delta^2}{12} \frac{\partial^4 u}{\partial t^4} + \dots - h_i \frac{\Delta_x^2}{12} \frac{\partial^4 u}{\partial x^4} - \dots - \\
&- a_i^k \frac{\Delta}{2!} \frac{\partial u}{\partial t} + \dots - b_i^k \frac{\Delta}{2!} \frac{\partial u}{\partial x} + \dots
\end{aligned}$$

We find the residual for our case. After calculations, we get:

$$\mathcal{F} = -a_i^k \frac{\Delta}{2!} \frac{\partial u}{\partial t} - b_i^k \frac{\Delta}{2!} \frac{\partial u}{\partial x} + O(\Delta^2 + \Delta_x^2).$$

We calculate the norm of the residual:

$$\|\mathcal{F}\| \leq \left\| -a_i^k \frac{\Delta}{2!} \frac{\partial u}{\partial t} - b_i^k \frac{\Delta_x}{2!} \frac{\partial u}{\partial x} \right\| \leq \Delta \left\| a_i^k \frac{1}{2} \frac{\partial u}{\partial t} \right\| + \Delta_x \left\| b_i^k \frac{1}{2} \frac{\partial u}{\partial x} \right\| \leq C_1 \Delta + C_2 \Delta_x = O(\Delta + \Delta_x).$$

The first derivatives of the function are considered to be bounded functions, therefore, the first order of approximation in time and space takes place. As a result, we got an estimate of the type (4).

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In the same way, it can be shown for $k = \overline{1, m}$; $i = \overline{0, n}$, from this it is clear that the first order of approximation of this scheme is relative Δ, Δ_x .

Conclusion. A priori estimates have been obtained for the solutions of equations of mixed type, and many scientists have devoted and continue to dedicate their scientific work in this direction. The study of the differential model of boundary value problems for mixed-type equations has not lost its relevance to this day. In our view, if a differential model of boundary value problems for mixed-type equations is studied, first, a numerical analogue of the a priori estimates obtained for the solutions of these equations is obtained, and it is proved that these problems can be solved numerically. The main task is to show the adequacy of the new discrete models under consideration or construction to the initial differential problem. In conclusion, the analytical solution of nonclassical equations in mathematical physics is a very complex process, so the boundary value problems in these equations are approximated by differential schemes and the stability is checked, which allows to solve a number of boundary value problems for mixed type equations.

And so we formulate the following theorem:

Theorem. (18) the finite-difference scheme approximates (16) - (17) the problem in the first order with respect to Δ, Δ_x .

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LANDSCAPE STUDIES OF THE NAKHCHIVAN AUTONOMOUS REPUBLIC: SEMI-DESERT AND MOUNTAIN XEROPHYTIC LANDSCAPES

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Abstract:

Introduction. The article notes that modern researchers pay special attention to the study of landscapes, the maintenance of landscape-ecological balance and the development of scientific foundations for the restoration, conservation and development of landscapes. Currently, the effective use of modern technologies for a deeper study of the laws of landscape studies is discussed. Knowledge about the landscape and information about nature are reflected. For the development of landscape science, the regularities of the formation of landscapes, the interaction of components and factors that ensure the development of these relationships were studied. The ecological situation in Nakhchivan was comprehensively studied by anthropogenic changes in natural landscapes and on this basis information was provided on effective measures to restore to a certain extent transformed natural landscape complexes.

Research methods. The article talks about the importance of using new methods that have replaced the classical-traditional methods of landscape research and are increasingly referred to by modern researchers. The ideas of conducting research on natural and modern landscape complexes by developing maps and diagrams based on field studies, satellite images, satellite images, orthophotomaterials and other materials using modern equipment and providing more accurate and meaningful information about landscape complexes of the area are substantiated.

Results and Discussions. The article deals with transformation of natural landscape complexes of Nakhchivan Autonomous Republic in a number of areas as a result of different effects over a long historical period, their replacement with modern landscapes, and important scientific importance of research of landscape complexes. It is spoken about the approach of researchers engaged in the study of modern landscapes of Nakhchivan Autonomous Republic from different aspects to the study of landscapes in different years. Thus, anthropogenic transformation of natural landscapes is considered as the most urgent issue of modern times and the role of factors in landscape formation proves its exclusivity.

Conclusion. The causes and consequences of the transformation of natural landscapes were examined in detail as well. Here morphometric indicators of the area, climatic features, soil and vegetation are taken as the basis. Classification of landscapes into classes, subclasses, types, subtypes and types based on morphometric indicators, climatic features, soils and vegetation of the area, the study of the main types of landscapes of plains, low mountains and middle mountains using modern methods and tools.

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Key words: *semi-desert, lowland, low mountainous area, landscape, type*

Introduction. Besides the tectonic-geological structure, orography, sharply continental climate, the Nakhchivan Autonomous Republic is distinguished by the complexity of other features, such as settlement and use of the territory as well. This is reflected in the specificity and diversity of the natural landscape complexes of the region, as well as in the transformation from natural and anthropogenic impacts.

The economic activities of the population and other anthropogenic impacts on the socio-economic development of the region caused varying degrees of overload of the natural landscape complexes of Nakhchivan. Despite a number of legal and administrative measures taken by the government of Azerbaijan in the field of nature protection, the effective use of nature in this area is still not at the proper level. The lack of modern technologies in certain areas of human activity, the misconception that has developed in society about the “inexhaustibility of natural resources”, as well as the lack of ecological culture in the interaction of man with nature have led to significant changes in the natural landscapes of the region. Thus, anthropogenic impacts have intensified in many territories, which in turn led to the emergence and development of a number of natural destructive processes, a reduction in biodiversity, a change in the natural and historical boundaries of landscapes, land degradation, etc. reinforced. As a result, as a result of the transformation of natural landscape complexes, relatively less stable natural and anthropogenic complexes were formed in the region.

Material and method. The problem of transformation of natural landscapes has attracted the attention of scientists in our country for many years, and research in this direction has been expanded since the 1970s. Such scientists as A.V. Mammadov, B.D. Alasgarov, M.A. Museyibov [21], B.A. Budagov, Y.A. Garibov [3], M.A. Museyibov, B.D. Alasgarov, S.S. Valiyev [23], M.A. Suleymanov [15], S.Y. Babayev [1], A.A. Mikayilov [13], E.K. Alizade [17], I.T. Mammadov [22], Y.A. Garibov [7,8] and others have made special contributions to the study of the landscapes of the Republic of Azerbaijan. Using various methods and techniques, the researchers conducted systematic research in different regions of the country, studied the natural landscapes, ways of their transformation and optimization from various aspects.

Field studies, stock materials, maps with different content, statistical data, historical, analogous comparison, mathematical-statistical methods, systematic analysis, observation, distance learning, internet resources, satellite imagery, space images and ArcGIS software were widely used during the study of landscapes in Nakhchivan Autonomous Republic. The ArcGIS 10.3 (ESRI, Inc., USA) program provides an information methodology for using WGS-84 və GCS_WGS_1984, GCS_Pulkovo_1942 projections during map development, space imagery obtained in Landsat satellite imagery, and orthophotolar research work. The map and archive data of the State Statistical Committee of Azerbaijan and Nakhchivan Autonomous Republic, the Ministry of Ecology and Natural Resources, the State Committee on real estate and land issues of Nakhchivan Autonomous Republic and the State Institute of Geodesy, Geodesy and mapping projects operating under it were used.

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Results. Knowledge of landscape reflects not only knowledge about nature, but also partly information about society and our history. Modern landscape science is considered as a valuable source of information on social development, racial, ethnic, sanitary-epidemiological, environmental processes, etc. For the development of landscape science, the regularities of landscapes, the interactions of components and the study of factors ensuring the development of these relations, the clarification of natural phenomena observed on the surface of the earth are of great importance. From this point of view, as in all countries of the world, the study of landscapes in our republic has important scientific and practical significance.

With the development of landscape science as a science, new directions were formed. Landscape transformation is one of the fastest growing landscape areas of our time and one of the hottest areas in need of comprehensive research to maintain landscape and ecological balance. Currently, the issue of landscape transformation is one of the most important environmental problems in the world.

Discussions. Studies have shown that tectonic movements influence the formation of landscapes. Changes in the landscape belts, the area occupied by them, and the lower and upper boundaries of the belts were determined by neotectonic movements. The relationship between landscape types and subtypes and morphotectonic steps bordering on new tectonic faults and identified in the modern relief has been revealed.

B.A.Budagov, A.A.Mikayilov [4] has done important work in studying natural landscapes for agricultural purposes assessment of the natural conditions of Jeyranchol-Ajinohur front mountain, Talysh mountains, Alazan-Ayrichay gorge, some mountainous and lowland regions of the Nakhchivan AR. Features of mountain-steppe, mountain-semi-desert complexes, Tugay forests, arid sparse-forest and meadow-marsh landscapes, as well as the history of the development of modern landscapes are given in these studies.

It is known that as the society develops, the process of transformation of the natural boundaries of landscapes is accelerated, and as a result, the study of landscape complexes always maintains its relevance. Based on the results of the research so far, we have continued the research using new methods and methods of study of landscapes. We have also used new methods in our studies that replace classical-traditional methods and which modern researchers refer more to. We tried to justify our thoughts by studying natural and modern landscape complexes and using modern equipment, making maps and diagrams on the basis of field surveys, satellite imagery, space images, orthophotas and other materials and providing more accurate and comprehensive information about landscape complexes of the territory.

Morphometric indicators of the area, climatic features, soil and vegetation were based and the landscapes were divided into class, subclass, type, semi-type and species, and the natural landscapes of the area were classified in 7 main landscape types, and the main landscape types of lowlands and low mountains were studied using modern methods and means.

In our opinion, conducting research with the application of the above-mentioned modern methods and methods in the study of landscape complexes can be considered as the beginning of a new stage in the study of landscapes.

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According to Landscape Research in the Republic of Azerbaijan it was started in the 60s of XX century. With the establishment of the Department of landscape science at the Institute of Geography named after Hasan Aliyev of the Azerbaijan National Academy of Sciences, the scale of research has been expanded and Azerbaijani landscape scientists have achieved a number of successes in a short period of time.

B.A.Budagov and A.A.Mikayilov (1985) noted one of the main problematic issues of modern physical geography the importance of new tectonic movements in landscape formation. This problem was included in the research plan of the Institute and investigated on the basis of the materials of the south-eastern Caucasus, which is part of the Alpine Orogen Region [5; 15].

Important research has been conducted to determine the role of relief in the formation of landscapes in mountainous and lowland areas of the country. O.A. Karimov [20] conducted research on the effect of relief on the differentiation of landscapes in the Shirvan plain.

The general geographical regularities of landscape differentiation in mountainous areas on the north-eastern slope of the Lesser Caucasus were studied by H.T. Hagverdiyev [18]. H.T. Hagverdiyev discovered the regularities of vertical and horizontal distribution of natural territorial complexes. He studied the violation and complication of the horizontal structures of landscapes, geomorphological features of the relief in the altitude-landscape zones.

Three landscape types found in the middle mountain range - medium mountainous, partly high mountain meadow complex (1600-2200 m); middle mountain forest complex (1000-1900 m); post-forest meadow complex (1000-1700 m). Five subtypes, 84 varieties of the species at a short distance (30 km), between absolute heights of 1000-2000 m, uneven horizontal and vertical fragmentation of relief, changes in surface inclination are associated with the presence of different morphogenetic relief types [5; 16].

H.T. Hagverdiyev [18] noted that the internal differentiation of the landscape in the middle mountain belt is closely related to the micro and mezoexposition of the relief. He also studied the asymmetry of landscape subgroups depending on the macroexposition of slopes.

Vertical and horizontal fragmentation of the relief, inclination of the surface, slope view are of great importance in the differentiation of natural landscape complexes. These factors are widely used in the study of landscape differentiation patterns.

The lithological basis of the landscape has an important impact on its differentiation. Thus, forest landscape mainly develops on Jurassic-aged volcanic sandstones, porphyrites, tufts, however meadow-steppe landscape develops on Jurassic and chalk-aged limestones, dolomite, porphyrite and mergels.

Anthropogenic factors play a major role in the change of landscapes and their borders in the Middle Mountain zone, the upper boundary of mountain forests is located at absolute heights of 1800-1900 meters. However, under the influence of anthropogenic factors, in some areas of the middle mountain range this boundary fell to an absolute height of 1600 m. The meadow-steppe landscape, which makes up

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26.6% of the total area in the Middle Mountain zone, was formed mainly on the site of the broken forests [5; 17].

O.A.Kerimov [20], studying the regularities of differentiation of landscapes in plain areas, noted that the share of natural complexes on horizontal zonality and the complication of their structures depend on the geomorphological features of the relief and hydrological conditions of the territory.

In 1970, B.A.Budagov, Kh.I.Omarova conducted important research works in studying comparative quantitative characteristics of landscape components, main landscape forming factors and structural types of landscape zone in south-eastern Caucasus.

In the Nakhchivan Autonomous Republic until the 60s of the XX century, substantial landscape studies were not conducted. B.A.Budagov and S.Y.Babayev's researches held in 1960-66 was considered the first initiative in a thorough study of the landscape of the territory.

B.A.Budagov noted that the landscapes of Nakhchivan AR were mainly influenced by the arid climate of Iran and formed in the conditions of closure of the middle Araz mountain depression [5; 22]. He also noted that the vertical and horizontal alternation of landscapes depends on high contrast of the relief and changes in climatic conditions in the autonomous republic. The aridity of the climate in the autonomous republic and its location in the high mountain zone reflects itself in soil and vegetation. The semi-desert, mountain-xerophyte, mountain-forest, mountain-steppe, mountain-meadow, nival-rock landscape types developed from the Araz to the watershed of the Zangezur range. The straight proportion of vertical cleavage with the rise in height increases the importance of this factor in landscape development mainly in the research area with mountainous relief. The uneven distribution of rivers, dry valleys and ravines in the area is characterized by the contraption of the horizontal breakdown of the relief, which, in turn, leads to the formation of various landscape complexes.

Researcher scientist B.A.Budagov also noted that vertical girdle structure of landscapes has changed as a result of descending and sharp narrowing of middle Araz mountain depression towards south, south-east, west, north-west.

B.A.Budagov has divided Nakhchivan territory into 3 Natural Regions based on exact typological mapping: Sharur-Ordubad-plain-low mountainous, semi-desert, Gunnut-Kilitdag-middle mountainous steppe, Kuku-Gapijig-high mountainous Meadow.

S.Y.Babayev made a speech at the V scientific conference of young scientists in 1966 on "landscape zones of Nakhchivan Assr and their importance". The article talks about the existence of semi-deserts, deserts, subalpine and alpine meadows and rocky zones as a result of the relief and climate of the above-mentioned area. Semi-desert zone, steppe zone, supalp and Alpine meadow zone and rocky zone were involved in the study. Climate, composition, plants, scope, soil types, economic significance of the mentioned areas are analyzed with interesting facts. The work also talks about the future activities of the republic: "in recent years, a number of irrigation measures have been carried out to make more efficient use of the semi-desert zone and several more large water constructions are planned. As a result of

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these measures, irrigation of 46 thousand hectares of land will be improved and 25 thousand hectares of new land will be provided with water” [1; 23-24].

In 1967, S.Y. Babayev made a speech at another scientific conference-the VI scientific conference of young scientists of the Institute of geography of the Academy of Sciences of the Azerbaijan SSR on the topic “main landscape types of the Nakhchivan ASSR”. In the work, six types of landscapes characteristic of the territory of the Nakhchivan ASSR and their features are involved in the study on a large-scale landscape map. These types of landscape include:

1. Semi-desert landscape (mainly sloping plains, low mountains and depressions).
2. Highland xerophyte landscape (developed in the middle mountainous area and in the troughs).
3. Mountain and xerophyte meadow-shrub landscape (developed in a heavily fragmented mid-mountain range).
4. Mountain-meadow and Meadow-steppe landscape (it is spread in dry cold climate in summer on intensively divided medium, high mountain slopes and weakly decomposed flat surfaces).
5. Forest landscape (it covers a small part of intensively divided mountain slopes, Nakhchivan river, partly upper flows of Alinja River basin).
6. Rocky-mountainous landscape (intensively developed on fragmented high mountain slopes and watershed).

The researcher also identified its types on the basis of landscape types. He gave information about different groups of each landscape by making valuable scientific considerations about landscape types such as plain, low mountains, and lowlands.

Along with B.A. Budagov and S.Y. Babaev (1965), Y.A. Garibov (1990-1992) and S.Y. Guliyeva (2011) made an important contribution to the study of the landscapes of Nakhchivan.

Guliyeva S.Y. (2011) conducted a number of studies on natural and anthropogenic factors affecting the desertification process in Nakhchivan Autonomous Republic, on arid geocomplexes of the Autonomous Republic and their changes by anthropogenic influences, on the development of the desertification process in arid and semiarid geocomplexes of Nakhchivan Autonomous Republic, on the main features of geographical distribution and measures to combat it. In the course of the research, changes in the soil and vegetation cover were studied by studying the influence of relief, climate and hydrographic network on the process of desertification. Having provided information about the indicators of desertification, their types and degrees, Guliyeva noted the importance of carrying out a number of measures aimed at combating desertification, such as preventing erosion, planting trees and shrubs to strengthen slopes, compliance with grazing standards, serious attention to irrigation standards and regime with the improvement of irrigation systems.

Y.A. Garibov has deeply studied the patterns of differentiation of natural and anthropogenic landscapes of the Nakhchivan Autonomous Republic, the anthropogenic transformation of natural types of landscapes. He, as a result of research conducted in 1990-92, through a comprehensive study of modern landscape

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complexes of the area, taking into account anthropogenic loads and features of desertification, together with Gulieva, he compiled a large-scale modern landscape map of the area. Y.A.Garibov also noted the acceleration of anthropogenic transformation, justifying the growing influence of people on the landscape by the growth of settlements, the creation of new processing enterprises and infrastructure as a result of rapid population growth. The researcher, having compiled a map reflecting the anthropogenic transformation of natural landscapes for the autonomous republic on the basis of satellite images, statistical data, font and cartographic materials, divided the territory into categories according to the degree of anthropogenization, determined the coefficient of anthropogenization of landscapes. According to the floristic richness, the territory is divided into 3 botanical and geographical regions: Nakhchivan Plain, Nakhchivan highland and Nakhchivan high mountain belts. The greatest biological diversity belongs to the middle mountain belt. So, there are 1426 types of cereals found here [16]. On the territory of Nakhchivan Autonomous Republic, the sharply continental climate, low rainfall and arid air contribute to the development of xerophytic plants. In addition to physical factors, anthropogenic factors also play a role in the formation of vegetation. "Professor L.I.Prilipko points out the presence of two zones of vertical zonality on the territory of Nakhchivan Autonomous Republic. The first belt is characteristic of the North-Eastern and south-western parts of the autonomous republic and includes sagebrush semi-deserts, frigans, mountain-bozgirs, garigas and meadow-bozgirs, their transitional senoses and, finally, alpine senoses; the second belt covers sagebrush semi-deserts, frigans, meadow-shrub and forest senoses, and then subalpine and alpine vegetation" [1; 74].

Over a long historical period, as a result of certain impacts, natural landscape complexes in many territories of *Nakhchivan Autonomous Republic* were transformed, as a result of which they were replaced by today's landscapes. The study of these replacement or newly formed complexes is of great scientific importance and is one of the most important and basic directions to be investigated. A number of researchers in different years were engaged in the study of modern landscapes of the Nakhchivan Autonomous Republic. Individual researchers approached landscapes from different points of view. The problem of anthropogenic transformation of natural landscapes in modern times can be considered one of the most relevant issues. In accordance with the relevance of the topic, the goal is a detailed study of the role of landscape formation factors, the causes and consequences of the transformation of natural landscapes. In order to determine the degree of transformation of natural landscapes, the boundaries of existing natural landscape complexes were clarified through the ArcGIS program using landscape research, field research materials, satellite images of the mentioned authors, and the area of different landscape types was calculated for the first time.

The plains and lowlands, covering 2,766 km² or 50.3 per cent of the total territory of the Autonomous Republic, are the first of the landscape types to emerge in terms of distribution in arid, cold, semi-desert and dry steppe climates. This type of landscape includes slightly and moderately split flat and sloping plains, and moderately and intensively broken lowland mountainous areas. The semi-desert type of landscape begins on the Sadarak Plain in the northwest and extends to the

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southwest by a strip encompassing the sloping plains of Sharur, Tananam, Kangarli, Sust, Boyukduz, Duzdagh, Garaultepe, Nakhchivan, Darydagh, Julfa, Yaiji, Dasta and Ordubad. This type of landscape is divided into 3 semi-types, which include flat, low-mountain and depression parts of the plain and low mountainous lands. 18 types of landscapes were formed on the flat areas, 10 on the low mountainous and 3 on the depression areas. Flat landscapes occupy 164705 hectares, low-mountain-98942 hectares, and low-lying-12971 hectares. For these landscapes, the total area of the semi-desert landscape type is 59.5%, 35.8% and 4.7%, respectively (table.1.1).

Semi-desert landscape complexes cover territories from 600 m to absolute heights of about 1200-1400 m. This zone differs from other areas in such key landscape-forming factors as soil, flora, fauna, types and species diversity, climate, precipitation and heat supply, and morphometric relief. Semi-desert plants developed in a dry climate with hot summers and cold winters. As a result of warming up the topsoil, the air becomes dry. Summer in this zone passes almost without precipitation. Precipitation falls in spring and autumn. Artemisa is common, Salsola are spread on gray and chestnut soils consisting of alluvial, alluvial-proluvial deposits, menthe, mint, alhagi on the banks of rivers, and hydrophytic plants in places of high humidity.

The slopes of relatively high plains consist of dissected ridges. Slopes of this type of arid-denudation origin are devoid of vegetation and soil cover. Such landscapes are also found around the Darydagh, near the Gyzylgaya Mountain, in the lower reaches of the Garadera, Gilanchay and Duylunchay.

The number of sunny hours here is 2800, the total solar radiation is 145-150 kcal/cm², the average annual temperature is 14.5⁰ C, the average temperature in January is 8-6⁰ C, the average temperature in July is 27⁰ C, the temperature above 10⁰ C is in total 44,00⁰ C, the average annual precipitation is 150-300 mm, possible evaporation is 1200-1400 mm, relative humidity is about 20% [6; 97].

Table 1.1.

Plain and low mountains summer dry winter cold transitional semi-desert and dry rainy climatic semi-deserts

Landsc ape type	Landscape semitypes	Landscape kinds		area (ha)
Semi-desert landscape on plains and low mountains with dry summers, cold winters and dry steppe climate.	Lowland		Artemisia on gray soils of moderately fragmented slope plains.	16234
			Artemisia on primitive gray soils on a weakly fragmented sloping plain.	13668
			Salsola dendroides on meadow soils of a weakly fragmented plain.	2347
			Meadow and swamp vegetation on meadow-gray soils on a slightly fragmented plain	9265
			Meadow on meadow-gray soils on a slightly fragmented plain	3614
			Lawn on irrigated soddy soil on a slightly fragmented sloping plain.	7434
			Artemisia on gray and gray-brown soils on a moderately fragmented sloping plain	19762

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			Lifelessness of sagebrush on gray soils in a slightly fragmented sloping plain	9823
			Salsola vegetation on gray primary and soil salinity of a weakly dissected sloping plain	8231
		0	Salsola on slightly dispersed salty soils	5031
		1	Lifelessness on gray soils on a weakly dissected sloping plain	4746
		2	Artemisia freegana phytocenoses on gray-brown and light chestnut soils in a slightly dissected sloping plain	13942
		3	Ephemeral plants on light gray soils spreading along slightly dissected riverbeds	11856
		4	Ephemeral vegetation, artemisia and thorny shrubs on gray soils in terraced plains	3343
		5	Artemisia and ephemera on clayey soils of weakly dissected slope plains.	6039
		6	Artemisia phryganoid on a slightly dissected sloping plain on flood cones.	7514
		7	Artemisia field on light chestnut-mountain soils in a moderately dissected depression.	6205
		8	Tugai shrub-meadow on alluvial stony-meadow soils of channels and riverbeds	15650

Continuation of Table 1.1

cold semi-desert with dry summers and semi-desert landscape in dry steppe climate in plain and low mountains	Low mountains	1	Astragalus on the chestnut-mountain soils in the medium dissected mountains	6560
		2	Artemisia and astragalus on gray soils in medium and weakly dissected sloping plains	23253
		3	Artemisia phryganoid on gray soils of a moderately fragmented sloping plains	14441
		4	Artemisia phryganoid on gray soils of moderately fragmented terraced-sloping plains.	2885
		5	Salinity and sagebrush lifelessness on primitive gray soils in an intensely dissected sloping plain	4722
		6	In an intensely dissected arid-denudation lowland, mostly soilless and devoid of vegetation	5639
		7	Artemisia on light chestnut and gray-brown soils in intensely dissected mountains	28905
		8	Artemisia and crops on a slightly dissected sloping plain, light chestnut mountain soils	1364
		9	Mountainous steppe, xerophytic plants and xerophytic shrubs predominate in intensely dissected mountainous terrain on light chestnut clay-mountain soils	8638
		10	Artemisia on light chestnut soils in moderately dissected lowland mountainous and sloping plains	2534

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	Valley	1	Artemisa, crops and various herbs on black-carbonate and chestnut-mountain soils in an intensely dissected valley	7671
		2	Artemisa ephemeral on a slightly dissected sloping plain, light chestnut-sagebrush and mountainous soils	2330
		3	Transitional artemisa phryganoid on light chestnut soils in medium dissected valley	2970

The semi-desert landscape covers areas where drought-resistant artemisa ephemeral, lifeless, saline, camel-thorn plants, partially-small bushes in the form of small groups are stretched on saline gray, initially gray, gray, gray-brown, gray-meadow, meadow, alluvial-meadow, meadow-marsh, chestnut-meadow, chestnut soils.

In the dry and cold climate of the middle mountains, the Upland xerophytic landscape covering moderately and intensely dissected mountainous regions occupies an area of 994 km², which is 18% of the total area of the Autonomous Republic. This landscape, which is the third among the landscape types in terms of the size of its distribution area, was formed mainly between the absolute heights of 1200-2000 meters. This landscape type, formed in different areas from the north-western zone of the Autonomous Republic to the south-western end, forms two subtypes, mainly formed in the mountainous and lowland areas of the middle and intensively divided middle mountains. 6 landscape types were formed in mountainous areas and 2 in the remaining valley between them. Mountainous landscapes cover 93,905 hectares, and lowland landscapes cover 5,517 hectares. The share of these landscapes in the total area of the mountainous xerophytic landscape type is 94.5% and 5.5%, respectively (Table 1.2).

Here, the total solar radiation is 145-150 kcal / cm² the sum of temperatures above 10⁰ C is 3800⁰ C, the average annual precipitation is 300-400 mm, the average January temperature is -6⁰ C, the average July temperature is 25⁰ C, the annual moisture deficit is 700-900 mm [5; 107].

Mountain xerophytic landscapes differ from the semi-desert type of landscapes in relief-climatic features, species diversity of soils, flora and fauna. Meadow-shrub landscapes on the intensely dissected chestnut soils of the highlands are spread over a vast area between the villages of Gunnut and Yukhari Yaiji.

This type of landscape also covers the mountainous areas located between the upper reaches of the Gabaglychay and the village of Chalkhangala, having a height of 1400-2600 m.

It covers the Payiz and Turkesh monicline ranges between Nakhchivanchay and Jahrichay, the areas west Gushkayasi and Saridagh, the Kirkklar mountain system, the Daridagh plateau, the middle mountainous areas at the south-eastern end of the Zangazur range, meadow steppe, steppe, freganoid xerophytic plants, sparse meadows and shrubs consisting of various types of trees and shrubs along with cereals are spread on the steppe lands.

Table 1.2.

Mountain xerophytic type of landscape in a cold climate with dry summers in the middle mountains

Landscape types	Landscape semitypes	Landscape kinds		Area (ha)
Mountain xerophyte landscape in a cold climate with dry summers in the middle mountains	Mountainous	1	Meadow-shrub vegetation on chestnut soils in intensely dissected mountains	27069
		2	Transitional artemisia-phryganoid phytocenosis on light chestnut mountain soils in intensively dissected mountains	12647
		3	Sparse xerophytic plants on simple light chestnut soils on intensely dissected and stony slopes	8536
		4	Mountain-steppe and partially mountain xerophytic plants on light-chestnut-mountain soils in intensively fragmented mountains	18322
		5	Mountain xerophytic plants on light chestnut soils on the sloping surface of the middle mountain range	8437
		6	Mountain xerophytes on steppe soils in intensively fragmented mountains	18893
	Valleys	1	Freganoid on chestnut-mountain soils in moderately fragmented valleys	4225
		2	Mountain steppe vegetation on light-chestnut-mountain soils in intensively fragmented valleys	1292

Conclusion. Along with the study of landscapes, modern researchers pay special attention to the development of scientific foundations for their restoration, protection and development in order to maintain landscape and ecological balance and conduct research, which is important in the implementation of measures to protect the environmental situation. . Currently, modern technologies are widely and effectively used for a deeper study of the laws of the landscape.

Thus, the ecological situation in Nakhchivan requires a comprehensive study of anthropogenic changes in natural landscapes and the development of effective measures to some extent to restore the transformed natural landscape complexes. Taking all this into account, the issues of territorial differentiation and anthropogenic transformation of the natural landscape complexes of the Nakhchivan Autonomous Republic, which we have chosen as a research area, are not only of scientific and theoretical, but also of practical importance in the study and assessment of anthropogenic impacts.

By studying the semi-desert landscape in the arid cold semi-desert and dry steppe climate of the plains and low mountains and areas of distribution of mountainous xerophytic landscape types in the arid cold climate of the middle mountains, detailed information was obtained on the main landscape components.

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ANALYSIS OF LEXICO-SEMANTIC CHARACTERISTICS OF PATHOLOGICAL TERMS IN AZERBAIJANI AND ARABIC

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Abstract:

Introduction. *Medicine or medical science is the oldest profession and is a field of theoretical (scientific) and experimental (practical) science that protects, cares for, prevents diseases and restores lost health of living beings. In ancient times, when the first people fell ill or were injured, they used various blessings of nature. Such simple forms of treatment have improved over time and taken the form of folk medicine and medicine.*

Medical science is considered to be the most sacred and honorable profession because it protects and restores health, which is the most valuable blessing given to human beings.

The contribution of Azerbaijani and Arab doctors and scientists in the development of modern medicine is great. Their valuable inventions such as diseases of the body, surgery, treatment methods and measures related to diseases, etc. are used in medicine.

Medical science is the oldest field in terms of history, but it is universal in scope. Medical terminology is one of the most important fields of terminology. Medical terminology is a very comprehensive and complex field. Medical terminology is a field of science that includes medical terms. The rapid development of medical science in modern times plays a major role in enriching the lexical structure of medical terminology.

These terms have developed a lot since they came to their current form. It can be said that medical terms are of Latin and Greek origin. The Latin language still retains its scientific significance in medical terminology. Just as the terminological system of each language contains concepts and expressions related to different fields of science, the medical terminology of the Azerbaijani and Arabic languages is very rich with regards to terms.

One area of medical terminology is also related to pathology (diseases and surgery). Pathological terms are a section distinguished by the relevance of medical terms. Their research is of great interest because of the ancient history of the origin, acquisition and development of terms related to diseases and surgery used in the lexicon of the Azerbaijani and Arabic languages.

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Research method. *The article presents scientific considerations using analysis, description and comparative methods.*

Conclusion and Discussion. *After giving information about the science of pathology (diseases and surgery), a branch of terminology and anatomy, the lexical-semantic features of several terms belonging to this system are explained on the basis of Azerbaijani and Arabic explanatory dictionaries. Here, the meanings of certain terms related to pathology in the Azerbaijani and Arabic languages are found, and their differences and similarities in both languages are identified.*

Conclusion. *The article examines the semantic features of pathological medical terms in both languages, provides information about their subtleties and peculiarities. The author concludes that a comparative lexical-semantic study of medical terms related to pathology demonstrates the antiquity and richness of medical terminology in both languages.*

Key words. *Pathology, scientific terminology, disease, wounds, tuberculosis, Azerbaijani, Arabic.*

Introduction. Pathology (medical pathology) is a word meaning “science of diseases”. In Greek, “pathos” means disease. Pathology (the science of disease) is a field of medicine that deals with the study and research of basic and functional changes in cells, tissues and organs in general.

Medical pathology is classified as surgical, blood and immune, cardiovascular, lymphatic, digestive, urinary, genital, respiratory, endocrine, sensory, skin, nerve, skeletal-muscular and other systems.

“Surgical treatment or surgery refers to the therapeutic effect on diseased tissues with the help of hands, tools and devices” [12, 97]. Due to its nature, the surgery is performed in open and closed forms. Surgery consists of general (asepsis, antiseptic, anesthesiology, diagnostics, etc.) and special (plastic surgery, lung surgery, etc.) sections.

Disease (pathology) and health (normal) are very interrelated processes. According to the ancient Greek philosopher Aristotle, health and disease are two biologically distinct categories. “The completeness, integrity and balance of the organism that can always be protected by a variety of physiologically complex and delicate mechanisms is accepted as health, however, a disorder of the normal functioning of the whole organism as a result of dysfunction in any of the health, organs and systems is disease” [12, 38-39].

Disease and health are opposites, altered forms. The factors that cause the disease in the body are the cause of the disease, while the factors that contribute to the disease are the condition of the disease. The state of a living organism depends on the environment. Factors that contribute to the development of the disease, as well as health, are mechanical (fractures, dislocations, wounds, etc.), physical (freezing, radiation, atmospheric pressure, etc.), biological (viruses, bacteria, insects, etc.), psychological (joy, shock, grief, etc.), social (pandemic, war, etc.), political (religious, political, ethnic views, etc.), space and environmental factors.

Mood disorder is a disease in the body. “Illness is a life spent in abnormal conditions” [12, 40]. Depending on the frequency of development, the disease is

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acute and chronic. Diseases go through four stages: the latent period, the period when the initial symptoms appear (the period of true illness), the period of development and recovery. When an organism becomes ill, all organs and tissues join the disease. Diseases are also classified according to their origin, pathogenesis, variability, pathogenicity, age and sex.

There is information about the III-II millennia in connection with the development of medicine in Azerbaijan. However, the development of practical medicine dates back to the Middle Ages. The medical views and works of Ibn Sina, Zakariya Ar-Razi, Ibn Nafis, Ibn Baytar, Ibn Rushd, Abul Qasim Zahravi, Ismail Jurjani and other great scientists of the East played an important role in the development of doctors in Azerbaijan. Famous Azerbaijani doctors and pharmacists Isa al-Rahi, Abu Mansur Muwaffag al-Haravi, Muhammad Hussein Nur Bakhshi, Kafiyaddin Omar ibn Osman, Muhzabaddin Ali ibn Ahmad Tabrizi, Abu Abdullah Muhammad bin Namwar Tabrizi, Mahmud ibn Ilyas Shirvani, Abdul Majid Tabib, Mansur ibn Muhammad, Ekmeleddin Nakhchivani, Fakhraddin ibn Jabrayil al-Nakhchivani, Yusif ibn Ismail Khoyi, Muhammad Bargushadi, Ramazan Ibn Sheikh Ali Lankarani, Mahmud ibn Ilyas al-Shirazi, Yusif Muhammad Yusuf Tabib, Murtuza Gulu khan ibn Hasan Shamlu, Muhammad Yusif Shirvani, Abulhasan Maragayi, Muhammad Mehdi Ibn Ali Nagi and others who lived between the 10th and 18th centuries can be mentioned. In their works, these scientists gave detailed information about the theoretical and practical issues of medicine. Extensive and valuable information about the protection of health and its causes and factors, the classification of diseases, diseases of individual organs and general treatment are very important for modern medicine.

The history of medicine in the Arabs is especially noteworthy. The Arabs, who were closely acquainted with the ancient Indian, Persian, Byzantine and Greek medical sciences, also contributed to the development of medical science in the countries of these nations with their unique medical discoveries.

Harith bin Kalada, Hunayn bin Ishaq, Abu Bakr ar-Razi, Ahmad bin Abi Ashaat, Jabrayil bin Bakhtishu, Arib bin Said, Ibn Juljal Andalusi, Jabrayil bin Ubaydullah, Abul Qasim Zahravi, Ibn Tufayl, Abu Imran Musa bin Maymun Ibn Baytar, Ibn Abi Usayba, Ibn Quff, Alauddin Ibn Nafis and other Arab scientists are world-renowned physicians who lived in the Middle Ages. In addition to medical discoveries, the works of these scientists are also distinguished by their value. These works, which cover all systems of medicine, there is research and information about theoretical and practical medical issues, diseases and their prevention, etc.

Medical terms on pathology in the Azerbaijani and Arabic languages:

In Azerbaijani: Patologiya (pathology), xəstə (patient), xəstəlik (disease), həkim (doctor), tibb bacısı (nurse), cərrah (surgeon), cərrahi əməliyyat (surgical operation), yara (wound), yaralı (wounded), xəstəxana (hospital), klinika (clinic), poliklinika (polyclinic), laboratoriya (laboratory), Ümumdünya Sağlıq Təşkilatı (World Health Organization), sağlıq problemləri (health problems), sağlıq sığortası (health insurance), tibbi test (medical test), müayinə (examination), müalicə (treatment), injeksiya (injection), simptom (symptom), sindrom (syndrome), diaqnoz (diagnosis), infeksiyon xəstəlik (infectious disease), xroniki xəstəlik (chronic

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disease), xoş xassəli (benign), bəd xassəli (malignant), infeksiya (infection), mikrop (microbe), bakteriya (bacteria), virus (virus), parazit (parasite), epidemiya (epidemics), pandemiya (pandemics), maska (mask), vaksin (vaccine), dərman (medicine), şiddətli ağrı (severe pain), yüngül ağrı (mild pain), rentgen filmi (X-ray film), endoskopiya (endoscopy), qida zəhərlənməsi (food poisoning), ürək infarktı, myalgiya (myalgia), otizm (autism), katarakt (cataracts), sümük əriməsi (osteoporosis), qızılca (measles), böyrək çatışmazlığı (kidney failure), nəfəs darlığı (shortness of breath), allergiya (allergy), vərəm (tuberculosis), qrip (influenza), koronavirus (coronavirus), şiş (tumor), qızdırma (fever), su çiçəyi (chicken pox), baş ağrısı (headache), karantina (quarantine), anesteziya (anesthesia), koma (coma), biopsy (biopsy), amputasiya (amputation), transplant (transplant), anestezioloq (anesthesiologist), kardioloq (cardiologist), radiasiya terapiyası (radiation therapy), kimyaterapiya (chemotherapy), bitkisel müalicə (herbal treatment), geri çəkilmə əlamətləri (withdrawal symptoms), yaşamsal əlamətlər (vital signs), sağlıq mərkəzi (health center), pəhriz (diet), sağlıq (health), şəfa (healing) etc.

In Arabic: علم الأمراض، مريض، مَرَض (داء)، طبيب، مُمْرَضَة، جَرَّاح، عَمَلِيَّة جَرَّاحِيَّة، جُرْح، مُصَاب، مُسْتَشْفَى، عيادة، مُسْتَوْصَف، مُخْتَبَر، منظمة الصحة العالمية، مَشَاكِل صِحِّيَّة، تَأْمِين صِحِّي، مُعَايَنَة الطَّبِيبَة (فَحْص طَبِيبِي)، مُعَالَجَة (عِلَاج)، حُقْنَة، عَرَض، مُتَلَاذِمَة، تَشْخِص، مَرَض مُعْدٍ، مَرَض مُزْمَن، حَمِيد (غَيْر سَرَطَانِي)، خَبِيث، الْعَذْوَى (خَمَج)، جُرْثُومَة، خَلْو مِنَ الْجَرَّاثِيم (مُعَقَّم)، بَكْتِيرِيَا، فَيْرُوس، طُفَيْلِي، الْوَبَاء، جَانِحَة (الْوَبَاء الْعَام)، كِمَامَة (فِنَاع)، دَوَاء، غَابِر، أَلَم شَدِيد، أَلَم خَفِيف، صُورَة شُعَاعِيَّة (تَصْوِير شُعَاعِي)، تَنْظِير دَاخِلِي، تَسْمُم غِذَائِي، اِحْتِشَاء عَضَل الْقَلْب، أَلَم الْعَضَلِي، مَرَض التَّوَحُّد، اِعْتِمَاد عَدَسَة الْعَيْن (كَتَارَاكْت، سَاد)، هَشَاشَة الْعِظَام، حَصْبَة، الْقَتْل الْكُلُوبِي، ضَيْق النَّفْس، حَسَاسِيَّة، تَدْرُن (سَل)، زُكَام (رَشْح، اِلْتِهَاب الْأَنْف)، فَيْرُوس كُورُونَا (كُوفِيد-19)، وَرَم، حُمَّى، جُدْرِي، صُدَاع، حَجَر صِحِّي (مَخْجَر صِحِّي)، تَخْذِير (خَذَر، تَنْبِيح)، غَيِّبُوبَة، الْبَنْزَر، خَزَع (اِسْتِئْصَال جُزْء)، غَرَس (الْأَعْضَاء أَوْ الْأَنْسَجَة)، طَبِيب التَّخْذِير، اِخْصَائِي الْقَلْب، الْعِلَاج بِالْأَشْعَاء، الْعِلَاج الْكِيمِيَايِي، الْعِلَاج بِالنَّبَاتَات الطَّبِيبَة، أَعْرَاض الْاِمْتِنَاع، عَلَامَات حَيَاتِيَّة، مَرْكَز صِحِّي، غِذَاء مُنَظَّم (جَمِيَّة غِذَائِيَّة)، الصِّحَّة، شِفَاء و غَيْرِهِمْ.

Since terms are scientific expressions, it is important to base them on scientific research when trying to explain their essence. Let's take a look at some of the most commonly used terms in both languages:

Yara (wound) (*lat. vulnus; greek. trauma*). "Injuries that are accompanied by a disorder of the integrity of the cover (skin and mucous membranes) are called open wounds. According to the type of factor (tool), cut, punctured, crushed, torn, peeled, bitten, stabbed and firearm wounds are distinguished" [12, 470]. Impairment of skin integrity, separation of edges, obvious appearance of subcutaneous tissue, bleeding, pain, pus, etc. are symptoms of wounds. The field of science that deals with injuries is called traumatology.

According to the Turkologist I.Z. Eyyuboglu, "yara (the wound) originated from the root morpheme yar (abyss, cracked and opened place) in the ancient Turkish language. Yar-a/yara Yar-a/yara (a wound (slit, shoulder, open area) has the same root with yariğ-yarıq (a slit). The verb yarmaq (split) is also derived from yar with the suffix maq. The fact that the word yara is pronounced in the form of yörə in comparison with the Persian yarə (bracelet) makes people assume that it is of Persian origin, but it is wrong" [8, 376].

The term has the following meanings in the explanatory dictionary [1, 531]: 1. Damage to the tissues of the body or its internal organs by any weapon or other sharp,

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solid object and the location of this injury. *Güllə yarası* (bullet wound). *Xəncər yarası* (dagger wound). *Yarasını sarımaq* (wrap the wound). *Yaradan qan axır* (the wound is bleeding). – *Qılınc yarası sağalar, dil yarası sağalmaz.* (Sword wounds heal, word wounds do not heal. (Proverb). *Hənifə arvadla Gülgəz Səmədin dizinin tikanlarını çıxardıb yarasını sarımışlar.* (İ.Hüseynov). (Mrs. Hanifa and Gulgaz removed the thorns from Samad's knee and bandaged his wound. (I. Huseynov). // In any case, an "injury" that occurs in one part of the body. *Əlləri yara içindədir* (His hands are full of the wounds). *Yara yeri* (Scar). *Bədənini yara basmış* (His body was scarred).

2.fig. Pain, suffering, concussion, heart grief. *Ürək yarası* (Heart grief). – [Rəsul:] *Sənəm yarım mərhəm eylər yaraya; Şəhri-Tiflis dedikləri budumu?* ("Aşıq Qərib" dast.). (– [Rəsul:] Sanem, my sweetheart will give you an ointment; Is that what they call –Shahri-Tbilisi? ("Ashig Garib" epos.). 3. fig. About the negative events in the society. *Yazıçı öz əsərində köhnə cəmiyyətin yaralarını açıb göstərmişdir.* (In his work, the writer reveals the wounds of the old society).

The word "yağır" (wound inside the skin) in folk medicine is used in some dialects. In the epos "Kitabi-Dada Gorgud" the word "zəxm" was used instead of the term *yara* (wound).

In the lexicon of the Azerbaijani language, the collocations used in connection with the morpheme "wound" also draw attention. For instance, *yara almaq* –getting injured; *yara vurmaq* –to injure. Fig. *qəlbini incitmək* (to hurt the feeling), *qəlbə toxunan söz demək* (to say a word that touches the heart), *tənə vurmaq* (to scold); *yarası tərsləşmək* (not healing of the wound) –*yarası şiddət etmək* (to make the wound worse); *yara bağlamaq* (to put bandage on the wound) –*imdada çatmaq* (to reach help), *kömək etmək* (to help); *yarasına toxunmaq* (to touch a wound) – to talk about someone's secret pain, to touch a weak spot; *yarasını təzələmək* (to renew a wound) – to make someone sad by remembering their pain, to renew their problem, etc.

The equivalent of the word in Arabic is the term "جُرْحٌ". The term is explained in the explanatory dictionary as following. [2, 586-587; 5, 254; 7, 115; 11, 86; 13, 272; 14, 358-359]:

جُرْحٌ [مفرد]: ج جراح وجروح: الشق أو الأثر في البدن. جَرَحَ يَجْرَحُ: جَرَحًا: أصابه، جُرْحٌ. الجُرْحُ: الاسم من الجرح.

Singular form of the term جُرْحٌ (scar on the body), plural أجراحٌ and جُروحٌ, جراح. The origin of the word is the verb to get injured جَرَحَ يَجْرَحُ جَرَحًا، فهو جارح، والمفعول مَجْرُوحٌ وجريح.

أحدث. 1.wound, injury (medicine.): work of the surgeon. 1- الجُرْحُ (طب): صنعة الجراح. scars in the body caused by weapons, stones and other sharp tools. جَرَحَ الرُّجُلُ: أَصَابَهُ جُرْحٌ. the man get injured. wounded (in singular and plural forms). جَرَحَ ج مَجَارِحَ و الجَرِيح ج جَرَحَى: المصاب بجرح. جَارِح –hurtful, damaging, جُرْحٌ جَائِش –swollen wound, جُرْحٌ دَائِم –bloody wound. جَرَحَى (ج. جَرَحَى). جَرَحَى – wounded man or women (ج. جَرَحَى).

3- الشاهد: 2. To hurt with words, (feelings) to hurt, to curse; 2- هُ بلسانه: سَبَّهُ و شتمه. 4- جَرَحَ، كَمَنَعَ: 3. Witness: not accepting his words and testimony; 3- لم يقبل كلامه و شهادته. 4- اكْتَسَبَ، كاجْتَرَحَ: 4. To sin and other meanings.

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The words قرحة and إصابة are also synonymous with the term جرح. For instance, قرحة المعدة – wound in the stomach etc.

"وَالْأَذُنُ بِالْأَذُنِ وَالسِّنُّ بِالسِّنِّ وَالْجُرُوحُ قِصَاصٌ" (السورة المائدة- الآية 45)

"The nose for the nose, the ear for the ear, and the tooth for the tooth (and revenge for each of them). There is revenge for the wounds". (Surat al-Ma'ida, 45).

الطبيب الجراح (طب): الذي يعالج الجروح و يُمارس فنَّ الجراحة.

– Surgeon (med.): a doctor who treats wounds and specializes in the work of surgery.

جراحة (ج. جراح و جراحات) والجراحي (طب) فرع من الطب يكون العلاج فيه كله أو بعضه قائما على جراحة (ج. جراح و جراحات) and operation. A medical field in which all or part of the treatment is based on surgery. جراحة التجميل – plastic operation, جراحة العظام – orthopedy (operation on bones) etc.

The phraseological expressions used in Arabic in connection with the term “wound” is also interesting:

وَضَعَ يَدَهُ عَلَى الْجُرْحِ: صَادَفَ أَسَاسَ الْمَشْكَلَةِ وَ أَصَابَ حَقِيقَتَهَا، عَرَفَ سَبَبَ الشَّكْوَى

– to put one's hand on a wound: to get to the root of the problem and get the truth; جرح اليد يُجْبِرُ، و – to relieve: to console, to soothe; جرح اليد يُجْبِرُ، و – to injure a witness: to speak ill of the truth, to damage the justice and to deny the testimony; جرح – جرحه بلسانه: سبّه و شتمه – to hurt feelings: to give sadness and pain; جرحه بلسانه: سبّه و شتمه – He hurt him with words: scolded, humiliated etc.

Vərəm (tuberculosis) (*lat. tuberculosis, phthisis*). Tuberculosis is an infectious disease and is currently one of the most dangerous infections in the world. The causative factor of the disease is tuberculosis microbacteria - Cox's bacillus. This perpetrator was discovered in 1882 by the German scientist R. Cox. Chronic disease is more common in people with poor nutrition, weakened immune systems, poor living conditions, heavy smoking, diabetes, and others. The disease mainly develops in the lungs, intestines and lymph nodes. Pulmonary tuberculosis is more common. In addition to humans, the disease is found in domestic animals, wild animals and birds. When a sick person speaks, sneezes or coughs, TB microbacteria are transmitted through the air to healthy people. TB prevention is very important. Timely detection of the disease is very important for effective treatment.

One of the most common terms in the Azerbaijani language is the term vərəm (tuberculosis) of Arabic origin. The word was used in ancient Turkic languages. “Vərəm (Tuberculosis) - a blister on the body as a result of an accident. This disease is called like this as it causes small blisters on the body” [8, 365].

This loan word is explained in the dictionary as following [1, 480.]: An infectious disease caused by a special microbe in the lungs and sometimes in other parts of the body called Cox's microbe. *Ciyər vərəmi* (liver tuberculosis). *Sümük vərəmi* (bone tuberculosis). *Vərəm mikrobu* (tuberculosis microbe).

Vərəmləmək (to get infected to tuberculosis) (verb) - 1. *Vərəm xəstəliyinə tutulmaq* (to get infected to tuberculosis). *Yüksəklərə, mavi göylərə doğru boylanın bacalar Qaraşəhərin zirzəmilərində vərəmləyən fəhlələrin dastanını oxuyurdu.* (M.S.Ordubadi). (Chimneys rising to the heights, to the blue skies, read the saga of

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Singular is سُلَّ and سِلَّ and plural is سُلَال. 1. The source of the word is the verb سَلَّ – والسُّلَّ وَالسِّلَّ وَالسُّلَالُ: الدَّاءُ، وفي التَّهْذِيبِ: دَاءٌ يَهْزُلُ وَيُضْنِي وَيَقْتُلُ – to be weak. سَلَّ يَسْلُ، سَلًّا – debilitating, exhausting and killing disease.

قال ابنُ أَحْمَرَ: بِمَنْزِلَةِ لَا يَشْتَكِي السُّلَّ أَهْلُهَا وَ عَيْشِ كَمَلَسِ السَّابِرِي رَقِيقَ.

As the Andalusian poet Ismail ibn Ahmar (1325-1405) said in his poem:

(Do not suffer like TB at home (i.e. do not be an adulterer), live your life sensitively and well).

Methods. Analysis, description and comparative method of medical terms related to diseases in Azerbaijani and Arabic.

Discussion. “Vocabulary is a valuable asset of any language. This wealth includes the history, life, ethnography of the people, as well as the social life of certain periods, lifestyle, the world of medicine, the state of folk medicine, the reality of health protection and so on. is reflected. Therefore, the vocabulary is constantly reacting to changes in public life and public demand” [9, 7].

The development of science in the world results in the emergence of new terms. The development of medical science and the emergence of new diseases create special terms in the lexical layer of world languages. In modern times, the study of these terms is important for the development of terminology.

“The term is derived from the Latin word “terminus”, which means border, limit, boundary” [10, 7]. A term is a word or phrase that has a definite meaning in a particular scientific system. Terminology is the most active and changing part of the vocabulary. A special and important part of vocabulary is medical vocabulary.

As it is known, medical science has a special terminology. Many terms found in historical medical works, and especially many plant names, belong to Latin, Hindi, and Arabic. Medical terminology has undergone a great development from ancient times to the present day, and has changed and enriched itself with new words. During cultural, economic, diplomatic and other relationships between the countries the exchange of words between languages during communication creates new terminological units. The development of medical science in modern times, medical discoveries have a great impact on the enrichment of its terminology. Medical terminology is the most developed field of terminology in the lexical layer of languages. Medical science has a unique terminology that is not clear to everyone. It is necessary to study it in depth in order to better understand this terminology.

During the lexical-semantic analysis of medical terminology of the Azerbaijani and Arabic languages, it becomes clear that national medical terms predominate in both languages. These terms were formed and improved in both languages due to the laws of word formation.

“The Azerbaijani language is the only means of communication of the Azerbaijani people. As the Azerbaijani language is one of the Turkic system languages, its original words are based on the all-Turkic vocabulary base. The main part of the lexical structure of our language is pure Azerbaijani words” [9, 113]. Compared to Arabic, loan medical terms in Azerbaijani are more numerous. Also, these loan terms are historically different.

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Throughout history, Azerbaijan has maintained good-neighborly and friendly relations with various peoples, in addition to the occupation of border and non-border states and empires. These relationships have led to the inclusion of many words from those languages in the vocabulary of the Azerbaijani language.

“Loan words make up a certain percentage of the vocabulary of our language. They are different in source and origin. Loan words are not the same in all languages, their quantity and date of loaning. When researching loan words in the lexicon of our language, it is necessary to pay attention to when, what historical event they are related to, what words from other languages (domestic, military, scientific, etc.) and how they are derived, with what external signs they come, and whether these words have different sources” [9, 117].

During the Middle Ages, all scientific, political and philosophical terms in Azerbaijan were derived from Arabic and Persian. Over time, these terms have changed their original form and sometimes their meaning in accordance with the grammatical rules of the Azerbaijani language. “Vərəm (tuberculosis)” (ورم), “damaq (palate)” (دماغ), “sətəlcəm (pneumonia) (ذات الجنب) and other medical terms of Arabic origin can be taken as an example. Currently, most of these words are used as common words in the Azerbaijani language.

Arabic has a special place in the enrichment of the vocabulary of the Azerbaijani language with lexical-terminological units. Due to the occupation of Azerbaijan by the Arab caliphate during the Middle Ages, many words and terms of Arabic origin entered the lexicon of the language. The Arabic language had a strong influence on the Azerbaijani language from the 7th to the 14th centuries. During this period, along with words of Turkish origin in the Azerbaijani language, medical terms borrowed from Arabic also prevailed.

The laws of language and its internal development are deeply influenced by innovations in social life. Language as a social phenomenon is connected with society. It lives and develops together with the society. The process of globalization creates a strong flow of words to the lexical layer of world languages, creating conditions for the abundance of information. In modern times, the lexical system of both languages includes a large number of medical terms of English origin, along with Latin.

Medical terminology is a field of science that is constantly evolving. Although medical terms are of Latin and Greek origin, most medical terms are now derived from English.

The terms used in modern Azerbaijani and Arabic languages have come a long way before taking their present form. The history of the origin of medical terms, the process of their formation, as well as the history of lexical addition from other languages are of great interest.

Results. Medical terms, which have a special and important place in the Azerbaijani and Arabic literary languages, include the history and common cultural development of both peoples. In both languages, medical terms are of great importance in terms of their sources, methods of formation, scope and lexical-semantic features. These terms, along with their origin, diversity of meaning,

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simplicity, clarity, level of development, in terms of grammatical and terminological research attract attention.

The culture of Azerbaijan and the Arab people, along with other sciences, is very ancient in terms of history of medicine. “Tibname” and “Garabadins”, which have survived to the present day, are valuable scientific sources that provide information about the antiquity and richness of medical science and its terminology of both peoples, the skills and knowledge of doctors and medical workers.

The development and formation of medical terminology in the Arabs and in Azerbaijan differ from each other. The older the medical history of Azerbaijan, as well as the history of the Arabs is, the older the terminology is. The date of formation and development of medical terminology in the literary language of both languages can be determined with reference to the history of medicine.

“It is necessary to distinguish the existing periods in the history of the formation and development of terminology according to their characteristics. Because it is necessary to take into account the specific features of each of these periods, the directions of development, as well as internal and external factors that determine the development of terminological vocabulary” [15, 5].

Exploring the origins of medical terms can be a great way to determine the date of origin of those words. The medical terminology of both languages differs from each other historically being ancient times, the Middle Ages and the New Age, as well as for the level of development.

Traces of medical terminology can be seen in the ancient Azerbaijani states of Media (VIII-VI centuries BC) and Atropatena (IV-III centuries BC). During the Middle Ages, there was a position of “public physician” called “leut”. In the state of Atropatena, those who engaged in medical work were called “lekar”.

The information about the medical knowledge of the Arabs of the ancient period (the period of ignorance) can be deduced from their poems, proverbs and sayings that have survived to the present day.

A comparative study of medical terms related to pathology in both languages, both diachronically and synchronously, can be of great help in the in-depth study of works written by Azerbaijani and Arab medical figures on diseases and their treatment.

Conclusion. The interaction of languages plays an important role in their development.

Both languages, which differ in their typological comparisons, have their own phonetic, lexical, morphological and syntactic systems. Arabic, an inflected language, differs significantly from Azerbaijani, which has an agglutinative structure, in terms of the variety of grammatical categories and the variety of means of expression.

The study of medical terms in the Azerbaijani and Arabic languages also shows once again that the origin, derivation, structure, meaning, etc. of terms in both languages differ from each other.

Unlike in Azerbaijani, in Arabic these terms are singular and plural, female or male, etc. forms are also available. Such a comparative study of medical terms related to diseases in the Azerbaijani and Arabic languages is a basis for the linguistic study of emerging modern diseases in both languages.

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CORPUS LINGUISTICS: HISTORICAL AND LINGUODIDACTIC ASPECTS

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Abstract.

Introduction. *The article considers the main stages in the development of corpus linguistics. First, the prerequisites for its development are described, it is indicated which branches of linguistics laid the foundation for corpus linguistics. This article details the history of the creation of the first foreign and domestic corpora, and also highlights the main controversial issues about the status of corpus linguistics as an independent scientific discipline. The last issue addressed by the author in the article is the current state of corpus linguistics and its importance in teaching a foreign language.*

Materials and methods. *The development of this approach was the beginning of the creation of corpus linguistics. Many of the technologies that are now used in building cases were invented long before the advent of computers and electronic resources.*

Results. *Based on the experience of foreign countries, we see that NC covers all layers of the language, and for the corpus to work effectively, it is required that each of the levels be equipped with the required information.*

Discussions. *Let's go back a few decades, to the moment when zealous disputes began about its status as an independent discipline. I would like to remind you that in the 60-80s of the XX century, when the first corpora began to be created in the USA and Western Europe, the rational (Chomskian) approach dominated the scientific community.*

Conclusions. *Thus, the linguistic corpus is a means for solving not only scientific, but also educational and methodological problems. The benefits of its application in various fields are beyond doubt, although the theoretical basis has not yet been fully developed*

Key words: *corpus linguistics, national corpus, Brown Corpus, British National Corpus, National Corpus of the Russian language, learning with the help of corpora.*

Introduction. The development of the science of translation in general and various areas of corpus linguistics in particular is largely associated with the use of modern linguistic resources and methods, including large volumes of texts, scientific, socio-political, legal, economic and their translations into foreign languages, collected in parallel boxes. The possibility of using extensive parallel corpora of translations makes real changes in the ways of accessing bilingual linguistic

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information, opens up new possibilities for its analysis and generalization, followed by the application of the acquired knowledge for the purposes of manual and machine translation, compiling dictionaries, and teaching foreign languages.

The most important role for the use of these resources is played by annotation of source text materials collected from a variety of sources, primarily from the Internet, starting from a simple comparison of sections, chapters, paragraphs of the source text with similar structures of the target text - to the alignment of sentences, phrases and words inside sentences, with morphological, syntactic and semantic parsing and comparison of parse trees, either in the model of immediate constituents, or in the model of semantic-syntactic dependencies. The size and degree of annotation of the corpus is determined by the tasks of its researchers. Large corpora, balanced in terms of subject matter, chronology and genres, serve to study the general properties of the language, while when creating specialized parallel corpora, they try mainly to solve the problems of analyzing specific aspects of translation, or specific types of texts, determining authorship, etc.

The development of corpus linguistics, as well as the construction of corpora, is one of the urgent problems of modern linguistics. At the moment, the use of corpora plays a leading role in most linguistic research. Although in the first half of the twentieth century it was possible to build buildings only by hand. It took a lot of time, effort and expense. Therefore, the appeal to the corpora of texts was minimal and only in the case when a large number of people were interested in this. But thanks to the development of corpus linguistics, the use of corpora has become possible everywhere. Structuring and synchronizing material has become much easier, and costs have dropped dramatically.

The importance of the development of corpus linguistics is beyond doubt. It combines many positive features of the humanities and technical sciences. But having arisen relatively recently, it did not have time to fully develop, and its status as an independent science has not yet been established. Thus, many scientists consider corpus linguistics as a sub-field of traditional linguistics. They argue that it has only applied application, and there are no theoretical justifications. In their opinion, corpus linguistics is an improved method of collecting and processing material, a new information resource. On the other hand, if there is applied corpus linguistics, why can't there be theoretical, i.e. discipline that has its own subject, method and theory. The lack of a theoretical basis at the moment does not affect the possibility of its development in the future.

Materials and methods. In the middle of the XIX century. the scientific community was dominated by a rational approach based "on linguistic intuition, distinguishing between correct and incorrect constructions" [1, 14]. In contrast to this approach, an empirical approach appears, which proposes to consider the language as "a resource that provides a set of opportunities for communication" [1, 14]. The development of this approach was the beginning of the creation of corpus linguistics. Many of the technologies that are now used in building cases were invented long before the advent of computers and electronic resources. Some of them were used as early as the 18th-19th centuries, when linguistics began to be considered an independent and independent scientific discipline. The famous Rosetta stone,

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created in the 2nd century BC, can be considered the beginning of the parallel building . and containing a parallel text in 2 variants of ancient Egyptian writing and in ancient Greek [2]. Back in the 60s , R.G. Piotrovsky argued that only from a large array of texts can one obtain reliable data on the semantic structure of language and speech [3,144].

In his textbook "Corpus Linguistics" Zakharov V.P. names the technologies that influenced the creation of cases. He identifies three main areas of linguistic research that formed the basis of corpus linguistics, although he notes that there were many more [4, 25].

The first such area he singles out is comparative-historical linguistics. Scientists working in this field have always turned to a huge number of different texts. The use of technologies for the reconstruction of proto-languages can also be found in modern linguistics. The second area, which Zakharov V.P. preference is the compilation of grammars and dictionaries and language teaching. Indeed, any grammatical rule needs to be illustrated. And in this case, examples from the text can perfectly help with this. Corpora as sources of empirical data play an important role in teaching a foreign language. The last area to influence the development of corpora is sociolinguistics. As early as the 19th century, scientists began to develop dialect maps and compile collections of dialect relations. At the same time, it was necessary to take into account various criteria when compiling manuals on dialects. All these factors served as the beginning of corpus linguistics.

At the moment, corpus linguistics is successfully developing the technologies and methods that led to its birth. Also, do not forget about the technical side of the issue. There has been a sharp leap in the development of computer and information technologies. These possibilities began to be successfully used in linguistics and linguistics. Thanks to the development and popularization of the global Internet, a huge number of users from different countries could use the data from the corpus. In addition, the problem of completeness and expansion of the buildings no longer arose. Most of the research in the field of corpus linguistics has been carried out on the material of English texts. There are two main reasons for this: firstly, there is an active development of computer technology in North America and Western Europe, and secondly, there is a favorable climate for the development of British linguistics in the 60-80s. 20th century

Brown corpus is considered to be the first linguistic corpus . corpus). It was developed in 1963 by N. Francis and G. Kuchera at Brown University. The volume of the first corpus is 1 million word usages, i.e. it includes 500 fragments of 2000 word usages each from texts of different genres: literary texts of famous writers and poets, articles from newspapers and magazines, examples of written business speech and texts on religious topics. There are several reasons for the creation of the Brown Corpus. First of all, this is the provision of a systematic study of English texts belonging to various genres. Secondly, providing a sufficient amount of material to compare these data. Thirdly, attracting the interest of many scientists to the emergence of a new scientific discipline. This was a breakthrough in applied linguistics, which caused a lot of controversy and discussion. As for the compilation of the corpus itself, it was built, on the one hand, on the basis of statistical data, and,

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on the other hand, on the experience and intuition of scientists. To achieve objectivity, it was necessary to use simple and transparent texts.

Later, in 1971-78, following the example of their American colleagues, European scholars began compiling another body of texts. It is called the Lancaster - Oslo- Bergen Corpus of British Modern English (The Lancaster - Oslo / Bergen corpus of british English , LOB). The compilation of this dictionary was carried out mainly by British and Norwegian scientists. They were guided by the same principles as scientists from Brown University. For the period of creation, it consisted of 500 texts belonging to various genres, with a volume of 2000 word usages.

The most popular at the moment is the British National Corpus (British National Corpus , BNC). It was created in 1991-1994. researchers from Oxford University and Lancaster University. Its volume is 100 million words and it is much larger than its predecessors. It consists of 90% written texts and 10% oral texts. The texts belong to the end of the 20th century and represent various genres. In it you can find newspaper articles, non-fiction literature, examples of business correspondence, texts on religious topics, transcribed recordings of informal speeches, radio shows, government speeches, etc.

Results. It is worth noting that it was the British Corpus that received the status of "national" first. Plungyan V.A. writes that “for the British, the word “national” meant primarily “characterizing the British national version of the English language”. After all, there are also American and Australian English. But after a while, this corpus became the standard of all corpus and the meaning of the word “national” changed somewhat. The corpus, which is the largest and most representative and which characterizes the language of a given country as a whole, began to be called national. Plungyan V.A. notes that the national corpus should not only be large in volume, but also contain texts of various genres in all their diversity in a given historical period, and at the same time contain them in the correct proportion [5, p. 7].

Take for example the British National Corpus (BNC from English. *British National Corpus* is a 100-million-word corpus of written and spoken British English from a wide range of sources. The corpus covers British English of the late 20th century, represented by a wide variety of genres, and is intended to be representative of the typical spoken and written British English of the time. [12]



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Many countries, following the example of the British National Corpus, decided to create their own national Corpus. Russia is no exception. For seven years from 2003 to 2010, scientists worked on creating a single text base. The Association "National Corpus of the Russian Language" offered cooperation to the "Yandex" company and with their technical support a website was developed, which hosts the current version of the National Corpus of the Russian Language. It contains more than 163 million word usages for the period from the middle of the 18th to the beginning of the 21st century. Thanks to the presence of texts from various eras, it is possible to find examples of both modern and historical texts. At the same time, the texts belong to the literary, colloquial, official business and scientific styles.

Based on the experience of foreign countries, we see that NC covers all layers of the language, and for the corpus to work effectively, it is required that each of the levels be equipped with the required information.

As we can see from Table 1, the BNC structure consists of 90% written and 10% oral corpus, which includes all styles and genres of the language. BNC is monolingual, that is, it contains only British English words. For example, let's turn to the National Corpus of the Russian Language (NCRL) [13]

Национальный корпус русского языка —
представительная коллекция текстов на русском языке,
оснащенная лингвистической разметкой и
инструментами поиска

ИРЯ ИЛП РАН Яндекс

[Подробнее о Корпусе](#)

Введите слово или фразу Искать

Основной (336 млн)	Параллельный (151 млн)	Поэтический (13 млн)	Мультимедийный (5 млн)
Газетный (790 млн)	Обучающий (664 тыс)	Устный (13 млн)	Мультипарк (229 тыс)
Синтаксический (1 млн)	Диалектный (485 тыс)	Акцентологический (133 млн)	Исторический (13 млн)

The difference between NCRL and BNC is that there is no division into written and oral corpus. It consists of 12 corpora covering the entire language structure.

On the official website of the National Corpus of the Russian Language there is a reference article about the meaning of the term "corpus", about the rules of use, and the purpose of its creation is also clearly defined. It also describes the structure of the National Corpus. It currently consists of the following sections:

- Main corpus (prose written texts of the 18th - early 21st centuries);
- Syntactic corpus (in which a complete morphological and syntactic structure is built for each sentence);

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- Newspaper corpus (articles from the media of the 1990-2000s);
- Parallel corpora (in which you can find all translations for a certain word or phrase into Russian or from Russian);
- Corpus of dialect texts;
- Corpus of poetic texts;
- Educational corpus of the Russian language (corpus with removed homonymy, the markup of which is focused on the school curriculum of the Russian language);
- Corpus of oral speech;
- Multimedia corpus (includes fragments of films from the 1930s-2000s provided with video and audio sequences);
- Corpus of the history of Russian stress (texts containing information about the history of Russian stress).

Russian National Corpus covers almost all facets of the language.

It should be noted that the national corpus of the Russian language is not the only corpus of the Russian language. Grudeva E.V. in his work "Corpus Linguistics" he singles out several more corpora [8, 35]. The first of these is the Uppsala Corpus of the Russian Language (The uppsala Russian corpus). It is the first corpus of the Russian language. Scientists from the University of Uppsala in Sweden worked on the creation of the Uppsala Corpus in the late 1980s and early 1990s. It includes 600 fragments of artistic and informative texts with a volume of about 1 million word usages.

It is also worth paying attention to another corpus of the Russian language. It was developed in 1999-2004. in Germany, at the University of Tübingen . It got its name according to the place where it was created (Russian Tübingen Corpus). It was developed on the basis of the Uppsala corpus, but the number of word usages has grown to 25 million word usages.

Discussions. Let's go back a few decades, to the moment when zealous disputes began about its status as an independent discipline. I would like to remind you that in the 60-80s of the XX century, when the first corpora began to be created in the USA and Western Europe, the rational (Chomskian) approach dominated the scientific community. Noam Chomsky and his supporters shared the opinion that the construction of correct and incorrect language constructions can be carried out only on the basis of the intuition of native speakers. The American linguist was an ardent opponent of the corpus approach, and there is a lot of evidence for this. N. Chomsky's answer to the interviewer's question about Chomsky's attitude to corpus linguistics is well-known: "There is no such thing" [8, 195]. And in one of the Corpora-List teleconferences, supporters of N. Chomsky entered into a discussion about the irrelevance of corpora [9, 334]. A supporter of N. Chomsky, Professor Robert Leese, in 1962 at a conference at Brown University, said that the creation of the corpus "is a waste of your time and government money. You are a native English speaker; within ten minutes you are able to present more examples of any phenomenon of English grammar than you can find in many millions of words of random texts" [9, 26]. There is undoubtedly some truth in their statements, however, corpus linguistics has found many supporters, both among scientists and in the government. More and more funds

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began to be allocated for the creation and modernization of buildings. “Linguistics has now largely rid itself of early generative illusions, in particular, of the belief that linguistic mechanisms as such can be known using a very limited set of examples (usually composed by the linguist himself). These rather naive ideas are being replaced by an understanding of the need to build a study of even the “smallest” fragment of the language system using a representative set of texts of the corresponding language” [10, 94]. As a set of texts, of course, there is a linguistic corpus. Although the criteria for the representativeness of such a corpus are not yet clear enough, the task that is set for the corpus is already well defined. “The corpus must have quantitative and qualitative parameters necessary and sufficient to build on its basis an adequate dictionary and grammar of the corresponding language” [11, 93].

When creating the National Corpus of the Russian Language, scientists, of course, asked the obvious question: for whom will the corpus be useful? In what areas of life can it be applied? Plungyan V.A. answered this question quite fully . in his work "Why do we need the National Corpus of the Russian Language?". First of all, it is an invaluable tool for professional linguists: “One way or another, they deal with the facts of the language, which means they must collect and systematize these facts” [5, 8]. Secondly, it is very useful for programmers. Not surprisingly, they immediately supported the idea of creating it. Of course, the linguistic corpus is also useful for people who have connected their lives with the word, for example, writers, editors of newspapers and magazines. Any difficult moment can be checked by referring to the body.

And, finally, the building will become an excellent assistant for teachers and teachers, both at school and at the university. In the world's leading universities, it is becoming a daily practice to use corpus data as material for lecture courses, student assignments, and independent projects.

All over the world, in higher education institutions, data from linguistic corpora are used in the preparation of various lecture courses and assignments for students. Many students themselves use corpus data when working on projects and homework. It can be assumed that students who are encouraged to independently study the language, its features and traits, master language competencies faster and more efficiently than those who are hammered into the head with the rules.

At the moment, one of the most popular areas of the corpus approach in teaching a foreign language is learning with the help of corpora, or data - driven . learning (DDL). The essence of this training is that students use "raw" language data directly from the corpus. This direction is based on the assumption that students can learn a language much more effectively when the learning process is encouraged to use the observe-guess-experiment model, i.e. when they have the opportunity to draw their own conclusions about the meanings of words, phrases, grammatical rules based on linguistic material. The process is not necessarily limited to a computer terminal. The results of corpus searches (concordances) in printed form can be easily incorporated into handouts, teaching aids, etc.

The corpus approach in teaching a foreign language changes the nature of the student's learning activity and puts him at the center of the learning process. The role

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of the teacher will be to organize and control the research activities of students. At the same time, the formation of students' ability to autonomously master linguistic knowledge and skills will require the teacher to make certain efforts to create methodological materials. As N.L. Baidikova, "one of the functions of a teacher in organizing training in effective methods of independent work is the methodological support of this process. The development of manuals seems to be the most important task, otherwise the organization of independent work of students turns into a laborious, cumbersome and uneconomical process" [9, p. 108]. You should be prepared that the corpus will not always give out data corresponding to the explanatory dictionary. Many of the examples can be difficult for students to understand.

At the current stage of the cultural and intellectual development of our country, one of the priority tasks is the formation of intellectual potential in the field of science, modern personnel, and high technologies. Cultural and information exchange presupposes active interaction. This, in turn, serves the intensive development of corpus linguistics in all its fields. The large-scale reforms in the language policy carried out in the republic led not only to the beginning of a new era in the development of the Uzbek language, but also to the transition to a new stage of research work in linguistics, increased attention to applied research that studies the language taking into account the human factor. Along with a number of tasks set for scientists, new goals were defined, which are to create the National Corpus of the Uzbek Language, software for the corpus, create linguistic foundations and linguistic models, as well as raise theoretical, practical and applied research to the level of the world standard.

Conclusion. Thus, the linguistic corpus is a means for solving not only scientific, but also educational and methodological problems. The benefits of its application in various fields are beyond doubt, although the theoretical basis has not yet been fully developed. That is why scientists still cannot answer the question: "What is corpus linguistics: a new scientific discipline or just an information resource?" We hope that soon the answer to this question will be found and corpus linguistics will become an independent scientific discipline.

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THE PROBLEM OF STUDYING THE CONCEPTS "GENDER" AND "SEX" IN WORLD LINGUISTICS

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Abstract:

Background. *The study of the correlation between biological sex and the choice of social behavior seems promising in terms of a systematic description of an individual's gender behavior. Despite the extensive literature in science, there is still no single view on the nature of gender. It is referred, on the one hand, to mental constructs, or models developed with the aim of a clearer scientific description of the problems of sex and the differentiation of its biological and sociocultural functions. On the other hand, gender is seen as a social construct created by society, including through language. Description of the relationship between the terms "gender" and "sex" is an urgent task of modern linguistics.*

Methods. *The research methodology is based on an integrated approach that includes various methods. The leading method for analyzing and presenting the results of the study was descriptive (with its main components: observation, generalization, interpretation, classification). The comparative method and the structural-semantic method were also used.*

Results. *Developments in the field of gender relations existed in the world humanitarian knowledge for almost two centuries, but genderology as a science that studies gender relations began to take shape in the 60-70s of the twentieth century. Gender issues and gender approach are gradually acquiring the status of a relatively independent theoretical discipline, with its own subject of study, with its own metalanguage, since gender studies have their own key categorical concepts, the main of which are "gender", "sex" and "gender stereotypes". The relationship between the concepts of "gender" and "sex" can be disclosed as follows. Natural gender is a component of the meaning of lexical units that reproduce the existential parameters of an individual. Gender reflects both the process and the result of the "embedding" of the individual in the socially and culturally determined model of masculinity or femininity, adopted in a given society at a given historical stage. The concept of "gender" covers broader layers of the language than just those units whose semantics include the "gender" component.*

Conclusion. *Modern science defines gender as a conventional ideological construct, which accumulates ideas about what it means to be a man and a woman in a given culture. The social nature of gender distinguishes it from sex, which is a biological categorization based primarily on reproductive capacity. The introduction of gender as a category of analysis into the research apparatus of linguistics opened*

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up prospects for comprehending various aspects of language from a different perspective.

Keywords: *gender, linguistics, humanitarian knowledge, biological gender, social gender, feminist linguistics, gender identity.*

Introduction. The end of the 20th century was marked in linguistics by the intensive development of new research paradigms based on the principle of anthropocentrism in the study of linguistic phenomena. When studying a person in a language, the individual characteristics of a linguistic personality are of great importance, the most important of which is gender. Gender determines his social, cultural and cognitive orientation in the world, in which language plays one of the main roles. Developments in the field of gender relations existed in the world humanitarian knowledge for almost two centuries, but genderology as a science that studies gender relations began to take shape in the 60-70s of the twentieth century. At this time there was a radical turn in the approach to gender studies. It was caused both by a change in the scientific paradigm and by social changes. The development of sociolinguistics, the formation of the postmodern theory of knowledge and the rise of the feminist movement played an important role. In linguistics, a separate direction has been formed - linguistic genderology, in which, along with the use of data from other sciences, its own set of methods and techniques has been used to study the manifestation of gender in language and speech.

Research methods. The research methodology is based on an integrated approach that includes various methods:

- Descriptive method;
- comparative method;
- structural-semantic method.

The leading method for analyzing and presenting the results of the study was descriptive (with its main components: observation, generalization, interpretation, classification).

Results. Gender issues and gender approach are gradually acquiring the status of a relatively independent theoretical discipline, with its own subject of study, with its own metalanguage, since gender studies have their own key categorical concepts, the main of which are such concepts as "gender", "sex" and "gender stereotypes". The theoretical basis of gender linguistics is the concepts of genderism (I. Hoffman), power (M. Foucault), cultural conditioning of gender-role differentiation of society (M. Mead). At the same time, in linguistic genderology there is no "one clearly defined methodological dominant. We can talk about the coexistence of a number of research microparadigms.

Discussions. The concept of "gender" was introduced into the scientific description in order to draw a line between the concepts of biological sex (sexus) and the social and cultural implications that are invested in the concept of masculine - feminine: the division of roles, cultural traditions, power relations in connection with hollow people [5, S. 24].

Sociologists and philosophers were the first scientists who forced the scientific world to look at the problems of gender from the point of view of its fullness with social, psychological and cultural aspects. It was they who first introduced an

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alternative to "sex" - "gender". The concept of "sex" plays the role of a label to denote the biological characteristics of men and women, and "gender" - contains a huge complex of social and psychological processes, as well as cultural attitudes generated by society and affecting the behavior of the individual, the choice of social strategies, etc. [9, p. 180]. In modern science, two positions have been formed in relation to sex and gender: either to distinguish between these concepts, or to synonymize them.

The relationship between the concepts of "gender" and "sex" can be disclosed as follows. Natural gender is a component of the meaning of lexical units that reproduce the existential parameters of an individual. Gender reflects both the process and the result of the "embedding" of the individual in the socially and culturally determined model of masculinity or femininity, adopted in a given society at a given historical stage. Thus, the concept of "gender" covers broader layers of the language than just those units whose semantics includes the "gender" component.

Thus, it is possible to distinguish between the "biological" gender and the "social" gender. Biological sex is a specific anatomical structure of the individual, social sex is manifested in a set of specific social roles offered to the individual, and in a significant way related to his structure. However, in the event that legal institutions or political structures are more essential for the functioning of society, the identification mechanisms of the individual undergo a transformation. As a result, the biological sex becomes irrelevant in determining the role of the individual in society. Rather, the biological sex is taken into account as long as it does not conflict with the social position occupied. As soon as such a contradiction arises, it is not the position that changes, but the gender self-identification [13, p. 80].

The concept of "social gender" in science is called "gender". Gender is not a purely linguistic category; this concept has long gone beyond the scope of grammar. This phenomenon is widely regarded as a sociocultural, discursive and psycholinguistic phenomenon. Gender is a large complex of social and psychological processes, as well as cultural attitudes generated by society and affecting the behavior of a national linguistic personality [10, p. 124].

Gender is a social construct, a real-life system of interpersonal interaction, through which the idea of masculine and feminine as categories of the social order is created, confirmed and reproduced. Gender is one of the basic dimensions of the social structure of society, along with class, age and other characteristics that organize the social system. Gender is also a social status that determines individual capabilities. And since social statuses operate within the cultural space, gender as a status corresponds to gender culture. Thus, in gender there is a complex interweaving of cultural, psychological and social aspects. Therefore, it is of interest not only to philosophers and sociologists, but also to representatives of a number of sciences, including linguists. Both language and speech can be analyzed in terms of their reflection of gender relations. The language considers sex from the angle of the social significance of this category, which makes it legitimate to apply the concept of "gender" to all phenomena of the language related to the problem of gender [5, p. 23].

Until today, there is no unified view of the nature of gender in science. It is referred, on the one hand, to mental constructs, or models developed with the aim of

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a clearer scientific description of the problems of sex and the differentiation of its biological and sociocultural functions. On the other hand, gender is seen as a social construct created by society, including through language [5, p. 10].

In linguistics, the study of the gender aspect is very important, since its specificity allows linguists to consider in detail the feminine and masculine picture of the world and, thus, better understand the real-life behaviors of men and women, as well as the characteristics of masculine and feminine speech strategies and tactics.

Despite the fact that the concept of “gender” is currently widely used in modern scientific discourse, there is sometimes controversy among linguists about the use of this term. So, for example, some authors suggest using terms that include the word “sex”: social (sociocultural) gender, sexual dimorphism, sex-role differentiation, etc. The term “sex” seems to many researchers acceptable also because in Russian, unlike English, the concept of “gender” is not identical to the concept of “sex”, because it was this fact in the English-language scientific discourse that became one of the reasons for the introduction of the term “gender.”

S.A. Ushakin, the author of the work “The field of sex: in the center and along the edges”, speaks out against the use of concepts “not having adequate symbolic forms in the Russian language”: “...an analysis of gender as a social institution, on the one hand, and the use of the methodology of modern foreign studies sex and sexual relations, on the other hand, do not inevitably lead to the Russification of English or French concepts. In other words, that “sex” should not turn into gender in order to become the subject of scientific research” [13, p.72]. Thus, the author proposes to distinguish between the concepts of “biological sex” to denote the biological parameters of the individual and “social sex” - for socially conditioned ways of personal representation.

The diversity of social characteristics of women and men noted in the world and the fundamental identity of the biological characteristics of people allow us to conclude that biological sex cannot be an explanation for the differences in their social roles that exist in different societies.

Table 1. Characteristic masculine and feminine features that form gender oppositions

Characteristic masculine features	Characteristic feminine features
Strong, athletic	Weak, unwilling to exercise
Worries less about his appearance and almost no fear of old age	Worried about her appearance and afraid of old age
Has sexual experience	Virtuous
Family breadwinner	Homemaker
Unemotional, persistent	emotional, tender
Logical, rational, objective, has a developed intellect	Frivolous, inconsistent, has a subtle intuition
Strives for power and leadership	Submissive, helpful
independent, free	Dependent, needs protection
Active	Passive
Striving for success, ambitious	Timid, shy

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To be a man or a woman in society means not just to have certain anatomical features - it means to fulfill certain gender roles assigned to us. Gender roles are learned behaviors that condition activities, tasks, and responsibilities that are perceived as masculine and feminine. Gender roles are not constant, changeable, diverse both within the same culture and in different cultures. Gender identity is constructed in the social sphere and is determined by socio-cultural factors, depending on the characteristics of a particular society. In the process of social activity, an individual affirms his or her formed gender image in society (consciously or unconsciously), thereby participating in the formation of the gender outline of the social structure.

There are a number of biological and social interpretations of the role relations of men and women in society. These representations are gender stereotypes. The term stereotype is interpreted as a certain "representation" of a fragment of the surrounding reality, a fixed mental "image", which is the result of the reflection of a "typical" fragment of the real world in the consciousness of the individual, a certain invariant of a certain part of the picture of the world [7, p.177]. In modern society, there are many different stereotypes, including gender stereotypes - culturally and socially conditioned ideas about the qualities and norms of behavior of men and women.

Currently, there is a tendency to weaken such stereotypes. Psychological research has shown that there is no "purely" masculine or feminine personality. The idea that stereotypes are not something natural, but are created by society, is increasingly penetrating both scientific and everyday consciousness. The women's movement and feminist ideology have largely shaken many gender stereotypes. As we can see, the complex concept of gender includes several subsystems: biological sex, gender stereotypes, gender roles and gender identity. None of these subsystems can be reduced to the concept of gender or be equated with it. And therefore, the term "gender" cannot be discarded, since it is part of the names of institutionalized scientific units, periodicals and has justified itself as a designation of an interdisciplinary scientific direction. If the category "sex" is significant for the analysis of the semantics of a number of lexical units, where gender is a component of meaning, then gender studies in linguistics cover a much wider range of issues and consider the construction of masculine and feminine identities as one of the parameters of a speaking personality, i.e. within pragmatics. The concept of gender is often interpreted as a specific set of cultural characteristics that determine the social behavior of women and men, their relationship with each other. Gender studies in linguistics are represented by two main areas - linguistic genderology and feminist linguistics. Structural separation of feminist linguistics and gender studies is due to the presence of different objects of research in these areas. Within the framework of feminist linguistics, the problem of gender is emphasized from the standpoint of the linguistic inequality of women and men. The object of study in feminist linguistics is linguistic behavior in natural speech situations that have social significance (public institutions, the media, etc.). Almost all the work done in the feminist direction is aimed primarily at social

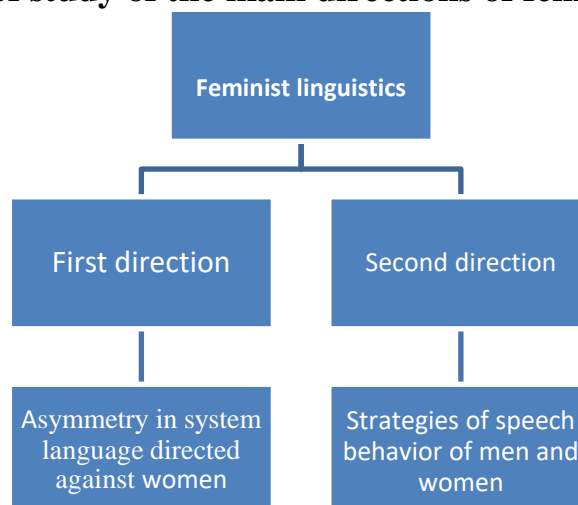
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political practice. The object of study of gender linguistics is the speech behavior of men and women, typical strategies and tactics, gender-specific choice of lexicon units, gender preferences in the choice of syntactic constructions - that is, the specificity of feminine and masculine "speaking".

Gender linguistics appeared after feminist linguistics. This term was proposed by L. Push [11]. It should be noted that representatives of feminist linguistics believe that the language is androcentric, and set out to destroy the patriarchal canons and models of linguistic expression. The history of feminist linguistics spans over fifty years. In 1970, Mary Rich Kay organized the first seminar on language and gender at the University of California, and then in 1975 published a book based on the materials of this seminar called "Masculine / Feminine Language" (MR Key, Masculine/Feminine Language) [4]. It is believed that the theoretical basis for the emergence of feminist linguistics was the work of O. Jespersen, E. Sapir, F. Mautner, as well as the Sapir-Whorf hypothesis of linguistic relativity. So, for example, in the work of O. Jespersen "Language: its essence, origin, development" there is a chapter "Woman", but there is no chapter "Man", because the author considers the feminine language to be marked, and the masculine language to correspond to the literary norm. The German philosopher and linguist, F. Mautner, noted that women can only learn the language that men create [1, p. 20].

Scheme 1.

The object of study of the main directions of feminist linguistics



In feminist linguistics, two main directions can be distinguished. The first direction explores the discrimination of the image of a woman in the linguistic picture of the world or "asymmetry in system language directed _ against women." Representatives his believe that _ language fixes masculine vision world, "imposing" men's values and evaluation. From this should the conclusion that practically all functioning languages _ in our patriarchal society, are "masculine". And image women reflected _ in language, equipped negative connotations and characteristics. One from central objects research first directions became lexicon language, so how exactly in German especially clearly reflected negative definitions in respect women. For example , agreement on the syntactic level according to the form of the grammatical gender of the corresponding part of speech, and not according to the real referent of gender, the concepts of "man" and "man" are identified , but in some

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European languages these concepts are simply interchangeable, feminine forms usually are derivatives from masculine, and not on the contrary (Student ~ Studentin [German], actor - actress, poet ~ poetess [English]), lexical means describing women and their qualities have predominantly negative connotations, which is especially pronounced in paremiology and phraseology, where women are attributed in mainly objectivity, or men are opposed to them as carriers of opposite principles and qualities. For example, Men are the stronger sex. A woman's place is in the home. It's a man's world. A woman's tongue wags like a lamb's tail. Foxes are all tail and women are all tongue. many women, many words; many geese, many turds. The second direction of feminist linguistics was the study of the characteristics of communication in mixed groups. The latter is based on the assumption that on the basis of patriarchal stereotypes fixed in the language, different strategies for the speech behavior of men and women develop.

The fundamental work in the field of feminist linguistics, which served as an impetus for the development of studies of the "feminine" language, was the work of Robin Lakoff "Language and the place of a woman", where she substantiates its androcentricity, as well as the inferiority of the image of a woman in the masculine picture of the world. R. Lakoff singled out the following distinguishing features of the feminine language: a specialized dictionary associated with women's areas of activity and interests; more accurate, detailed color naming - mauve, lavender / mauve, lavender, aquamarine, etc.; affective adjectives used to express an emotional attitude, rather than denotative information, and words-intensifiers; separating questions that imply a woman's insecurity when expressing her own opinion - don't you? isn't it? / is not it? is not it? Yes? it is so? words and phrases of diffuse semantics that soften the categorical nature of the statement (hedges) - kind of, sort of, you know, well super politeness and tendency to euphemism; hypercorrectness, etc. Subsequently, R. Lakoff's hypothesis was subjected to numerous analyzes, some of the above theses were confirmed, and some were refuted [8].

R. Lakoff, C. Krameny, M. Daly are representatives of the dominance paradigm, which tends to attribute more social value to the feminine language than to the masculine one. In linguistics, there is also an oppositional paradigm of differences, whose representatives are D. Tannen, J. Holmes, D. Moltz and R. Broker and others. They consider communication between men and women from the perspective of two cultures. For example, D. Tannen sees the following differences between feminine and masculine speech: men and women form different patterns of language use; women pay more attention to affective (interpersonal) functions of communication than men; women are more likely than men to use linguistic forms that emphasize solidarity; women build communication in such a way as to maintain and strengthen relationships of solidarity; men in communication (especially in official contexts) seek to maintain and strengthen power and status; in the same social situation, women use more standard forms than men from the same social group [12, p.253].

As we have already noted, in Europe the founders of feminist linguistics are L. Push, who in her work "German is the language of men" claims that the German language is convenient and clear only for men. Another representative of the

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analyzed direction, S. Treml-Plötz, adheres to the theory of scarcity, previously put forward by R. Lakoff, and agrees that feminine oral and written speech lacks aggressiveness, dominance, etc. [10, p. 125].

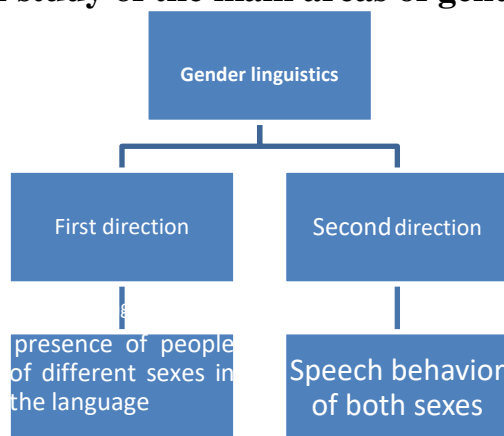
It should be noted that feminist linguistics not only preceded the emergence and development of gender linguistics, but also made a significant contribution to its development. Feminist linguistics has introduced a number of new linguistic concepts and expanded the interpretation of the traditional concepts of "linguistic behavior" and "meaning", contributed to a deeper study of the word-formation and nominative systems of the language, as well as cultural stereotypes of femininity and masculinity in general. However, according to E.I. Goroshko, the most significant achievement of feminist linguistics can be considered that "this discipline allowed women to "see themselves differently" through language, express themselves differently in language, and simply be heard" [3, p. 541].

Despite the fact that feminist linguistics served as a kind of basis for the development of gender linguistics, its theorists are condemned for being too emotional and biased when studying a language from a gender point of view, which sometimes leads to false conclusions and assessments. In our opinion, this can be avoided directly in gender linguistics, which studies the speech characteristics of both sexes and involves other disciplines in the study of language and gender, for example, sociolinguistics, psycholinguistics, intercultural communication, literary criticism, etc., which indicates the interdisciplinary nature of the concept under study, which can be studied in different directions.

There are two main directions in gender studies. The first direction is connected with the analysis of gender reflection in language. The focus is on the nominative system of the language, the category of gender, syntax. The main task that researchers set themselves is to study and describe ways of fixing the presence of people of different sexes in the language. The second direction studies the speech behavior of representatives of both sexes. The most typical communication strategies for men and women, the choice of lexical units, syntactic constructions, as well as the specifics of masculine and feminine behavior are analyzed.

Scheme 2.

The object of study of the main areas of gender linguistics



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A.V. Kirilina in the study of language and gender identifies the following areas: 1) sociolinguistic gender studies; 2) feminist linguistics; 3) gender studies proper (studying the linguistic behavior of both sexes); 4) the study of masculinity (the youngest direction that emerged at the end of the 20th century); 5) psycholinguistic research; 6) cross-cultural, linguistic and cultural studies, including the theory of gender subcultures. However, the author of this classification considers it conditional, and the directions listed above may have much in common [6, p. 42].

In sociolinguistic studies of gender, the works of U. Labov and P. Tradzhil, who mainly dealt with the phonological aspect of language and gender, occupy a significant place. U. Labov, for example, in the course of his research found that women use prestigious forms of pronunciation, and the frequency of differences in pronunciation between men and women decreases with an increase in social status and level of education. Approximately the same conclusions were reached by another researcher P. Trajil [2, p. 15].

The psycholinguistic gender direction studies the specifics of masculine and feminine associations, the reflection of images of masculinity and femininity in linguistic consciousness, the gender-specific development of a person's language ability, and children's speech. The researchers involved in this area include E.I. Goroshko, A.M. Kholod, G.A. Vartanyan, V.I. Galunov, N.N. Nikolaenko, F.G. Samigulina, M.V. Kitaygorodskaya, N.N. Rozanova, E.S. Oshchepkova.

Linguocultural and intercultural studies reveal the cultural specifics of gender, the general and the special in its construction, depending on the language and culture of a given society, which makes it possible to establish the degree of androcentrism of different languages and cultures. Conducting research on the material of different languages also makes it possible to identify the features of the national worldview, study national concepts, identify and describe ethnic stereotypes that are expressed in speech activity as a necessary component of intercultural communication.

The most detailed and detailed process of the emergence and development of gender linguistics in foreign and Russian linguistics is presented in the works of O.A. Voronina, E.I. Goroshko, E.S. Gritsenko, A.V. Kirilina, G.G. Slyshkina and others. One of the authors who made a significant contribution to the development of gender linguistics in the post-Soviet space is A.V. Kirilina. In the book "Gender Studies in Linguistics and Theory" she covers such important questions for linguistics as the concept of "gender", the philosophical foundations of gender studies, the evolution of gender studies in linguistics, the conceptual apparatus and methods for studying the gender aspects of language and communication. In the course of the research, the author dwells on the description of the current state of gender linguistics, pointing out that "a new scientific direction is being developed mainly by young researchers", because the academic environment initially did not show any interest in gender [6, p. 81].

Gender linguistics studies language and speech behavior using genderology tools, and linguistic gender studies, respectively, studies gender categories using linguistic tools. However, according to A.V. Kirilina, it is not always possible to draw a clear line between these two directions. Also A.V. Kirilina examines in detail

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the relationship between such concepts as "gender" and "sex". The author notes that among Russian linguists there is no unity of views on this problem. Some linguists (S.A. Ushakin, M.A. Krongauz) prefer to operate with the concepts of "gender" and "gender identity", because the concept of "gender" does not have adequate symbolic forms in the Russian language. Another researcher, O.V. Ryabov, believes that the concepts of "sex" and "gender" are correlated as a whole and a part. According to A.V. Kirilina, the term "gender" cannot be replaced by the term "sex" or discarded, although its derivatives are more often used in Russian: gender studies, gender aspect, etc. The word "sex" helps in the context to understand in which cases we are talking about biological aspects, and in which - about culturally determined. According to A.V. Kirilina in Russian linguistics tends to use both terms, as is already happening in German [6, pp. 120-127].

Conclusion. A review of the scientific literature on gender linguistics shows that this area of research is quite young and continues to develop: this is evidenced by the insufficient development of the conceptual apparatus and categories, the dual approach to defining the direction itself (gender linguistics or linguistic gender studies), as well as the ambiguous interpretation of the concepts of "gender", "gender" and "gender stereotypes" in terms of linguistics.

Modern science defines gender as a conventional ideological construct, which accumulates ideas about what it means to be a man and a woman in a given culture. The social nature of gender distinguishes it from sex, which is a biological categorization based primarily on reproductive capacity. The introduction of gender as a category of analysis into the research apparatus of linguistics opened up prospects for comprehending various aspects of language from a different perspective.

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PROVERB AS AN ESSENTIAL LEXICAL UNIT REPRESENTING NATIONAL CULTURE AND IDENTITY

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Abstract:

Background. Modern paremiology studies proverbs and their wide usages in various linguistic functions. Proverbs are considered to be one of the most essential folklore types that are closely related to this or that nation's national identity and culture. They reveal some inner secret data related to national identity of this or that nation. Every language contains some proverbs that have got peculiar features of the language that cannot be repeated in other languages in neither form nor meaning.

Methods. The proverbs' peculiar features, their relationship with culture and national identity of the nation, comparative analysis of this or that nation's proverbial layer is studied with the help of observational, secondary data analysis, descriptive, comparative analysis.

Results. Proverbs reflect emotional characteristics of any nation that has got a language communication, the investigated expressions either coincide in some basic categories or express polar points of view and attitudes. Being a valuable object of linguo-cultural investigations proverbs realise not just functions of the language but that of culture as well. Proverbs and sayings are an integral part of the national language picture of the world. As linguo-cultural units, proverbs explicit a definite layer of culture of a separate ethnic group, reflect spiritual and physical activity of culture representatives, the peculiarities of mentality and world perception of a definite linguo-cultural society.

Discussion. Proverbs reflect cultural values widely accepted in the society and contain widely used and accepted evaluations of human behavior and actions or deeds in various situations and in different circumstances. Surrounding phenomena often become part of proverbs. Analyzing origins of some proverbs we can state that firstly they were used as religious teachings nearly in every language. They were accepted as advice or recommendation that had to be followed completely due to some religious obligations. From the very early era of human civilizations proverbs were implemented in people's speeches as the lexical units that served for forming some rules and shaping social relationship in different languages. Due to this analysis one can state that proverbs can have more cultural and national data than any other lexical units.

Conclusion. Proverbs are mirrors of this or that nation's cultural, historical identity. They can even reveal some forgotten or unused cultural features of this or that nation. Proverbs are keeping valuable data related to the nation's traditions, beliefs, rituals, folklore and etc. Even today they may be used to shape some behavioral rules in society and play as one of the main principles of teaching and

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upbringing some layers in it. Proverbs are probably one of the key ways to influence or persuade a person to fulfil this or that task. They are powerful and persuasive lexical units used in spoken and written speech.

Keywords: *cultural identity, heritage, peculiar features, pariomological basis, historical background, data.*

Introduction. At present time paremiology has become one of the most popular linguistic sections that require much attention to study in order to reveal some unique features of a language related to culture and national identity. As we know proverbs are studied in paremiology and they are the main target of learning. Proverbs contain a lot of essential data that are closely tied with nation's traditions, customs, rituals, festivals, holidays and etc. They belong to folklore of the nation and pass from mouth to mouth, from generation to generation for centuries. Proverbs as we see them now are made so long ago that origin of some of them are not known or clearly formed. But anyway they are actively used as important way of teaching, bringing up young people or forming special rank of behaviour in society. Proverbs do not only shape social rules but they sometimes dictate rules of life.

This rich culturally loaded material should be included in a speech course. The knowledge of proverbs of the studied language leads to better understanding of culture and national identity. Proverbs are able to give interesting glimpses at a people's geography, religion, history, social views and attitudes. If a person is not aware of culture of this or that nation sometimes it is complicated or even impossible to comprehend the meanings of some proverbs. Proverbs are materials that seem to have got special data chip including data about nation's culture and identity; that is why a person who is unaware of culture, historical background of the nation cannot be able to get into the context or concept that is meant by this or that proverb.

Proverbs and sayings are short statements of wisdom or advice that are transmitted from generation to generation and have passed into general use. Every culture has a collection of wise sayings that offer advice about how to live your life. Proverbs have been considered the flowers of popular wit and the treasures of popular wisdom. Widely recognised as the world's leading paremiologist, or scholar of proverbs, German-born US academic Wolfgang Mieder defines a proverb as: "a concise statement of an apparent truth which has currency among the people"[1].

We can see culture, traditions and history of the nation, to learn what is kind and evil and feel what a nice means for developing of man's moral values and cultural level can proverbs and sayings be. English proverbs characterize distinctive character traits of England, like self-restraint, self-control, tolerance, conservative, hard work, love of their home and health. And I also tell you about love to the animals, gardening and tea ceremony. Proverbs are vivid manifestation of national art and important part of language. In proverbs people shared their ideas of truth, love and friendship, justice, man and his relationship with people around him, life and death, wealth and poverty, in the past and present, in the various aspects of reality [2]

Proverbs and sayings have been developing together with the history of the people. They reflect people's mentality and transferred from one generation to another both in written and oral form. The main sources of proverbs and sayings are

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drawing from other languages, Bible text and folk. There are proverbs which are common for the most of people of the world and which are peculiar for a certain nation [3].

Methods.

Any nation can somehow have got some proverbs that were probably copied from other languages but each tongue contains some paremiological units that are unique in that culture; that cannot be found in other languages. This is peculiar feature of any language paremiology.

Proverbs are derived from the wisdom of common folk. Often, familiar metaphors are used to encapsulate profound life experiences. Interestingly, they are often used casually and without much thought — if my ancestors said this and so does everyone around me, so will I.

Below we are going to give different opinions of linguists concerning proverbs and their relationships with culture.

Whether called maxims, truisms, cliches, idioms, expressions, or sayings, proverbs are small packages of truth about a people's values and beliefs. Values like ambition, virtue, generosity, patience are addressed in sayings from most every culture [3].

The "language - thought" model refers to the process of expressing one's thought through the word and its outcome. In this group mind, thought and mood is actively used. The proverbs and sayings of this group mention about the relationship between language and thought. "Language is known as a vehicle which expresses a person's thought" [4].

Communicative phraseological units include proverbs and sayings which are often used in the process of intercultural communication. Proverbs and sayings are the product of folk's art. They are known to all people of the world. Each nation or ethnic group has its own proverbs and sayings which reflect customs and traditions, way of life and mentality of people [5].

In nearly every culture, proverbs, communicated in colorful and vivid language, offer an important set of instructions for members to follow. These "words of wisdom" endure, so that each generation learns about what a culture deems significant [6].

Proverbs are especially interesting because, like much of ordinary language, they accomplish both conceptual and pragmatic work. On the one hand, proverbs offer succinct ("pithy") descriptions of events. A familiar expression such as "It only takes one bad apple to spoil the barrel" brings a number of salient and well-known propositions about people and social life to bear on a particular person or situation. In doing so, this proverb provides an interpretation of specific actions or events in terms of a general, shared model [7].

Proverbs express happiness, joy, pain, suffering, advice, command, prohibition, training and accuracy in decision-making and other notable points, and for this reason they are passed from mouth to mouth and often have similar shapes. And they become believable, and this is because proverbs themselves express cultural cognition based on experience in the event [8].

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The functions idioms and proverbs fulfill in daily discourse and the means for performing those functions in meaningful communicative ways without violating the conventions of social appropriacy is far more critical than mere quantity of acontextualized idioms or proverbs learned [9].

Human communities belonging to different nations, countries and continents, are no longer isolated. Not only one planet Earth unites us, but also the common interests of survival on this planet, the development of civilization and the development of cultures [10].

All these opinions prove that proverbs are part of culture describing some issues existing in it.

Those who utter certain proverbs may not really appreciate how profound they are, and those who hear them may just reply with a cursory nod. Accustomed to hearing these sayings, people believe that there must be a deeper meaning behind them, even if they may not fully understand it themselves. This is just like a villager receiving a hot steamed bun from someone — he would just eat it. He wouldn't think about where the flour came from, how the wheat was milled, or how the crop got from farm to table.

Only when their environment changes and they arrive at a foreign land would people see such sayings in a different light. The local proverbs — also spoken casually — seem to be morsels of wisdom distilled from thousands of years of life experiences. Now, when they go back and think about the sayings they themselves have heard since they were growing up, they would suddenly realise that those phrases also sprouted out of their own culture's various circumstances and conditions.

Results.

Proverbs are essential norms that are able to define key cultural, historical background of this or that nation. There are some proverbs that are peculiar only to that language; one cannot meet proverbs with such content and meaning in any other culture or language. This shows that proverbs carry unique national identity of this or that nation.

A proverb is a saying that expresses a common truth. It deals with truth simply and concretely and teaches the listener a lesson. It can help to understand a culture and can help to determine if it is a group- or individual-oriented culture. It may also help in understanding what is desired and undesired as well as what is considered correct or incorrect in the culture. In nearly every culture, proverbs, communicated in colorful and vivid language, offer an important set of instructions for members to follow. These “words of wisdom” endure, so that each generation learns about what a culture deems significant.

Discussion.

Below we are going to present some proverbs used in some languages that are connected to culture and identity giving peculiar cultural, historical features. Here we should remind that proverbs have got characteristics of teaching people and forming them into a social rule and state's law. Some proverbs make people good, obeying religious people. Below we are going to give some examples in the English language and discuss how they represent cultural and historical features of the nation:

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a) The grass is always greener on the other side of the fence – this proverb teaches us it's not good to be jealous (to want what other people have). It may seem like everyone around you has “greener grass,” meaning nicer cars, better jobs, etc. Being one of the most used and popular proverbs in English it gives some data related to the lives of English people. The nation has always had neighborhood relationship that influenced the language and its content.

b) Don't judge a book by its cover - things are not always what they seem. This proverb teaches you not to make judgments about other people because of how they look or dress. A book with a boring or plain cover could be amazing. The same is true with people. A person might look like an athlete or fool, but there is probably a lot more to them than clothes suggest. Books are printed in England in massive production since the time when printing machine was brought to the country. Books have always been essential part of the English nation that impacted lexical layer of the language as well.

c) Strike while the iron is hot - this old proverb comes from the days of blacksmiths (people who work with metal). To shape the metal, the blacksmith would have to beat it with a hammer. Iron is easier to work with when it's hot. This proverb means you should take advantage of the moment. If an opportunity presents itself to you, take it! Take action because the chance may not come again.

d) When in Rome, do as the Romans do - when you are a visitor somewhere away from home, you should act like everyone else. It is polite to do so, and could keep you from getting into trouble. This proverb is from the ancient days of the Roman Empire when the capital city had visitors from all over the world. Cultures were very different between cities in those times. But while in Rome, one would behave like a Roman, no matter where you came from.)

The origin of this proverb takes us to the very ancient time when the British Isles were conquered by the Roman Empire, era when this state was also mixed up with the history and culture of this great Empire in history. Nearly half of the world was ruled by the Romans, a lot of nations were under their rule but when they happened to be in Rome they have to forget about their culture, traditions for a while to behave as a Roman person in the capital city of the Empire.

e) Don't cross the bridge until you come to it - this proverb tells you not to worry so much! Problems will certainly come in the future. But what can be done about that now? It's better to think about what you are doing right now—without worrying about the unknown—and take care of issues when they happen.)

One of the most commonly used English proverbs which teaches people how to behave appropriately. This is pure English proverb that is connected to its every day life.

f) An apple a day keeps the doctor away[11].

An apple is full of Vitamin C, which keeps you healthy. However, the “apple” in this proverb means eating healthy in general. If you eat well and your diet includes a lot of fruits and vegetables, there will be no need to visit the doctor.

This proverb is probably popularly used in many languages being told in original version or in translated form. Each person remembers the English language or people when this proverb is used.

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The following proverbs are taken from the Russian language; we are going to analyze them to see cultural and national features in the content of them:

a) Без труда не вытащишь и рыбку из пруда.

Without hard work you cannot achieve anything in your life, hard work, dedication to your job may guarantee you to reach your goal. This proverb shows peculiar features of Russian culture, this nation's life style was related to catching fish in past, the proverb reveals historical features with its content.

b) Будет день — будет и ночь.

Another proverb that is based on natural phenomenon of rising of the day and setting of it. The proverb teaches people not to worry when a problem comes out as a human being can have both good and bad days. When bad days are coming to you, it means that good days will also approach you soon.

c) Все в свой срок: придет времечко, вырастет и семечко.

Another proverb that can be called as a pure Russian one, the proverb that contains data related to every day life style, traditions, customs of the nation as well. Probably the origin of the proverb is related to agriculture of the Russian people. How hard you try, this or that plant or corn gets ripened only on appointed time, neither earlier nor before appointed time. The proverb teaches people to be more patient, to wait for something happen on its time.

d) Всяк человек своего счастья кузнец.

Another proverb that reveals cultural and national identity of the nation; Russian men were engaged in iron-making in past as well, they were able to make various things from this material; this effected their language content too. The proverb above teaches people that building their own happiness is due to their own attitudes towards life and how hard they try to achieve their target.

e) Не всегда коту Масленица[12].

Another proverb containing peculiar features of Russian culture and history. As we know before starting a big fast, Russians have a big holiday “Масленица”. They celebrate it setting a big table and giving a big feast, people sing songs, dance, play different national games. The proverb above contains this holiday's name relating it to the language content. The proverb suggests that people cannot have happy or feasting time every day. There are some days when people have ordinary days.

f) Нет друга — так ищи, а нашёл — так береги.

Friendship is important human relationship that is appreciated in all cultures; Russian culture is not an exception. This shows how human relationships are mirrored in their language and life.

Uzbek paremiology has also got some specific themes that cannot be met in other languages. One of the key themes that exist in Uzbek proverbial world is laziness. A lot of proverbs teach people not to be lazy, be industrious. Stupidity is another vice that is criticized in Uzbek society and culture. Below we are going to describe several proverbs in Uzbek.

a) Аҳмоқнинг кулгуси кўп,
Дангасанинг — уйкуси.

The proverb that criticizes bad evils in person's character agitating to be well-behaved, helpful person to society.

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- b) Ари захрин чекмаган
Бол қадрини билмас.

One of the most popular proverbs in Uzbek that is related to appreciating things, richness that is achieved with the help of hard work. A person should appreciate, value what he or she has got, that is usually done by the person who has achieved those things by his hard work.

- c) Бекорчидан эл безор,
Сўзидан кўнгил озар.

Uzbek people are industrious and hard-working people from the past; Uzbek society respects people who do their jobs professionally. The proverb above also agitates hard work, doing the job professionally, as it says the people do not like lazy and loafer.

- d) Бозорингни ўзинг қил,
Тегирмонингни ўзинг торт.

Another Uzbek proverb that reveals some content related to national identity and culture of the nation. The proverb contains words as “market”, “mill” that is related to Uzbek life and culture. Uzbek people’s lives are linked with bazaars where they went not to do their shopping only but to get news, to get acquainted with social, political and cultural life of the state. Mills were important places for making bread. The proverb suggests people should earn money for a living by their own power and they should not be albatross around another person’s neck.

- e) Боғни боқсанг — боғ бўлур,
Ботмон даҳсар ёғ бўлур [13].

Another Uzbek proverb that is related to the nation’s past. Nearly every Uzbek family had orchard where various fruits were grown, a proverb says if you look after your garden well, you can have a luxurious life without financial problems. It is another proverb that teaches people to be hard-working, job-loving.

Below we are going to look through some proverbs in the Tajik language to see their characteristic features as well.

- a) Аз дӯсти нодон душмани доно беҳтар.

Friendship is one of the key themes in paremiology. It has always been at the centre of attention, the proverb above teaches people not to get friend with a silly, stupid person, this person may cause problems to you.

- b) Гап дар калла, на дар салла.

Another pure Tajik proverb reveals some peculiar features of Tajik nation. Science and getting knowledge has always been appreciated and agitated in Tajik society that impacts language content as well. Mind is considered more important for a human being rather than other outer things of a human being. No we wear is important but what knowledge we master dominates over other things in life as the proverb suggests.

- c) Сад задани сузангар, як задани оҳангар.

Another Tajik proverb that reveals peculiar features of Tajik culture. Men and women have got separate functions in Tajik society to fulfill that cannot be mixed up. Each gender’s role is appreciated separately. Men’s work in hard physical activities is

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vividly difficult and how hard the woman tries to fulfill to do man's actions, it is probably difficult for them to do that task as the proverb says.

d) Кудак азиз аст, адабаш аз он азизтар.

Being Eastern state Tajik language has got a number of proverbs that are related to education and upbringing of children and kids. The proverb above teaches parents that it is important to bring up children well, as their behaviour play crucial role in forming rules in society.

e) Офтобро бо доман пушида намешавад [14].

One of the most popular Tajik proverbs that may have analogues in other languages as well meaning that it is impossible to keep something secret as everyone knows a thing that is popular and known to everyone. Being a sunny state Tajik language has got lexical units that are related to the sun in proverbs as well. One cannot hide the sun with a cloth as the proverb says; that is why it is better not to try to keep something secret, it is better to avoid doing misbehavior.

Analysis of proverbs in several languages revealed some essential data about this type of folklore. Our cultures have many layers of meanings, while proverb provides only a small part to understand culture. However, it does offer a kind of window to seek through the outside world—the culture diversity. And in this way, proverb is a good way to analyze what the other kind of culture is and why it is being so. At the same time, proverb provides important information of the culture pattern or culture value orientation

Conclusion.

In brief we can state that proverbs are mirrors of this or that nation's culture and history. National identity is formed with the help of the most essential historical events of the nation, besides geographical location, natural surroundings, language and others can have big impact on its shaping. It is based on traditions, customs, everyday life style, rituals, holidays, festivals, folklore that are coming from generation to generation. Proverbs in every language have got peculiar features that are not repeated in other tongues and cultures. Proverbs used in our speeches may refer to a number of historical and cultural events happened in the past. It can reveal some unique features of national identity. Proverbs are creations of the nation. Most of them were just created by ordinary people who lived according to some social rules. One cannot deny the fact that proverbs play a vital role in the lives of people, to form some social discipline, that is to say proverbs are more than simple lexical units to persuade or influence some people, they are markers of national and cultural identity of the nation.

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LITERARY CRITIC BEGALI KASIMOV IS A RESEARCHER OF MODERN LITERATURE

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Abstract:

Background. Begali Kasimov, while analyzing and researching the legacy of the representatives of modern literature from a scientific and theoretical point of view, determined the general and specific aspects of modernism and modern literature. Studied the similarities and differences of the Jadidism movement of Turkestan with Tatar Jadidism, the ideas of Jadidism in Azerbaijani and Kazakh literature, and "Tanzimot" in Turkey.

Methods. The article uses historical-comparative, analytical, hermeneutic, biographical and sociological methods of analysis.

Objective. The practical result of the work is expected to be: Begali Kasimov's researches on jadidism and jadid literature: the first stage; 2) perfection; 3) proves that it has gone through a gradual process, such as the study in the context of world literary movement; it is proved that in the works of the scientist mainly sociological, biographical and hermeneutic research methods are used;

The analysis of scientific works shows that the scientific and theoretical basis for the study of modern literature was developed in the research of Begali Kasimov;

Begali Kasimov's scientific works prove that the common and peculiar features of the interpretation of the ideas of Jadidism in the literature of the Uzbek and fraternal peoples are studied in a comparative aspect.

Conclusion. Literary scholar Begali Kasimov seriously studied the literature of the Jadid period, studied and analyzed the works of the artists of that period on a deep scientific basis. The scientist studied the works of Mahmudkhoja Behbudi, Abdulla Avloni, Mirmukhsin Shermuhamedov, Saidrasul Azizi, Sofizoda, Nozimakhanim, Sidqi Khandayliqi, Tavallo, Botu, Mirmulla, Cholpon, Fitrat, Kami and acquainted them with their creative activity. He identified the connection with Russian and world development movements. It showed the role and place of modernism in the formation of the national idea, renewed social thinking, national liberation, independence movements and their development in mutual cooperation with the literature of the Uzbek national renaissance. He brought the term "Uzbek literature of the national renaissance" into scientific circulation. It is a clear proof that his research on Jadidism has gained attention and recognition abroad in the USA, Germany, France, Turkey, Japan, Russia, Korea, Ukraine, Afghanistan, Iran, Kazakhstan, Kyrgyzstan, Tatarstan, and Bashkortostan. In addition, how should the researcher understand the content of "new literature" in the pamphlet "I searched and found..."? asks the question that it is known to everyone that the new era in the science of history began with the bourgeois revolution that took place in European

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countries, including England, from the 17th century. When we say "new era" in literature, we mean important changes in its content, of course. For example, in Europe, the understanding of the history of world literature as a whole process begins with the time of Voltaire. In the East, after a long period of stagnation in historical and cultural life, the transition to new social relations and a new way of thinking is connected with the ideology of enlightenment. Social activism became the most important feature of the literature of this period. Issues ranging from any limitation of personality to social justice have been put on the agenda of literature, says the researcher.

Keywords: *independence, enlightenment, education, agility, revolution, progress.*

Introduction. Special attention was paid to national issues, the independence and freedom of the nation, the emergence of journalism, prose, dramaturgy, revision of socio-aesthetic principles became the leading feature of the literature of the new era. The researcher compares the literature of this period with representatives of Arabic, Turkish, and Indian literature. Creators of Arabic literature Mustafa Kamil (1874-1908), George Zaydon (1861-1914), Namiq Kamal (1840-1888) in Turkey, Abdulhaq Hamid (1852-1937), Ahmed Mithat (1844-1913), Tavfiq Fikrat (1867-1915), Indian Urdu poet Muhammad Iqbal (1877-1933) also expressed social spirit and social relations in the works, which shows that this aspect was expressed not only in Uzbek literature, but also at the international level at the end of the 19th century and the beginning of the 20th century. At the beginning of the 20th century, the socio-political image of Turkestan was extremely complicated, and the cultural way of life of the people was in a very deplorable condition. Such changes taking place in the life of the society did not fail to have a strong influence on the literary life of the nation. The scientist researches on the basis of the evidence that the stratum of intellectuals, who have various agitations against oppression in the field of social consciousness, began to manifest themselves in this process, including that this process took place not only in our country, but also in neighboring countries such as Tsarist Russia, Azerbaijan, Crimea, Tatarstan, and Bashkortostan. In Begali Kasimov's research work entitled "Mirmuhsin Shermuhamedov and his literary environment", the scientist cites the following opinion of Abdulla Tokai, who expressed the intellectual awakening in Tatarstan: "For centuries, our thinking has been submerged in the swamp of darkness. Who took us captive? It's time to break the cages and fly, breathe freely. "Let's renew our thinking!", their thoughts give an example of the growth of the Tatar people and culture to a new stage.

Materials and methods. *The article uses historical-comparative, analytical, hermeneutic, biographical and sociological methods of analysis.*

At that time, the cities of Tatarstan and Bashkortostan, such as Kazan and Ufa, became important points of social and cultural activity, and writers such as Aliaskar Kamal, Fatikh Amirkhan, Majit Ghafuri provide information that they continued the path started by Abdulla Tokai, which directly shows that the scholar's modernism is not a narrow topic. , proves that its scope and scale is a wide process, he scientifically proves it in his research. In this process, the peoples of the Caucasus and

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Bashkortostan were united in mind and heart in this regard, and contributed to the rise of the struggle against oppression by being sad and pained, shoulder to shoulder. As a result of social, political and cultural cooperation with the Tatar and Azerbaijani peoples, cultural growth and intellectual awakening began in Turkestan at the beginning of the century, including the establishment of the press, the publication of newspapers and magazines, the establishment of theater, and the beginning of noticeable innovations in literary genres, 1905-1917 the cultural upliftment in the country was particularly noticeable in the 1990s, the lithography "Ghulomiya" by Ghulam Hasan Orifjanov, Ilin and Pertsev lithographs were put into operation, and for the first time in the history of Turkestan, books were published in multiple copies, in 1907, readers of the first progressive newspaper "Shuhrat" under the editorship of Avloni. The information presented in the research on the reference to the verdict serves to expand the imagination of the cultural growth in the social life of the period. In general, the researcher makes a comparative analysis of the processes that took place in the social, political and cultural life of Turkestan in 1905-1917 in the historical aspect. The events of 1916 left their mark not only in our country, but also in the literature of the brotherly peoples living in Turkestan.

Results and discussion. The proof of our opinion is that dozens of poems and epics have been created in Kazakh literature, which has a rich tradition of folk art. We pay attention to the following information, which reflects the sad scenes of labor recruitment, published in the scholar's 1983 pamphlet "Izlay-izlay-tengim...":

Shiniminen my slave,
Are you going to the beach?
Who knows,
What else are you missing?!
Kurap Katgil Kuv Patsha,
Let him build with satisfaction!
Contents:
My dear servant,
Are you going, soldier?
Who will have it
For property left without owner?!
Get rid of the king
Let him fall from his throne!

It seems that in this place, such a terrible event as labor recruitment in 1916 can be found in the literature of all the brotherly peoples living in Central Asia. In the same way, condemnation of the tsarist government, which mercilessly suppressed the Turkestan liberation movements of 1916, feelings of sympathy for the working people can be found in the works of Tatar poets. For example, if we pay attention to the excerpt from the poem "Bir Navha" by Majid Ghafuri:

Hearts are broken,
Bloodshot eyes.
It's a terrible day...

Or Sh. Babich's poem about General Abdulaziz Davletshin, who participated in the suppression of that famous "Recruitment" uprising in Turkestan:

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You, Abdulaziz, put an end to all conflicts,
Don't stop killing any Muslim for the sake of faith or conscience.

While researching the details, causes and consequences of the events of the single labor in this process, we can witness that he found a 2-volume book entitled "History of Kazakh Literature" published in Kazakh in 1965, a 2-volume selection of M. Ghafuri published in Kazan, and analyzed the poems in it. Or, he gives information from L. Qayumov's book "Revolution and Creation" published in 1964. The researcher points out that these indelible pages of the history of the liberation movement of Turkestan were repeatedly referred to by the writers of the Soviet era, in particular, in the novels "Kutlug Khan" and "Childhood" by Oibek, Nazir Safarov extensively described the Jizzakh incident of 1916 in the memoir "Korgan kiferganyrim", writer Asqad Mukhtar. He points out that a chapter in the novel "Plant" is devoted to this topic, and this topic is also widely described in the poetic novel "Baqi Dunya" by Muhammad Ali. At the same time, brother Turkmen and Kyrgyz poets Mukhtar Avezov's "Difficult Time", A. Nurpeisov's "Blood and Sweat", B. Kerboboev's "Dalid Step", Kh. cites that his poetic novels such as "in front of" were recognized as an important event in his time.

Also, the views on religious progress and solidarity against European colonialism, characterized by the names of Jamaluddin Afghani (1839-1897) and Muhammad Abduh (1849-1905), which were widespread among Eastern Muslim countries at the end of the 19th century, cannot be overlooked. The term "Jadid" is used in Turkey to refer to the literature of the beginning of the 20th century, and its only direction. We also find the terms "Russian Jadidism", "Bukhara Jadidism", "Turkistan Jadidism". In our opinion, the movement is common, the views are different because they are clear, the essence is the same - renewal. It was manifested in different forms in different places. For example, in Turkey in 1839, when the famous Mustafa Rashit Pasha wrote and published in Gulkhana Square, and went down in history under the name "Gulkhonai khata Humayun" and started the "Tanzimot", the researcher says, the period of renewal is modernism. True, it was based mainly on westernization. Therefore, national ideas such as "Turkism", "Ottomanism", "Islamism", and "Turanism" were thrown into the background. Europeanization was one of the important characteristics of modernism in our country. We also know that the tsar's government used this to Russify the local people. But the criterion was to leave the local people's religion and beliefs untouched, and to use European science to protect them. It is not for nothing that Turkishism, Islamism, and local Uzbekism come to the fore here as well. In fact, the confusion of thoughts and ideas in our modern times is very strong. For example, Muqimi, Furqatlar, who were at the beginning of the formation of new Uzbek literature, were generally correctly interpreted as representatives of modern literature in the 1930s. In his comic works, Mukimi criticizes trade and industry, that is, the capitalist way of life, which destroys our national morality. And Furqat praises his coming into our lives. One is affirmative, the other negative. Or let's take Dukchi Eshon, who is a supporter of achieving independence by force. He also appears as a Jadid: a religious reformer, a political fighter, but our Jadids rejected him. A number of our Jadids consciously cooperated with the Soviets and became communists. It is

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emphasized that it is necessary to reckon with them, and this is especially evident in the struggle for independence. This process was analyzed in the scientist's research in the following 3 ways:

1. Getting rid of dependence on Russia by force, gaining independence by force (Dukchi Eshan uprising, labor movement of 1916, printing)

2. The way of reconciliation. Enlightenment with the help of Russians. Getting rights, restoration of national characteristics in the matter of enlightenment (I.Gasprali, M.Behbudiy).

3. The way of cooperation. Participating in their programs with the Tsar authorities, and then with the Soviet government, and gaining independence as soon as possible. Jadidism in our country is more tied to traditions than jadidism in the Caucasus, Volga, and Turkey, and it was difficult for jadidism to be involved in the pan-European socio-cultural process. The democratic and open policy in the country, which began in 1985, made it possible to study modernism on a scientific basis and in a planned manner. A number of scientific conferences were held on this issue, including a special meeting devoted to Turkestan modernism was convened on November 10, 1987 in FATAI of Uzbekistan, and at this gathering, specialists of our Republic who have been dealing with this field for a long time had the opportunity to exchange ideas. On October 12, 1988, a similar international symposium will be held with the participation of scientists from Azerbaijan, Tatarstan, Tajikistan, Uzbekistan, and Moscow. 15 people will participate with a lecture. Writer Izzat Sultan will start the discussion. The orator defined the formation and development of modernism as the traditional years 1905-1917, dividing the path he traveled by October 1917 and dividing it into two. Until 1917, he assessed the part as progressive, and the part after that as reactionary. He defined the direction as enlightenment. He kept him away from political issues. Naturally, most of the conference participants objected to these ideas. But all the participants support the comments of the master literary critic that modernism is a very important ideological factor for the development of Uzbek literature, and that its thorough study and impartial evaluation is an urgent task of today's science. A. Maniyofov from Tajikistan, M. Shukurov, R. Khodzoda, G. Ashurov, O. Sayfullaev, A. Mirakhmedov from Azerbaijan, I. Nurullin from Tatarstan, E. Yusupov from Uzbekistan, E. Karimov, H. Ziyoev, E. Vohidov, S. Kasimov, O. Fayzullaev and research scientist Begali Kasimov participated, B. Kasimov says that representatives from Tajikistan came to the meeting more seriously than others. Tajik researcher G. Ashurov divided the path of Jadidism into three periods:

1. Formation (before 1905)

2. Progress (1905-1917)

3. Partition (1917-1920)

Jadidism appeared later among the Tajiks than among the Turkic peoples of Russia. For example, it is known that modern Tajik schools and textbooks for them began to appear only after 1905. The speaker defined the issues before the science of history. He noted the ways of cooperation. Aziz Mirakhmedov questions the widely held opinion among experts that the Jadids had no organizational devices. He considered the "Muslim Union" association of All-Russian Muslims, founded in 1905, to be an attempt in this direction. I. Nurullin gave a number of interesting facts.

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Importantly, this conference gained significance by bringing together historians at the international level. As a result, opinions were exchanged within the topic, mutual literary-creative cooperation was established. As a continuation of this, at the end of April 1989, a 2-day meeting of the Justice Commission was scheduled with the participation of the UzFA and the Writers' Union. The lectures of about thirty representatives of the field will be heard. New facts, new names are mentioned at the meeting. After independence, similarly, on December 3, 1990, a meeting was held in Moscow dedicated to the study of the legacy of repressed artists. Three of our scientists from Uzbekistan took part in this meeting: O. Sharafiddinov, N. Karimov, scientist B. Kasimov. In almost all of the above-mentioned gatherings, it is noted that Jadidism is a special stage in our social and spiritual development, the need to study it in different directions is stated, and the fact that opinions are exchanged about specific artists, their activities, and their heritage shows the urgency of the issue. Gaining independence of the republic has opened a completely new page in our spiritual and cultural life as well as in the socio-political sphere. We have acquired our own minds, our own property, our own labor. Evidences and events related to our history, big and small personalities are no longer evaluated with the eyes and minds of others, but from the point of view of the sanctity of the interests of the Nation and the Motherland. In this context, the event that went down in history under the name of "Turkistan Autonomy", which was the first example of the struggle of our moderns for political independence, but was treacherously soaked in blood by the Soviets, was infamously called "printing", but in fact, the struggle of our people for their own free will and spirituality was the movement of national liberation. revaluation has begun. Philosophers and jurists were also involved in studying the activities of Jadidists. It was possible to study it comprehensively. Our historians became more active and began to study the political aspects of Jadidism. The new 3-volume history of Uzbekistan has been published. Turkestan modernism and its specific features, its scope and scope are also studied abroad. The names of Professor Lazzeri of the University of New Orleans, Frenchman A. Benningson are well-known in the world. American E. Alworth, German I. Baldauf, Japanese X. Komatsu has been effective in this regard. In order to share the work of these scientists, a large symposium dedicated to this topic will be held in February 1995 at the Central Asian Research Institute under the Embassy of France in Uzbekistan. Prominent archaeologists from different countries of the world will take part in it. The fact that his results and lectures were published in French scientific journals is proof of our opinion. Well-known specialists such as Ingeborg Baldauf from Germany, Turaj Atabaki from the Netherlands, Chantal Kelkej from France, Adib Khalid from America, and Marco Buttino from Italy will take an active part in this process. During the conference, new facts and observations were revealed on important and interesting issues such as the conditions for the emergence of Jahidism, its connection with the national liberation movement, and the attitude to women's freedom. At the same time, some of our local colleagues have a tendency to evaluate this phenomenon in an old-fashioned way, and our foreign friends are not aware of the work carried out by Uzbek historians, says B. Kasimov.

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The role of the press in covering and promoting the activities of Jadidilik has become incomparable. In fact, the newspaper entered the life of the Turkic people in the 30s of the last century. "Taqvimi vaqoe" ("Calendar of Events"), published in Turkey, was the first official newspaper not only in this country, but in the Turkish world as a whole. After "Tarjumoni Ahval" and "Tasviri Afkor" (1862), which began to be published in Turkey in 1860, journalism became popular. In Azerbaijan, this phenomenon happened relatively later, that is, in 1875, newspapers began to be published. Hasan Zardobi's "Ekinchi" newspaper was one of the first steps in this regard.

Conclusion. The most famous newspaper at the end of the last century was Ismailbek Gasprali's "Translator". This newspaper, which began to be published in Boqchasaray in 1883, not only in Turkey, in Russia, but in general, in all the continents of the world, introduced the Turkic peoples to each other, called them to unity and cooperation on a cultural and spiritual basis, and, therefore, for more than 20 years, in order to organize national affairs. An opportunity was created for the wide study of Jadidism at the international level. With the help of the press of that time, it became possible to truthfully cover the history, literature, culture and spirituality of Jadidism. B. Kasimov's fundamental research in this direction is a clear proof of this.

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CLASSIFICATION OF VARIOUS TYPES OF CHARACTERS IN LITERARY WORKS

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Abstract: *the article focuses on revealing some types of characters in children's prose. The aim of the writer in creating foil characters is to show that the protagonist has a special characteristic feature comparing with other characters in novels. Thus, the protagonist can be of general importance in novels which arouses interest for every reader.*

Introduction. *An author delineates generalization by exaggerating the individual characteristic features of characters in literature. Theoretical approaches were applied to elaborate individualization; foil character acquires generalizability in a creative work. That is the main reason why two opposing aspects (individuality and generality) of characters are simultaneously embodied in literary works.*

Research methods. *Dynamic or changing characters cannot only change physiologically and biologically, but they can change morally and spiritually during the evolving of events in literary works. A static character plays a certain role in the realization of the protagonist's goal.*

Results and discussions. *The children's writer pays more attention to every detail in creating characters in his literary works. He utilizes special words and collocations that are clear and understandable to everyone in describing the outer and inner world of his characters. The description the psychology of main heroes and characters is focused on a specific goal and concept of an author in children's prose. Didactic literary works ameliorate the psychology of teenagers which are necessary for the spiritual maturity of young readers.*

Conclusion. *It should be noted that the state of aggression of teenagers in the literary works of T. Malik, Kh. Tukhtaboyev has an artistic and scientific basis. It is acknowledged that this aspect has not been studied for a long time in literature, Similar studies have also focused on the factors that contribute to the formation of aggression in teenagers. To illustrate, such important features as social factors: customs and rituals in society, the presence of parental behavioral disorders, low social status of the family, internal family conflicts (parental divorce, children from a second marriage, excessive demands of parents to their children, etc.) are clear examples of the inner psychological world of the protagonists in the literary works.*

Keywords: *foil character, dynamic and flat characters, the sidekick, ideal person, suffering, individualization, generalizability, concept, style.*

Introduction. *It is crucial to study not only the psychology of a protagonist but, the psychology of a deuteragonist (a close friend of the main hero) is also considered to be one of the significant exploring aspects in literature. In this sense, to*

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study the psychology of a deuteroganist plays an important role in the characterization of the protagonist in world literature. The following types of a deuteroganist can be observed in this case: a) the sidekick; b) a deutronagonist who became a secondary character by dint of 'love' and 'care' of a protagonist. A researcher from the University of India Kamalakar Baburao Gaikwad stated the following idea in his article "Protagonist: A Prime Mover of the Plot of a Literary Work": "Sidekick is a secondary type of a hero who always accompanies and follows the protagonist". [3,6]

Moreover, Rebecca Ray noted that "Another type of a fictional protagonist is the portrayal of foil (contradictory in character) characters which help to reveal the protagonist." Rebecca was able to classify the differences and similarities of the protagonists and foil characters by analyzing Shakespeare's tragedy "Romeo and Juliet.". [18,1]

Materials and methods. For instance, the characters of Herbert and Pip in Dickens' "Great Expectations" appear to be as "*foil*" characters when compared to each other. On the one hand, Herbert was a character from a rich family who wanted to be an independent merchant with his own efforts. On the other hand, the protagonist Pip was from a poor family who had ambitions of taking a higher position in society. Moreover, the characters of Rose and Nancy are mutually "*foil*" characters in "Oliver Twist" by Charles Dickens. While Nancy lived in a thieves' slum and she used to have a miserable life, but Rose was born in a rich family and she lived happily forever.

The aim of the writers in creating "*foil*" characters is to show that the protagonist has a special characteristic feature comparing with other characters in novels. Thus, a protagonist can be of general importance in novels which arouses interest for every reader. It is pointed out that the artist-writer delineates generalization by exaggerating the individual characteristic features of characters in literature. Due to this individualization, foil character acquires generalizability in a creative work. That is the main reason why two opposing aspects (individuality and generality) of characters are simultaneously embodied in literary works. [17,70]

A famous children's writer, Kristy wrote lots children's picture books which had a huge impact for the development of world children's literature. She published her illustrated books, such as "Superheroe Manual De Instrucciones" ("Superhero Instruction Manual"), "Diez deditos de los pies, dos piececitos" ("Ten Little Toes Two Small Fee").

It is crucial to investigate Kristy's picture book by name "Superhéroe Manual De Instrucciones" in modern contemporary children's literature. She indicates seven ways to motivate children to become spiritually "superheroes" so that they can become an ideal person in their future: [12,2]

1. Choosing a super name for a hero. Reflecting a child's favorite color on a pet that has a positive impact on the child's psychology;
2. To find a companion for the child - to make friends, to help him always endure hardships in life;
3. Wearing a mask proves the safety of a superhero who avoids from perils around him.

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4. It is advisable to always look for hidden places in order to avoid from danger;
5. In order to have a great power, he must show his best skills one more time. For example, you need to exercise a lot to increase your running speed;
6. Follow a healthy diet;
7. It is said that saving the whole world from danger will lead to make lots of friends and fans around a person.

Kristy has captured the hearts of young readers by writing nine illustrated stories in modern children's literature. The writer emphasizes that she strictly adheres to three important factors while writing stories for children.

1. Be able to anticipate the purpose of the reader;
2. Pay attention to the content of a creative work; the reader's interest prioritizes of all.
3. Kristy's main concept is to create complicated characters in order to influence the child's psychology with her picture books with different illustrations. She emphasizes that by reading many stories, every child can perceive themselves who they are in society.

If a teenager takes pleasure out of reading literary works, he can ameliorate his outlook about the world and he learns life lessons from books.

Results. It is advisably true that according to the concept and the style of a writer characters are divided into *flat* and evolving *dynamic* types in children's prose. The *flat* character - (simple, stable) is a very simple hero, the reader knows about this type of character in advance in world children's prose. For example, the character of the stepmother has always been the symbol of cruelty in the fairy tale of "Cinderella". This type of character can be easily memorized by every reader. The motive of step motherhood is also present in Uzbek folk tales, like a fairy tale "Zumrad and Qimmat". Zumrad's stepmother has vicious, greedy characteristic features. Her attitude towards the main heroine Zumrad is unchanging, and it proves that she belongs to the type of flat characters.

Dynamic or changing characters cannot only change physiologically and biologically, but they can change morally and spiritually during the evolving of events in literary works. According to the writer's concept and style, the characters can change from wicked into a noble person. Even secondary characters can change dynamically and they become an ideal person in novels.

For example, Huckleberry Finn and Jim's outlook about life had gradually evolved and they strived to achieve their goals in "The Adventures of Huckleberry Finn" by M. Twain. Jim had a great desire to be a free, independent person, by fighting for his rights and freedom.

Discussions. Furthermore, Abel Megvich in Dickens's "Great Expectations" is considered to be a dynamic character that caused to evolve the plot of the novel. He made a great contribution to the protagonist Pip's becoming a real gentleman. Firstly, being moneyless and very poor, he interfered in the criminal world to make ends meet. Then he earned money by carrying on his own business and he became a noble man. He sent the large amount of money to the protagonist Pip. He wanted Pip to achieve the happiness which he could not achieve in his own life. Helping Pip to become a "gentleman" gave him pleasure. Firstly, Pip felt abhorrence towards him.

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Even Pip told his friend Herbert that he hated Abel and he used to look at Megwich with contempt. Thereafter, his repugnance had melted away, Pip started to care about Megwich like his own father:

“Yes, Pip, dear boy, I’ve made a gentleman on you! It’s me wot has done it! I swore that time; sure as ever I earned a guinea, that guinea should go to you. I swore afterwards, sure as ever I spec’lated and got rich, you should get rich. I lived rough, that you should live smooth; I worked hard, that you should be above work. What odds, dear boy? Do I tell it, fur you to feel an obligation? Not a bit. I tell it, fur you to know as that there hunted dunghill dog wot you kep life in, got his head so high that he could make a gentleman – and, Pip, you’re him!” [1,423]

It can apparently be observed that Megwich became a dynamic character because he proceeded to live honestly in society and he had aspired to be a good person. Abel Megwich came to the city to find Pip . He sincerely expressed all his feelings to Pip as his father.

There are many dynamic characters in Uzbek children's adventure novels either. The protagonist Hashimjon used to be a playful, uneducated boy who set out travelling to become a great person without acquiring education in the novel "Death of the Yellow Giant" by Kh. Tukhtaboyev. Then Hashimjon as the dynamic character promoted to a senior lieutenant who eliminated all lawbreakers and bribe-takers in society: “I am happy and jolly. Everyone, adults and youngsters look at me with envy shaking my hands and wishing me good luck for my future work. As I was filling Colonel Ali Usmanov's steel chest with secret photographs and tape recorders, the colonel praised me to his friends twice or three times, looking at me with a big confidence and hope and saying, "Comrade Ruziyev will show great heroism in near future." [20,151]

Hashimjan's bravery and his capture of the leader of the gang of thieves were highly praised by everybody. He was recognized as a policeman with an “extraordinary talent” among other police officers and the recommendation was sent to be promoted by the head of the ministry.

Static stable characters do not change from the beginning to the end of novels. A static character plays a certain role in the realization of the protagonist’s goal. A writer makes extensive use of extraordinary features, imagination and exaggeration by describing such characters. Miss Hevisham can be incorporated into static characters in “Great Expectations” by Charles Dickens. Miss Hevisham wore an old wedding dress and she lived in the castle for a long time. She was like a character whose heart had turned into “ice” because of the unhappiness in her life. It seemed as if she felt like an alive "ghost" living in a dark castle forever.

Miss Havisham brought up a young girl by name Estella; she brought up the girl as an arrogant and selfish person who had a feeling of contempt with people. Miss Havisham called Pip to her castle every day, so that Pip would fall in love with Estella. Miss Hevisham's desire for revenge was hidden in her heart. It seemed as if by breaking the heart of the protagonist Pip, she could sooth herself down: “It would have been cruel in Miss Havisham, horribly cruel, to practise on the susceptibility of a poor boy, and to torture me through all these years with a vain hope and an idle

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pursuit, if she had reflected on the gravity of what she did. But I think she did not. I think that in the endurance of her own trial, she forgot mine, Estella.” [1,476]

Pip was suffering from his unhappiness and a pain in his heart. The protagonist of the novel "Great Expectations" tried to concentrate on his mind wandering along the deserted streets of the suburbs to forget his misfortune for a while.

Yakutkhan is one of the static character in the novel of "Sad Eyes" by Kh. Tukhtaboyev. Yakutkhan was a skillful character in amassing wealth, distinguishing pure gold from counterfeit one. Yakutkhan was engaged in the sale of jewelry due to her unique ability to distinguish the original gold. At times, she would reassure her husband that gold merchandising would never harm her family:

“I don't want to bring customers to our house. They don't know my name and where I live. My dear honey, do not panic! If you are sacrificing yourself for your children's happiness, am I ostensibly playing with a snake for my grandchildren's bright future?! By the way, the source of our happiness is our inexhaustible wealth.” [19,44]

The protagonist Zafar could not stand the death of his mother and he was sent to hospital in the novel "Sad Eyes". Zafar was constantly thinking about his mother; he did not believe that his mother had died, that he would wake up when he saw his mother in his dream, and that his mother's love would not leave him forever:

“ My dear honey, have you got into a trouble for me?! Come, put your head on my knees, I will caress you. All right, do you like it, has the pain stopped?

– It has stopped, mum.

– If it's stopped, wake up, honey, we will go home. Your daddy is waiting for us. We will go to pick up tulips by our Volga. Do remember we went together and picked tulips, cooked kebabs and had a very good time last year? You gave me a bunch of tulips. I hugged you and kissed on your face. Do you remember?

– I remember, mum.

– Will you pick them up again?

– Of course, I'll pick them up.

– Put these tulips on my grave, will you?

– Why are you saying so, mum?

– Oh, my son, I'm dead.

– No, you're not dead, no, no!!!” [19,248]

Kh. Tukhtaboyev delineated the character of Yakutkhan as a static image of a woman who used to love a luxurious life and wealth. She considered that gaining wealth was a way to happiness. Consequently, her gold merchandising led to the collapse of her entire family.

The artistic interpretation of the determining the reasons for teenagers' interfering into the criminal world determine the essence of the content of Uzbek children's detective stories.

The literary works by T. Malik and Kh. Tukhtaboyev deserve recognition in this sense. Particularly, "Goodbye, Childhood!" by T. Malik was the first detective story which was written about teenagers' life. It was a new phenomenon to delineate the mental state of teenagers such as Qamariddin, Asror, Salim, who committed crimes in Uzbek children's literature. Children's libraries used to be full of books about main heroes' life in traditional literature. It is almost infeasible to evoke

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sympathy for readers towards the protagonists who commit crime or theft, burglary. It is complicated to describe the psychology of teenagers who commit crime from his childhood. In this regard, the role and importance of children's detective stories should profoundly be investigated by researchers.

Young teenager had specific causes to commit crimes knowing the detrimental consequences; initially, the protagonist Qamariddin's immoral behavior started when he could not tolerate boys' bullying him in the street; after that it turned into a huge crime, when he was imprisoned for killing his father's "friend."

One of the teenagers who joined in Qamariddin's gang was Asror in "Goodbye, Childhood!" by T. Malik. He went to weddings with his father to make ends meet. Initially, Qamariddin forced Asror to deprive him from his pocket money, then, Qamariddin started to sponsor Asror; he was angry with Asror's father as the boy's father used to take his son to weddings against his will, and his father, who was determined to earn money, made fun of his son. Qamariddin's kindness was reflected on his true friendship to Asror. He noticed Asror's interest for getting education and he promised him to allocate some amount of money for his getting education. Asror was an intelligent teenager-boy who used to try to achieve his all dreams by his own efforts. The boys who gathered around Qamariddin considered him to be the avenger of life.

The following characteristic features can be observed in the psychology of Asror in "Good-bye, Childhood":

1. *Becoming a member of a group of thieves* - Asror's father would not give him money to go to school, he would not support him. His only proponent used to be Qamariddin, the leader of a group of thieves. Knowing that Qamariddin's partners were bad guys, Asror interfered in the group of robbers.

2. *The feeling of helping his friends in their hard times* – Asror was constantly giving money to Dilfuza, who was like his sister. "Asror was obsessed with his own problems and at the same time he was thinking about Dilfuza on these days. They stopped seeing each other at the same place on their way to school. Asror didn't know whether it was a reprimand at school or the awful incident on that dark night. He was now on his way to Dilfuza's house when he realized that he was far away from the girl. He had initially taken the girl under his protection. Then walking with her became a usual habit for him. Asror was constantly telling Dilfuza, –We are brothers, – but there was an outrageous feeling that he could not understand himself." [21,188]

3. *The formation of the ability to comprehend the characteristic traits of people in Asror's psychology*. Asror commenced to compare Salim's mother with Qamariddin's. Salim's mother was a kind person, who was ready to sacrifice her life for her family. Asror's clever mind realized that Salim should be away from the gang of thieves. "Every child comprehends the concept of happiness in a simple way, but adults comprehend it in a different way. Still, Asror's childish mind correctly identified the most significant thing: Salim's mother is a good woman! She should not be humiliated! For this, Salim must leave Qamariddin's group. Asror will tell this to Qamariddin. Qamariddin is a good person, he will understand it. It is clear that he will be as kind to Salim as to Asror. [21,152]

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4. *Asror's attempts of trying to save his friends from criminal world.* There was a strong sense of remorse hidden in Asror's psychology that he wanted to escape from the world of crime and he had a great desire to be a decent person in future. He wanted to deter Qamariddin from intending to "kill his mother."

Although the fate of all the teenagers ended tragically, Asror could realize all his mistakes before his death and he tried to save his friends from criminal world in the story. His conscience was constantly torturing him wherever he went; he was fighting with himself. Without realizing what was happening around him, unknowingly his feet marched towards the canal where the corpse was drowned. The author described Asror's state of mental agony and his death in a following way using a hidden type of psychologism:

"Asror's heart sank." "Salim ... Salim ..." his lips whispered. He turned back slowly. He stumbled and fell on a rock. A leather bag flew over his shoulder. Someone sighed. "Who has sighed, Salim or that man?" Asror's thoughts were obsessed with it as he was standing up. He stood up and sat down dizzily. Someone else sighed. Asror's eyes widened. Something splashed in the water. Asror looked and he tried to shout, but his voice did not come out of his mouth, he hissed hoarsely. The dead man came out of the water. He was laughing at him. He was holding on his hand Salim who was covered with blood. Salim sighed..." [21,220]

Apparently, while describing the psychology of a teenager, the writer utilized from the character of an adjunct, a secondary hero, i.e. a deuteragonist, as well as delineating the spiritual state of a protagonist (or a positive protagonist). T. Malik used from the character Asror in the story, because he was able to rise deuteragonist to the level of the secondary main hero who indicated the writer's main concept.

According to the author's concept, he "lives" in an environment of young teenagers' group; he separately introduces to readers about family relations, parental relationships, friends's interactions with each other, teenagers' interests, and behavior. In particular, the socio-psychological situation is profoundly analyzed in the artistic interpretation of the images of Asror and Qamariddin. As a result, every reader will be able to observe more about the process of juvenile delinquency and its causes than its consequences.

Detective stories of world children's literature flourished in the second half of the twentieth century. Readers can ameliorate their logical thinking while analyzing the psychology of the characters in literary works. Investigating the psychology of protagonists can also be observed in Yashar Kamol's "If They Kill the Snake".

It is also noticeable to analyze the psychology of the protagonist Hasan in Yashar Kamal's "If They Kill the Snake". The author utilized hidden type of psychologism while delineating spiritual world of a young boy. The protagonist Hasan was alone. He used to be in nature; he used to carry a big gun; he took care of the babies of eagles; being in nature Hasan forgot all his misfortune of his family. Hasan could not tolerate the humiliation of people about his mother; he fought with everybody who humiliated his mother. Yashar Kamal delineated the boy's behavior in the following extract:

Hasan's mother was brought to the large square. His uncles beat her incessantly, her face cracked, her white handkerchief and her hair, covered with

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blood. Women, men, and children - all the villagers beat and spat to Hasan's mother; Hasan stared blankly for a moment, then threw himself at those who were beating his mother. He bit his uncle's arms to the bone and he almost cut them off. It is said that like a madman, he was constantly beating those who hit his mother, and he spat in return on those who spat on his mother." [23,15]

This scene vividly illustrates the psychology of the protagonist - Hasan. The author told vividly about the sufferings of Hasan in his childhood, the attitude of the people around him, the interactions of relatives. As a result, the writer embodied the environment, family, relatives and friends who forced the boy to commit crime in the reader's eyes. It is said that each event in the plot of the story serves to reveal the spiritual world of the protagonist. As psychologists stated that

" a person does not forget the trauma of childhood for the rest of his life."

Conclusion. To wrap up, the renewal and enlightening children's contemplation, their attitude to society and to their relatives all of these are reflected on the concept of the writer. Consequently, the interpretation and investigation of aggressive state of children and teenagers who have entered the world of crime in detective stories are urgent issues in society. "It's not a secret," the researcher M. Mahkamova writes, "that we live in the age of information technology." It would not be exaggeration if we say that our young people are making negative and positive innovations in their lifestyle, spirituality, outlook and mind. More and more contemporary teenagers are obsessed with mobile phones and the Internet. The disadvantages of these devices can be observed when up-to date devices transform human beings into robots who do not have any feelings. Modern technology turns young teenagers into cruel, ferocious, apathetic and frivolous person;

It is pervasively wide-spread to write about teenager protagonists. In particular, it is necessary to express the most sensitive feelings and psychological state of teenagers; a researcher strives to explore the characters of contemporary teenager heroes's spiritual world and the changes in their psychology.

The children's writer pays more attention to every detail in creating characters in his literary works. He utilizes special words and collocations that are clear and understandable to everyone in describing the outer and inner world of his characters. The description of the psychology of main heroes and characters is focused on a specific goal and concept of an author in children's prose. Didactic literary works ameliorate the psychology of teenagers which are necessary for the spiritual maturity of young readers.

It should be noted that the state of aggression of teenagers in the literary works of T. Malik, Kh. Tukhtaboyev has an artistic and scientific significance in Uzbek literature. It is acknowledged that this aspect has not been studied for a long time in literature; similar studies have also focused on the factors that contribute to the formation of teenagers' aggression. For example, such important features as social factors: customs and rituals in society, the presence of parental behavioral disorders, low social status of the family, internal family conflicts (parental divorce, children from a second marriage, excessive demands of parents to their children, etc. are clear examples to reveal the psychology of the protagonists in literary works.

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Navoiy gulshani

CHU JILVA AYLADI UL HUSN ISTABON OSHIQ...

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Every artist has a wide world. However, Alisher Navoi's demand for art was very large. In the preface of the poem "Badoe` ul-bidoya" the poet dwells on this subject in detail. The great artist of words, through the magic of poetry, encourages members of different worldviews, different categories of society to live with a single goal, an objective goal. There are important reasons for this conclusion. It is interesting to note that when we read the preface of the above-mentioned collection carefully, the following thought came to our attention: the couplet of each letter does not differ from the previous couplet and other couplet in style. With this emphasis ("previously written couplet") the poet is referring to the couplets placed in the first place instead of on the walls. In the first couplet in "Garoyib us- sigar", the most perfect miracle created by the truth is glorified by mature(perfect) person. The first couplet of "Navodir ush-shabab" describes the work that distinguishes man from the creatures of truth and defines his essence. Because man has a responsibility to know and understand the truth. This poem is dedicated to the interpretation of the same idea:

Chu jilva ayladi ul husn istabon oshiq,
Saloyi ishqin etib ofarinish ichra nido.
Pari qabul eta olmay ani, magarki men,
Qilib otimni zalumu jahul birla ado.

The place of love in human destiny, and its "history" is given in verse 72 of surah al-Ahzab:

We made the trust for the heavens and the earth and the mountains and the rocks, but they refused to bear it, and they feared it. And man took it upon himself. He was ignorant), that is, the whole universe knew how heavy the burden was and could not bear it, but man unknowingly undertook this difficult task. " When he took on this "burden of trust", Man was "cruel and ignorant." Because the path of love is spiritual. By taking only two words from this verse, the great poet referred to the divine history of Man and his classic sense of love. Another aspect is that the Qur'anic ideas are also propagated by this means. According to theological-mystical views, the purpose of creating man was to demonstrate the power of the soul. In the first ghazal of "Badoe` ul-vasat" the truth is hidden, the happiness of the two worlds is embodied, the treasure of true knowledge and love - the power of the heart is glorified:

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Zohid, ko`ngulning xilvatin matlub g`ayridin orit,
 Sen sayr qilsang qil, kerak ko`nglungga bo`lsa inzivo.
 Desang Navoiy jon aro mahbub bo`lg`ay jilvagar,
 Avval ko`ngil ko`zgusidin mahv ayla naqshi mosivo.

According to the poet, if you want to see the absolute beauty of beauty in the mirror of the soul, free it from the sorrows of the world, that is, if the heart is not pure, the opposite will not appear. The content of the hamd is created and arranged on the basis of high divine and mystical views. We read the logical continuation of the "thought" (ishq and kon g i l) in the couplet at the beginning of both collection in the 1st couplet of "Favoyid ul-kibar". Because when love is a guide to the heart, it is inspired by the mysteries of the unseen world.

Ishqingda bir devonalig`, shavqingda bir farzonalig`,
 Ag`yordin begonalig` aylab o`zungga oshno...
 Bordur Navoiy bekase, ishq ichra andoqkim xase,
 Chun o`rtading oni base, do`zaxda kuydurma yano.

The lover, who sees the reflection of the Mutlaq in the mirror of the soul, burns in the fire of love, longs for his guardianship, and feels helpless in this world. It is a sign of divine love. Burning in the work of truth is the destiny of the Perfect Man. Therefore, the poet praises the perfect man in the 1st ghazal of "Khazayn ul-maoniy" and replaces the other three devons with the notions that classify man in the 1st couplet. And the definition of a lover in the state of a lunatic. Literary scholar Alibek Rustamov called the first ghazal of "Gariyoyb us-sigar" "a program of Alisher Navoi's creativity". According to the poet, it is very difficult to understand the world of ideas of other couplet in the collection without understanding the "style" of this couplet. In order to clarify the issue, we found it necessary to refer to this couplet. In fact, the "previous ghazal" in the collection (according to the poet) should begin with praise to Allah. However, due to its location in the complex of collections, the first couplet is dedicated to the praise of a perfect man. Due to the completeness of the Qur'anic meanings, goals and ideas in his mind, Mir Alisher devoted his entire life and work to "the source of the message", "the flower of love", "the world is beautiful, the world is pure", "the earth is pure light". , "the garden of rhizvan flowers", "mahzani irfan" - from all the smallest works - from the fard to the epic. Therefore, the great poet begins the devon not with the praise of the qualities of truth, but with the description of the highest example of the art of truth, and ends it with a poem dedicated to the Prophet Muhammad, the true embodiment of the perfect man.

Sening madoyihi na`tingda, yo Rasululloh
 Tamom bo`ldi Navoiy takallumi poki.
 Bu to`rt daftarida hamdu na`t aro xalali,
 Gar etmish o`lsa ayon tab`u kilki beboki.

The sensitive poet, who deeply understood the essence of such classical concepts as irfan, love, and soul through life experiences, blindly condemned prayer and said that the only center for his knowledge of the secret industry of "Kuntu kanzan" (It is only as a result of the study of man, the realization that he is a miraculous example of perfect art, that he creates with the aim of praising the truth sincerely. It is known that each couplet of the great poet has its own set of content,

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system. In the cuplet in collection, the central issue of mystical teaching is the conditions of maturity (the seven levels of perfection of the heart and soul of the lover) based on a strong system of symbols. Therefore, in each cuplet the word jomu may is repeated.

Ashraquat min aksi shamsil ka`si anvor-ul hudo

"Yor aksin mayda ko`r" deb, jomdin chiqdi sado.

"Against the sun of the wine cup, the rays of the path of truth shone." The wine cup is a whole being created out of love. The sun is a symbol of Allah, and vice versa. According to mystical literature, before man was created, all beings were in the form of soulless darkness, and Man was created to polish them. By saying, "The light of the path of truth has shone," the poet is referring to the perfection of Allah through man, and in the second verse, the essence of the material world is the center of the mockery of the divine names. In Hazrat Jami, this great principle is interpreted as follows:

Shud dar qadahi sahbo akse zi ruxat paydo.

Qad ashraquat ad-dun'yo min ka`si muhayyono.

In "Sahbo" (red wine) the reflection of your face appears, the world split from our glass. "That is, its inner meaning is as follows: Sahbo glass is the mockery of all beings and creatures. In this cuplet, the status of the heart and its levels of development are described as the preconditions for the spiritual and spiritual maturity of the soul. The cuplet refers to these levels. " This is the status of the demand and the state of the heart in need of love at the level of SADR. The "tourist of the world of enlightenment" is the source of truth, its knowledge and the treasure of love.

G`ayr naqshidin ko`ngil jomida bo`lsa zangi g`am,

Yo`qdur, ey soqiy, mayi vahdat masallik g`amzudo

"G`ayr naqshi" (worldly worries, lustful needs) corrupts the heart, turns it into a grief. It begins with following and loving the perfect. The first condition of the status of love is friendship. Because the goal of the sage is only to the truth, he is the most knowledgeable in the divine science. The lover is envious of the "sadness" of unity. Unity, that is, "sorrow" (cleansing from sorrow, removing sorrow) attains the status of unity. Love is one of the attributes of status.

Ey xush ul maykim, anga zarf o`lsa bir sing`on safol,

Jom o`lur getiynamo, Jamshid ani ichkan gado.

When the "broken pottery" is united, it becomes "getiynamo" (worldly) like Jamshid's magic cup, and the gado who drinks it feels like Jamshid. Jamshid is one of the most legendary kings of Iran. He discovered two cups. Jamshid's magic in that magic mosque did not end with a drink (Jomi Jam) and all the events in the world could be observed from the other (Jomi getiynamo). The poet was able to skillfully express the above-mentioned intentions through the art of talmeh. And the Enlightenment stage. Love is the key to perfection. Even if the gado enjoys divine love in his heart, he feels like a king and does not submit to the kings of the kingdom. On the contrary, kings felt the need for Iranians free from worldly worries. Wisdom, knowledge of the secrets of enlightenment, is the king. Because now the Beloved is the Ruler of the Soul.

Jomu may gar buyladir, ul jom uchun qilmoq bo`lur

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Yuz jahon har dam nisor, ul may uchun ming jon fido.

If Jomu May has such power, it is worth sacrificing a hundred worlds for an envelope (for Jomi Jam) and a thousand souls for such an soul. It is a sign of the incomparable dignity and rarity of a perfect man who seeks to enjoy the wisdom of truth. In short, when the true power of love and the soul is revealed, the secrets of enlightenment are revealed. This is a sign of the f u o d level of the heart, the status of Istigno.

Dayr aro hush ahli rasvo bo`lg`ali, ey mug`bacha,

Jomi may tutsang, meni devonadin qil ibtido.

The word "dayr" is used to mean a Tavern. The people of Hush are ignorant of the oil of love. Those who are ignorant of love always accuse true lovers of insanity. It is impossible to understand the secret of unity without being unconscious. As mentioned above, this cuplet is a program of the poet's work, so it has a wide range of topics and ideas. A certain part of Hazrat Navoi's work is the ideas of blame. There is also a reference to this in the byte. "Devona" is the anesthesia of love, awareness of the secrets of the unseen truths of the soul, the highest level of sensitivity. Only awareness becomes the embodiment of the truth. Divine love is the true victory of the Spirit over the mind and the body. The poet skillfully used both real and figurative meanings of words. The real meaning of "Dayr" is a temple of non-Muslims, firefighters. Love is a fire that purifies a person from lust. A lover in love is completely free from worldly desires. The fire of love turns the heart away from fleeting thoughts and worries. That is why a lover (like Samandar, a lover of fire) does not worship any other fire than the fire of love. The lover who burns in this fire attains the status of true love. In the above verse, the fire of love is emphasized as the basis of self-denial, spiritual purification (as fire is glorified in fire-worship). It is impossible to reach the truth without self-denial. The poet skillfully uses the subtleties of the meanings of words associated with the belief in fire, such as "dayr" (tavern) and "mugbacha" (child pouring wine). When purified by the fire of love, the soul becomes a treasure of the knowledge of the unseen. This is the status of Tawhid and the knowledge of the soul to reach the laduni, to approach the center of the original essence - the qualities of the water level.

Toki ul maydin ko`ngul jomida bo`lg`ach jilvagar

Chehrayi maqsud, mahv o`lg`ay hamul dam moado.

The complete conquest of the soul by divine love ends with the "moado" - the extinction of other, transient needs. The essence of the divine miracles that unite the universe and man, with an incomparably wide spiritual level, shines in the "face of purpose". This is the place (level) of the soul where the divine rays are manifested.

Sen gumon qilg`ondin o`zga jomu may mavjud erur

Bilmayin nafi etma bu mayxona ahlin, zohido!

Through this verse, the poet pointed out the educational significance of mystical teachings, which have proved the essence, truth and power of love on a large scale, free from narrow views.

The ascetics did not use the word love so that it would not be found in the Qur'an. Those who espoused this notion, on the other hand, were constantly opposed. Divine love elevates the lover above certain religions and religious observations.

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Religions, sects, sects are the ways to Allah. In Najmiddin Kubro's words, the path to Allah is due to the breath of the creatures. The address and the essence are one. Therefore, the poet admits that they are all the same in essence. "O Zahid, you only want to go to Paradise in obedience and deny other ways to reach Allah," said the poet. To understand Sufism in a narrow sense, to mold it is to make fun of oneself, - says Amir Khusrav Dehlavi:

Dar tasavvuf rasm xustan xanda kardan bar xud ast,
Dar tayammum mash kardan xok kardan bar sar ast .
Hazrat Navoiy matla`da boshlangan fikrni shunday xulosalaydi:
Tashnalab o`lma Navoiy, chun azal soqiysidin
"Ishrabu yo ayyuha-l-atshon" kelur har dam nido.

"Azal soqiysi" – Al lah. "Ishrabu yo ayyuhal-atshon" - ichingiz, ey tashnalar" O drink thirsty people". The purpose of creating man was to show the power of the soul. May (love) is a divine manifestation, a means of satisfying the thirst and leading to the divine essence.

Verse 72 of Surat al-Ahzab in the Qur'an states: Indeed, he (the oppressor and the ignorant) knew that the whole universe was a heavy burden and could not bear it, but man unknowingly found it difficult. Took over. " Scholars have interpreted the word "deposit" as "love". Love is unique to man, and other beings are deprived of it. Man is thirsty to know the secret of the whole being. The desire for enlightenment satisfies man's thirst for eternal and eternal Unity. He saves man from ignorance and delusion, and leads him to the eternal world, meaning that he is a part of the divine being. That is why there is always a cry from the "eternal drinker": "O thirsty, drink the blood of love." This call alerts a person through the Mind. The idea that begins with the "sound of the cup" in the poem ends with the "cry" of the "eternal drinker" in praise. This is a sign of man's striving for Allah and Allah's "always" for man (hadith: "If you take a step towards Me, I will be a hundred steps closer").

This poem is dedicated to the interpretation of the mysterious moments of the soul with love, the flight of the world to the unseen and the attainment of the status of Unity - the gradual development of perfection. The basis of the sect of perfection is to promote the enjoyment of a peaceful and peaceful life on earth through reconciliation. The great poet devoted his whole life and work to the interpretation and promotion of this great goal. This idea is reflected in the poet's vital activity - the establishment of a warm atmosphere between the palace and the people, the coronation disputes between the father and son (Sultan Hussein Boykaro and his crowned sons), various events inside and outside the country. The fact that he was able to resolve troubled and dangerous situations by mutual consent and peace, and that he was a guide to the people of knowledge.

Therefore, Hazrat Jami Mir Alisher's authority in the socio-political life was described as: Amir Alisher is a scholar of the rules of the nation and religion, who is devoted and devoted to him. The great Navoi could not remain indifferent to the socio-political problems of his time. In addition, he lived and worked at a time when there were frequent disputes between different sects, Shariat and sects. The poet seeks to master the various currents of mysticism, the masters of the sect in the climate of words, and to turn the people of the Shari'at from dry, false worship,

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superstition, shortsightedness. Repeated Because the relationship between “truth and man” is interpreted differently in the Shari’at and the teachings. The poet believes that the main reason for these conflicts is the lack of understanding of the essence, the low level of enlightenment. In Alisher Navoi's devon, after enlightenment-artistic couplets in the direction of praise, nat and sermon, artistic-enlightenment couplets are placed. As the literary scholar Ibrahim Haqqul noted: "Alisher Navoi filled in the gaps and shortcomings in the Uzbek literature where he felt the gaps or shortcomings, and put an end to the shortcomings." His contribution to the development and development of praise poems in literature (including praise poems) is commendable in this regard. Many people do not understand the essence of couplets, which are expressed through complex symbolic systems. Or, conversely, superficial understanding has led to various conflicts.

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**AL-HAKIM AT-TERMIZI “HIDDEN ISSUES”
 (“AL-MASOIL AL-MAKNUNA”) BROCHURE.
 A STATEMENT OF THE ISSUE OF “THE SOUL IS THE MASTER OF
 THE ORGANS OF THE BODY”**

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Abstract:

Introduction. *The abode of the soul is in the head, and then it may have spread throughout the body. The concupiscence, on the other hand, lives in the abdomen, which also covers the whole body. He represented the mind to the soul and represented enlightenment to the mind. Mind, knowledge, enlightenment, understanding and intelligence are all soldiers of the soul. The love of lusts, the joy of lust, and its adornments are its soldiers. They are both alive, and they both have life. One is heavenly life, the other is earthly life. One was called a spirit and the other a temptation. The abode of the soul is in the head, and then it may have spread throughout the body. The temptation, on the other hand, lives in the abdomen, which also covers the whole body.*

Research methods and materials. *We are the beloved of Allah. Other nations are obligated by Allah. Allah has compelled them to submit to us and Allah has no will towards them. We were created for the love of God. Other nations were created to obey God. All of them are persistent in carrying out the command of Allah. And we are steadfast in the love of God, and love is our foundation. And in this love there is joy, there is bliss, there is life. These things are all the result of love.*

Results and discussions. *Whoever captures his soul and strives, captures his temptation. Commands and retreats enter his soul, and his soldiers appear, his sultanate appears, and his emirate is pure. When a person attains this status in the religion, even if he is completely free from the filth of sins, some worldly connections, some filth, will remain in him. Of course, he will also be rid of impurities such as polytheism and disbelief.*

Conclusion. *If only you were persistent in loving obedience, if you loved asceticism, if you loved piety, and if you loved the gifts that come from Allah. Even if you love all this for the sake of Allah! But your love for God is multifaceted. There is a connection in every love. These streams, these kings, have not yet been enslaved to the original love that has grown. If you had achieved this, your soul would have been saved and pure. And you would have given up stealing. Because then your soul would be filled with the love of God. This love has flowed into your chest and veins. Then you will be in the presence of Allah, and you will be at peace. Your soul and soul will rest from the pleasure you find.*

PHILOSOPHY, LAW AND POLITICAL SCIENCES

Keywords: *Enlightenment, mysticism, theology 'Hakimiya', hadith studies, the power of the human mind, discussion and debate, the rules of etiquette, will control, soul nurture.*

Introduction. Allah created man and created a piece of flesh in him and called him a soul because he is changeable. And he commanded this soul to the members, and put into the soul his own enlightenment and knowledge of His Being. The soul was mandated to maintain the members. Banda, on the other hand, was commanded to keep the soul and hold it. He did not entrust this work to anyone else. However, Allah turns souls as He wills. He represented the mind in the soul and placed in the mind enlightenment and knowledge of the Essence of Allah. The belly of lusts has made man's stomach. And there he placed lust, desire, longing for different things. He represented the air in these matters, and in the air he put the darkness of not knowing Allah. So, the mind directs the soul towards Allah with the knowledge of Allah and the knowledge of Allah. The air, on the other hand, leads the temptation to transient sexual things. [1:22]

If a person sleeps, the temptation leaves the body and ascends to Allah, and the soul remains in the soul. In fact, lust is based on the soul. The temptation becomes entangled, unable to get out and unable to do anything. That's why sleep deprivation happened. If the distance of the temptation goes away, the snoring decreases and the movements slow down, the limbs become as if they were dead. This is because there is a small amount of temptation left in the body. That is, most of it is gone, and only the part that rests on the soul remains. It is stated in the word of Allah: "Allah takes the souls when they die, and those who do not die when they are asleep."

Allah revealed to the slaves that the soul is the ruler and that the treasures are hidden in it. There is a covenant in the presence of Allah for the soul. "I have soldiers around my soul," says Allah, "I have placed this soul among all the members, I have placed two soul eyes in my chest, I have made the human soul a place to measure and judge, to distinguish between right and wrong. I gave this man a hearing ear that could understand my words addressed to him, and in his soul I created an eye that sees the essence of things and observes the unseen. I placed my light in his eyes, the light of life in his ear, and the quality of thought in his soul. I gave a thought that he was looking for me, that he would find me with this. If the soul finds me, it will be mine, and I will be his.

If the soul is in this state, the emirate will be strong and its subordinates will be polite. He can keep them within the limits of what I have commanded and returned, putting everything in place of my creatures. He puts my orders in place. Performs each of my activities. Knowing this, he will rule with justice to his subjects. The soul will have all the riches. On the day he comes to me, all the joys will be in him. He will be very happy the day he meets me, and the day he sees me, he will be healed. [1:23]

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Whoever grieves the sorrow of his soul twice, that is, sometimes thinks of his Lord, and sometimes the grief of his temptation, then innumerable sorrows will sprout from his temptation. In each of these sorrows there is pleasure, there is lust, there is pleasure. Such a soul will be gone from me, it will be embraced by the pleasures of their thoughts, - says Allah taala. Grief, anxiety means wandering. It means to be sad, to think, of course, he was lost, he was a wanderer. So, the thoughts and worries of the soul are for their Lord, who is a wanderer in the way of finding Him. However, the soul is a piece of flesh and never leaves its place in the body. It contains the light of enlightenment, the light of knowledge, the light of reason, the light of life from Allah. With the light of God's life, the above three lights come into being. These rays are stored in memory. The reason for such preservation was Allah Who gave them. If allowed, the protection in the slave's brain will emit these rays. When the soul reveals these rays, the servant remembers. It is at this time that the servant is remembered by his Lord. This remembrance is the aspiration of the soul to the Lord with the rays of intellect, knowledge and enlightenment. The light of life is the mark of this remembrance and conveys it to Allah. Each remembrance strengthens the soul according to the amount of its share of the light of life. [1:24]

The one who receives the most benefit from this light is the one who is strong, high-ranking and close to Allah.

So the remembrance of some of the dhikrs ascends to heaven, then becomes helpless and stops. The remembrance of some reminiscence, on the other hand, goes as far as Illiyya, and then becomes weak. The remembrance of some reminiscence rises to the Throne and stops there helpless. The remembrance of a group of reminiscence rises to the status of hijab, and then becomes helpless. The remembrance of some of the reminiscence reaches the presence of Allah and calls out from behind the curtains of light, "Podshoho, Podshoho," so that I may be noticed in the presence of Allah. All this will happen with the light of life given by Allah. This is called the journey of the soul towards Allah. But all the meat remains in its place in the stomach. And all these rays in him are called souls because they belong to him. The same person is called a human being because of the ounce in him. Again, just as human beings are called human because of their humanity, their initiative. This quality is a merger, and Allah created it with His mighty hand. That is why eating is called "idom", in terms of its closeness to the word "man". Because a person adds that food to his food to make it sweet. He called it idom because he liked the human food and joined it. Again as it is called hayy because it is alive because of temptation and soul life. The life of the soul is different from the life of the temptation. [1: 24-25]

Research methods and materials. The soul was called the soul because it changed. Allah changes it from foot to foot because there are so many types of

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service. Other things are subordinate. Obedience requires constant standing, not going away. Whoever Allah has created for service, He will make him change, because He created him for His will. The desires of Allah are different in this servant.

The reason why Allah transforms the slave according to His will is that Will this servant enter into the will of Allah Almighty with joy or not? Does it follow with pleasure? If the will of Allah is seen in one work, then His pleasure is to forget his other work, but also to forget himself, and in this work he runs and flies according to the will of Allah, and finds his pleasure between his lips. [1:25]

However, if the temptation deprives the slave of this work, his life will be lost or his life will be wasted, or the slave will not be in a hurry for the work of Allah, he will hesitate, he will be heavy, he will hesitate and turn his lips. The Almighty, the Holy One, despises the judgment of the Almighty, just as a runaway camel is unaccustomed to its owner.

Whoever was created for these things, service is his duty. In front of such a slave is the whole universe. Because the different desires that are opposed to you will be different, they will be hidden in you as a treasure. He doesn't like some of the wishes. So whether He created you from among the people in this way, He created you in this way forever. Other creatures return to the original things they created. If they are created from dust, like animals and birds, they will return to earth. Things created from grass, such as the sun and the moon, return to the grass they created. And man will remain in his eternity. [1: 25-26]

Hence, the completeness of the service will depend on the endurance of mankind. Mankind must devote his soul to the will of Allah in all matters, in all circumstances, at all times. The desires of the temptation must be destroyed before the will of Allah Almighty. Because the desires of the slave are a sexual sweetness. When the will of Allah Almighty comes, the servant will feel the love of Allah in his soul, will love Him, and will feel the pleasure of that love with all his soul. He does not feel the pleasure of lust.

Because the pleasure of Allah's will has filled his whole soul. There was no place left for the love of lusts. So the slave was defeated in the face of the pleasures of love.

One of the teachings of Allah to us is that He created the fire (Hell). And he put various ornaments and joys around the gates of hell. That life is the ruling sultan there. Death may have been created from that sultan. Therefore, all sexual acts kill the soul if its owner is unaware of Allah. [1: 26-27]

Allah Almighty has given mankind these adornments and joys that surround the hell. The Messenger of Allaah (peace and blessings of Allaah be upon him) said: Hell is full of lusts.

We have seen our bodies placed between two kinds of love and two kinds of joy. To be happy with Allah and to love Him or to be happy with temptation and to love temptation. The source of love and joy for God is the soul. The source of joy with the temptation and its lusts is the stomach. Slave loves both and rejoices with her. But this joy is the joy that comes with Allah, and the source of that love is from Allah, the Most High, in Paradise. And the essence of the second joy and love is also from Allah at the gates of hell.

Which one does the slave follow and which one does he incline to? If he was inclined to love Allah, to rejoice in Him, he would have acted for Paradise, for Darussalam, he would have obeyed Allah's commands and prohibitions, and he would have severed his worldly ties. Or if he was inclined to the adornments and joys at the gates of hell, he acted for his own self, which was a victory for his soul. Then this slave will go beyond the limits of the Shari'ah and will lose the obligations. Hawaii would have acted on lust. This is where the struggle between the temptation and the soul arises. The soul is inclined to the love of Allah, to His joy. The temptation, on the other hand, is prone to the joy of lusts, to the love of lusts.

Mind, knowledge, enlightenment, understanding and intelligence are all soldiers of the soul. The love of lusts, the joy of lust, and its adornments are its soldiers. Whoever abandons mujahideen, his soul will be taken captive by his desires. None of Allah's commands and prohibitions will remain in it. The inner world of such a slave becomes one of the enemy cities. [1:27]

The Messenger of Allah, may Allah bless him and grant him peace, explained why. This means that the body has a right over you, and if you load something into your body beyond its capacity, a disease can occur in it, which means that you have wronged it. Because the body was standing on two legs. If you wear a shovel while standing, you will be able to lift one of your legs [to wear a shovel]. In this case, the body has to throw the load on one leg. Your veins will ache. If the veins are in pain, it is inevitable that any disease will occur, that is, if the veins are in pain, the risk of disease will increase. Because blood vessels are the pathways through which blood and air travel. If the arteries constrict during the time of distress, that is, when they are tormented, the blood pressure rises, and the same air in the arteries becomes agitated, it is possible to suffer from a lifelong disease. If the arteries become suffocated and constricted, they can sometimes rupture. As a result, bleeding is observed. When the blood hardens, it stops flowing and the blood breaks down. Sometimes the bod-air in the veins is constricted. As a result, the air in the still body becomes agitated. This can also cause big problems. [2:11]

Results and discussions. It should be noted that al-Hakim al-Termizi puts together such concepts as light, knowledge, soul and, in general, purity, fear of Allah. All of these concepts come together, and as a result, the sharp differences between

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them, even gradually, become imperceptible. Thus, in the teachings of Sufism, light and science are considered equally, and they are interpreted together as the basis of mysteries. Light is a symbol of inspiration, emotion, excitement and the beginning of enlightenment, the prelude to science and systematization, the theoretical and practical field and an integral part of the Muslim world, the enlightenment of Sufism. [3:54]

But we said some dirt would remain. Yes, if a slave loses contact with the world, these filths will go away and the clouds that will block him from Allah will remain. These clouds are a sign of privacy.

Mankind will be far away from Allah before believing in Allah. Because if he believes in these things, turns away from shirk, he will come out of the najas, and then if he does not commit sins after that, he will also come out of the filth. If it is disconnected from the world, it will also come out of the dirt and only clouds will remain in it. [1:28]

These desires, which confuse and confuse the human being, are the thoughts that are considered with the eyes of the soul. He then leaves the hesitant fantasies. Imagination becomes an idea when it is abandoned. Thoughts become a pleasure in the soul and veins. The veins absorb the desires of the lustful air.

These clouds and curtains purify the soul. That is why the soul turns to Allah in secret. Because Allah had made a condition with the human child in the sense that "the soul is for Allah and the other organs are for the soul." The soul was made for the love of God. Now the slave loves with love, even if he loves the other. Because he was created for love. The actions of the slave will be connected to that love, that return to that joy. If a servant turns to Allah with his soul, he will be freed from the bondage of lust with great difficulty. Then the slave breaks the covenant and goes down again, secretly looking towards Allah. This is a joke and a game with the Lord. If the soul saves itself, it will stop stealing.

Therefore, Allaah says (interpretation of the meaning): "I do not live in houses. Whoever seeks me, I am in the soul of a chaste, merciful, calm and gentle servant. "

Afif is such that his soul is protected from sensual pleasures and is chaste. Because this soul has received a perfect share of God's love and is filled with this love. A merciful person is a calm person who leaves his lusts for Allah. Those who are gentle are those who are merciful and devote their entire lives to the cause of Allah.

Such a slave is soft as well as hard as a vine. The vine is soft, wet, flexible. Bamboo and similar trees are examples of this. If you praise such a person, he will be praised, that is, if you bend, he will turn, if you eat, he will bend, he will not break, he will not break.

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The soul is soft because it is chaste. Because the client of lusts is hot and dries up the soul. The soul dries up as a result of lusts. If he is chaste and merciful, then his soul will be a soul for Allah. And the owner of such a soul keeps it for Allah. [1:30]

The Lord revealed His presence to the Throne. At the same time, He manifested His presence in the soul of this quality. Because such a soul can find its way to the Throne, to the honored places in the presence of Allah. If God is in the soul, such a soul will be a beating soul for him.

This is narrated in the Qur'an from the Messenger of Allaah (peace and blessings of Allaah be upon him): "If I love my slave, I will be his ear, eye, hand, foot and soul. He hears with me, sees with me, touches with me, thinks with me and walks with me".

The Messenger of Allaah (peace and blessings of Allaah be upon him) said in a hadeeth, "The most thief of the thieves is the one who is stolen from his prayer." What do you think of a person who steals his soul from Allah if he is a thief who steals from his prayers?

There is no monotheist if his soul is not dependent on Allah. This is a condition of faith. After that, man begins to steal his soul from Allah little by little. Gradually it covers his whole soul. The soul remains as if hanging on a string. If it breaks, it leaves. That is why Allaah said, "O Musa, if your love is cut off from me, no other thread will be tied to Me." This verse is also mentioned in the Qur'an: "So whoever denies the devil (or idols) and believes in Allah, then he has seized the trustworthy people."

Conclusion. That is, there is no interruption from Allah, no interruption. When this slave believed in Allah, he became attached to Allahu ta'âlâ out of love, and adhered to the Urwat al-Wusqân (Shari'ah). Then his soul began to steal. The knot of this handle was weakening and loosening. He was torn from his weakness and thinness.

Now all the actions of the slaves are abandoning all their desires. After all, those desires motivate the slaves to do the same. Because these desires come from a treacherous soul and a prone soul. Abandonment of desires is the riyâat of the faithful in their leeches on the path to Allah. [1:31]

According to Al Hakim al-Termizi, the abode of the soul is in the head of man, from where it spreads throughout the body of man. The abode of the temptation is in the abdomen, from where it spreads throughout the body. Al-Hakim al-Termizi says in his commentary that the soul is "heavenly" and the temptation is "ardiy" (belonging to the earth), the soul is cold and the temptation is hot. If a person blows "puff", cold air comes out, which is the coldness of the soul. If he says "hah" and hot air comes out of his mouth, it is the heat of the temptation. The first cold air is lust, and the second hot air is lust. The habit of the soul is obedience, and the habit of the

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temptation is to give in to lust. As al-Hakim al-Termizi begins to interpret any hadith, the elements of spirit and temptation occupy a central position in it. The scholar also refers to the elements of the *sadr* (chest) and the soul in many ways in revealing the inner meanings of his hadiths. [4:18]

If you give up your desire, lusts will leave you. When you do this, things that you don't like will come and you will start to get depressed. Even if you have reached the highest level, you will be hesitant, even if your desires are completely gone and the things you do not like have become easier for you. There is good news for you at this time. The miracle of turning to Allah has become a reality for you. Verily, Allahu taaala is the Most Merciful, the Most Compassionate. [1: 31-32]

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AHMAD DONISH'S VIEWS ON SOCIAL JUSTICE AND POLITICAL EQUALITY

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Abstract:

Introduction. According to Ahmad Donish, in order for civil society to function in the country, reforms are needed in government agencies, particularly the legislature. The thinker stressed that the development of the country, the peace of the people, the growth of the economy, culture, the necessary conditions for the establishment of democracy depend on the strict conduct of state affairs. Therefore, he writes, "it is necessary to develop a law that would regulate the head of state and officials, the order of meetings, the attitude of officials, family relations, relations with other peoples."

Materials and methods. Ahmad Donish writes that the task of managing political power is a very honorable, responsible and difficult task, which can be accomplished only by people who are wise, fair, caring about the people in practice and loyal to him. According to him, the country will be prosperous and its people will prosper only if the ruler pursues a fair and reasonable policy on all fronts, conducts foreign trade and cooperates closely with the peoples of other countries. Recognizing the essence of the state as wisdom, he concludes that "the mind and the state are inseparable, and that foolish people cannot govern the country."

Results. Of course, in this case there will be no peace in the country, and where there is no peace, people will not be able to live a prosperous life. Ahmad Donish also uses the art of painting to expose the oppressors of his time. In his memoirs there is a humorous picture of a drug addict who has lost his human appearance. In her miniature "School", kept in the collections of the State Art Museum, the idea of raising women was put forward. In particular, his painting "The Poet and the Dervish" is made in the style of miniature art of the 15th century, which expresses deep ideas about the fate of the Motherland.

Discussions. The fact that a person's greed leads to bad consequences for society occupies a special place in the work of the great thinker Ahmad Donish. The scholar discusses various issues in several chapters of the famous work "Navodir ul-wakoe" and focuses on this topic. According to the thinker, such people "do not interfere with people, do not leave them, do not commit grave sins, lie for the sake of accumulating wealth and treasures and commit many treacherous acts."

Conclusion. According to Donish, the development of the country, the peace of the people, the growth of the economy and culture depend on the systematic conduct of state affairs. According to him, success in social and political life is possible only with a regulated state mechanism, "of course, there must be a law on the exercise of state power, the organization of state bodies." He seeks the path of

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justice through enlightenment. It should be noted that the scientific and spiritual heritage, recommendations and suggestions of the thinker Ahmad Donish will serve as a positive solution to the problems of leadership and management, the system of training, retraining, training and selection of national and local specialists, modern leaders. Ahmad Donish also emphasizes the importance of the role of a leader in the development of a democratic state and civil society.

Keywords: *establishment of democracy, society, regulated state mechanism, civil society, leader in the development of a democratic state*

Introduction. The definition of social justice in society and the establishment of a just state are the basis of the ideas of mankind. Great statesmen and thinkers at all stages of history were interested in questions of building a just system. After all, the noblest dreams and desires of a person can be realized only in a society where justice is decided. President of the Republic of Uzbekistan Sh.M. Mirziyoyev said: "We consider it our primary task to make a broader solution to the sense of justice that our people have always valued and put above all else".

Ahmad Donish put forward his recommendations and theories to ensure political equality for all citizens living in the country, to fully build a free society based on the rule of the people, the duty of every citizen to comply with the law and to form an active and responsible approach to public life. Ahmad Donish carried out a number of effective practical works on the formation of civil society, showed its results and served as a spiritual basis for the future formed movement of Jadids and civil servants.

The first President I.A. Karimov said: "A person with a clear conscience cannot remain indifferent to the events around him, to the problems of people in need of help and assistance, to the suppression of justice. In particular, he will never be silent about atrocities that harm the interests of people, and will never accept betrayal and betrayal of his country and people. " Justice and law are closely related categories. Ahmad Donish connects the concepts of social justice and a just state with a just king, a leader. This stems from the basis of his political, legal, philosophical and spiritual views (figure 1).

It should be noted that Ahmad Donish's concepts of justice, politics, and law and the categories he uses in this regard are different from the concepts and categories in modern political science.

Ahmad Donish also turned out to be not only a theoretician, but also a practitioner. Develops a project of democratic reforms that will be implemented in the country and recommends it to the Emir of Bukhara for its implementation. According to the project, the state should serve the interests of the people, not the needs of a group of people, but the interests of the general public, ensure prosperity and well-being in the country, develop the country, create all opportunities for people.

In his opinion, he recognizes that the only way to ensure justice is to have an enlightened, knowledgeable, just ruler who serves the interests of the people and can see himself as an ordinary citizen in solving any problem.

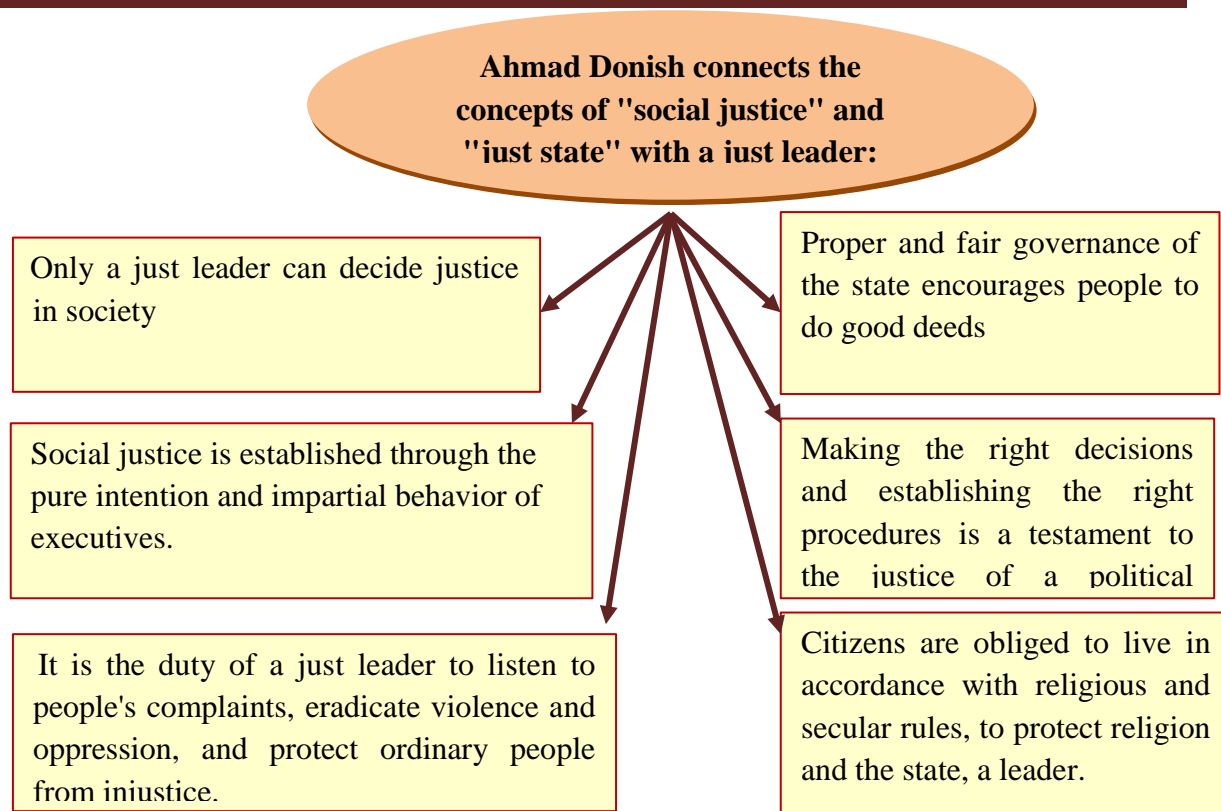


Figure 1. Justice, observance of the order established by law is the most important sign of a just state

An official must have the most important qualities for a person at the top of the state. Only then will order and justice prevail in the country, and society will flourish. Donish believes that from the point of view of justice, everyone should be content with their land.

An important aspect of Ahmad Donish's political views is the idea of democratic governance.

Ahmad Donish is well versed in public administration and, as he has extensive life experience in this field, seeks to implement democratic reforms and develop guaranteed tools and legal mechanisms for social justice in society. He classifies the models of a democratic state in this regard as follows:

- Proximity of heads of state to the people, direct communication;
- the head of state monitors and controls the actions of ministers, civil servants and governors;
- Proper spending of taxes in the interests of the state and the strengthening of human rights, the elimination of leadership to meet the personal needs of the ruler;
- adopt fair laws (decrees) and ensure their priority and implementation;
- appointment of the Prime Minister from among the most popular officials through consultations;
- clearly define the duties of each person, control him and provide him with a sufficient salary;
- to take into account the abilities, experience and knowledge of the personnel appointed to the position and to control their activities.

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As the head of our state Sh.M.Mirziyoev concluded, "In order to ensure the interests of the people, first of all, it is necessary to communicate with people, to know their concerns, dreams, problems and needs."

The righteous ruler is central to the socio-political views of Ahmad Donish. This approach is inherent in the work of all progressive thinkers in the East. According to them, Allah gives the king the state and the qualities necessary to govern it. According to Ahmad Donish, the king is primarily responsible for ensuring justice in the country. The righteous king, the supreme ruler, will put an end to oppression. The chapter of Ahmad Donish's Navodir ul Vaqoe, entitled "A treatise on governing the country and enlightening the people," describes the positive qualities of just rulers in public affairs and their importance in the life of the people and society. The pamphlet describes the king's responsibility to the people on the basis of ten conditions:

In the first condition, if there is a conflict between the ruler and the citizen, he considers the damage to the citizen as his own damage, in the second condition, he deliberately does not wait for the needy people who come to him, in the third condition he is polite and content, and in the fourth condition he is patient. and not to be impatient to listen, not to be ashamed to talk to the poor and needy, not to act arrogantly in the fifth condition, not to be slow and begging, not to be kind to the people like a father in the sixth condition, not to annoy the citizens, not to deviate from the right path in all matters. - to look at the little one, to act honestly and justly, and in the eighth condition to listen to the advice of wise men and scholars, to beware of hypocrites and deceitfulness, in the ninth condition to investigate the traitors, to punish the traitors in an exemplary manner, to be fair, just, anti-oppression, morality. Finally, in the tenth condition, he enumerates such aspects as pride, arrogance, avoidance of arrogance, the ability to suppress anger, and forgiveness.

Ahmad Donish emphasizes that being vigilant and prudent in dealing with the people, and carelessness, leads to unprecedented disasters: and whoever escapes from them will be saved. " In his pamphlet On the Order of Civilization and Mutual Assistance, he expresses his views on a just ruler, emphasizing that such a person must adhere to the ten conditions. They are: to resolve a case fairly when an issue is being considered; being quick, responsive, not expecting people; not to oppose the Sharia; to do good, not to be selfish; consultation with scholars, enlightened sages; ensuring the security of the country; adherence to eating and dressing etiquette; to see each case with proof; to be fair, conscientious; to be humble, kind.

Ahmad Donish says running a country is a very honorable and difficult job, it should be led by people who are smart, fair, really thinking about the lives of the people, loyal to it. Historical facts confirm that these qualities remain the same even in the conditions of independence.

Ahmad Donish lived and worked in Turkestan during the reign of medieval relations, so his worldview is full of contradictions. He sought to achieve a just system by spreading enlightenment among the people, advancing his ideal idea of a just king. According to him, if the king pursues a just policy in all areas, creates conditions for the people to flourish their profession, develops trade with other countries, the country will be prosperous and the life of the people will be prosperous.

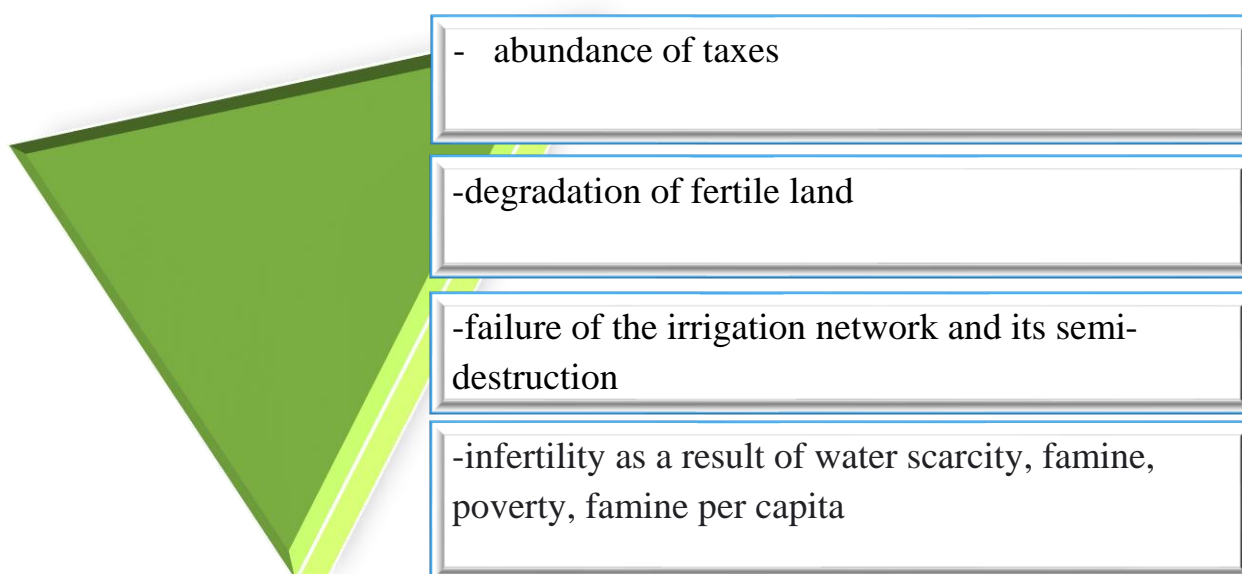
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Ahmad Donish, based on his life experience, shows who he can't communicate with and is even dangerous. "Since you have to communicate with people, choose people who are close to your character, smart and intelligent. Because a sane person does not want to harm himself ... Such people are found among the wise and faithful. Study the people of the other class as well, keep an eye on them, find out if they will get rid of the bad qualities from their behavior, and only then make friends with them. Communicate with your wealthy relatives and descendants only when absolutely necessary, and be as kind to your poor relatives as you can.

Materials and methods. Ahmad Donish writes in Rare Events: "Europeans have a theory that first everyone had equal property, then the strong plundered the weak, resulting in inequality. That inequality must be eliminated." He reacted positively to such ideas, writing: "If these things happen, then there will be peace and prosperity for the people." Then, according to the thinker, the distinction between wealth and poverty will disappear, and all people, regardless of religion or nationality, will help each other and strengthen mutual friendship. They work according to their professions, then there will be no wars, no need for soldiers and weapons, everything that is valuable on earth will serve humanity.

In the days of Donish, the nobles of the time used to gather and hold meetings and conversations. Donish writes: "Sometimes during the meeting there was talk about the intolerance of the times, the condition of the peasants, and sometimes the injustice of the rulers and scholars." From the point of view of the state protecting the interests of all members of society, everyone can "demand their rights." According to Donish, members of society should have equal rights and equal responsibilities. "All people should have equal access to work and rest, happiness and unhappiness, because they are the descendants of one father."

Ahmad Donish criticizes the emir's policy, complaining about the underdevelopment of agriculture, the desecration of fertile lands, the encroachment of moving sands on gardens, vineyards and crops, and also that the emirate did not take any action against this. The thinker explains the reasons for the migration process in the Bukhara Emirate as follows (table 2).



Here is an example of the drying up of the Jilvon canal (now Shafirkan district - R.J.), which supplies water to many areas. He stressed that this situation has

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a negative impact on the development of the country, the environment and public health. Ahmad Donish advocated the enlightenment of all people, thinking that in order to save the homeland and the people from backwardness, it was necessary to establish a just government, develop agriculture, support artisans, enjoy the achievements of science, train scientists. Ahmad Donish dreamed that everyone would have a full stomach, idols and knowledge, and at the same time be able to easily answer the questions of any foreigners who come to Bukhara.

These ideas of Ahmad Donish have a great socio-moral significance, he put forward the issues of educating young people to be enlightened, intelligent, patient, honest, pure conscience, the formation of high human qualities in them. Donish once said, "... we were born to make the world prosperous, to explore the rivers and seas, to discover the riches of the earth, to know all the continents of the earth, the people there." Ahmad Donish points out that the current political system is an obstacle to development and is looking for ways to remove this obstacle.

Results. Ahmad Donish voluntarily left the civil service in the late 1970s, which was inconsistent with his vision of a just state. He writes of the incident: "... because of the lack of order in the service of the army and the governors, service in the palace seemed difficult and fruitless to me. I left the palace, despite suggestions and objections, and settled in a madrasa, satisfied with dry bread." In governing the country, the ruler believed that important state affairs should be decided in consultation with the statesmen around him. Again, treat the friend-enemy well so that the love of the friend increases and the enmity of the enemy decreases. Ask for advice from older people who have seen and experienced a lot. This view of knowledge implies a specific order of democracy, a system of governance based on collegiality. At this point, his views coincide with those of Abu Nasr al-Farabi. Abu Nasr al-Farabi linked the principles of justice, as well as the need to achieve equality and general happiness, to the qualities of a ruler. Ahmad Donish writes that not only the ruler of the country but also those around him should be knowledgeable, just and wise. Only in this way, order and discipline will be established in the society, the state will develop. The scholar was the first of the Central Asian enlighteners to try to show the importance of the property factor in the formation of the state. "Let the king not only be content with his own honesty and justice, but also urge all statesmen, especially the servants around him (the political elite - R.J.), to justice and fairness. Let him not be silent about any of their oppression. Officials will be held accountable if they remain silent about the tyranny of the king ... " Only a government based on justice and the rule of law will be strong. "Neither the treasury nor the army can save the king if the people are dissatisfied with the order of the state and the policy of the kingdom," he said. If the people agree with him, let him know that no one can stand against him. " This opinion is in line with the views and practical actions of President Sh.M. Mirziyoyev.

A leader should not harm anyone's heart for no reason. Because the people raised him to a higher position for the peace and freedom of people. As long as the leader hurts people, it does not lead to good. He must treat people well during his leadership so as not to be embarrassed when he loses his position. If a leader wants to establish justice for his people, he must understand that citizens have a right to him,

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and fulfill each task in due time. Second, the leader must meet the needs of the people.

A leader should not do something that does not suit him or her and is not worthy of leaders. Too often, people quit their jobs and take on jobs that don't suit them, and then they lose their jobs and can't even finish. A leader must behave and abstain in all of his affairs. A leader must be patient in every situation.

Let the leader avoid arrogance, be gentle and generous. If a leader has a lot of arrogance, he will get angry at even trivial things. It is well known that anger comes from the person who is angry, and many unpleasant things happen as a result. Therefore, the leader should be patient in everything and not rush too much, especially when he is angry, and should not do anything without suppressing his anger. Let him know that if he is forgiving and gracious, he will do the work of the prophets and saints. If he does not do so and acts in anger, then he will commit the act of beasts and cauldrons. In any city without the following five things, no wise man would stand in such a place, writes the thinker (Table 3).

- | | |
|---|---|
| 1 | One must be a strong and fair leader. If the leader is weak and cruel, the number of bad people in the country will increase, and the neighboring country will begin to invade the land. There will be no peace. |
| 2 | Officials and governors must be honest. If they are cruel, even if the leaders are just, the country will be ruined and the villagers will be devastated. If the leader knowingly keeps silent, then he himself has joined the ranks of the oppressors. |
| 3 | Every city must have enough qualified doctors. If there are no doctors in the city, people will die for internal and external reasons. In this case, society will be destroyed. |
| 4 | The people of the city should be friendly and hospitable. If there are many hospitable and generous people among them, it will be easier for those who come from far and near, and the society will increase. |
| 5 | The water flowing from the rivers, large and small, must be sufficient for the country's agriculture. If there is not enough water in any city, it will soon be ruined. |

The most necessary and important aspect of the human world is that leaders and government officials have access to justice and morality. Before the morale of the people is restored, it is more important to restore the morale of leaders and government officials. Because if the leader is moral, it will affect not one city, but one region and even the entire climate. The corruption of the leader also causes the corruption of the people of the whole country. Therefore, it has become so necessary to write a manual for leaders and statesmen. Allow leaders and government officials to use such books so that others who love the truth can also contribute to it. It is well known that being a leader is one of the greatest achievements in life. Then the manager can perform this set task with knowledge and practice.

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Let the head of state entrust the important work of the state to reliable, experienced people. Beware of unreliable deceivers. Because if the people in the country are not trustworthy in everything, state secrets are not well kept. If people close to the leader are bad and the leader takes their words into account, such people will not hesitate to call people to the leader with various malice and kill them. In this regard, Fitrat states: The Supreme Ruler - Amir can not personally monitor the situation of every citizen, so he appoints a person as the ruler of a particular community and requires him to fulfill his rights and obligations to himself and the people.

Discussions. However, according to the custom of the universe, it is impossible to reach a high level at once, a person who wants to climb the stairs to the roof rises from the lower steps to the upper steps, and then ascends to the roof. Anyone who wants such leadership must first serve them as a soldier. Or a person who wants to be the governor of a city must first agree to become the head of the village and start to serve. Then he can slowly ascend to a higher level. When the state and the country fall into the hands of incompetent and unworthy people, the judiciary and presidential power remain in the hands of the ignorant, illiterate, and those in power are dishonest and wicked, only such people will fight for positions and titles. ... On the other hand, wise scientists do not consider it advisable to strive for a career and a title. Because illiterate, unworthy people at the top of the state do not value wise people and do not appear before the court. As a result, the wise are forced to step aside and not interfere. They do not agree to worship such inferior ones. If a person is ignorant, if he does not have the ability to lead, but he still strives for high positions, does not dare to make a profession in accordance with his condition, eats bread without working, and thinks about getting a state without acting, such a person is called ignorant. Witty, open-minded, thoughtful, and intelligent people are worthy of service. Those who claim to be judges and presidiums must be smart, calculating and have a university degree in fatwas and litigation sciences. These qualities inherent in such people are passed on to them instead of profession and actions. Perhaps, without wasting his life, he should take up a profession that will benefit people.

If the head of state leaves them too free at the will of the people, the morale of the people will be corrupted, and no one wants to obey, and the affairs of the state will suffer. They do not comply with government taxes and do not pay taxes on time. As a result, everything turns upside down. This is why a leader must command good and forbid evil, and he implements policies in accordance with what works best for the people. Social inequality was one of the widespread manifestations of society in the Bukhara Emirate. The lower strata of the population lived in poverty, and due to the lack of economy and lack of social protection, there were countless people in society in need of social protection. In addition, there was a high level of unemployment, and job seekers were also a characteristic feature of that period. Craftsmen, artisans and peasants worked hard. The upper class — the rich, the aristocracy, the ruling class — lived in economic prosperity. Ahmad Donish did not consider such a way of life to be acceptable for himself. Ahmad Donish writes: “Let the king offend no one for no reason. Because the people raised him to such a high

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level that people live in peace and freedom. As long as the king oppresses them, everything will be the other way around. "

Conclusion. In conclusion, it should be noted that many objective and subjective factors influenced the formation of the socio-political views of Ahmad Donish. It should be noted that these views were formed as a result of the struggle between two opposing environments of that time, i.e. Ahmad Donish was influenced by the religious and ideological traditions of Bukhara and cultural elements of public life in connection with the arrival of Tsarist Russia. In addition, Donish's socio-political, economic and educational views have not lost their relevance and remain relevant today. An in-depth study of the heritage and historical experience of our ancestors who fought for independence in building a democratic state and building the foundations of a civil society in the Republic of Uzbekistan requires the development of appropriate conclusions. One of the important issues requiring study is the socio-political views of the scientist Ahmad Donish, which do not require proof. Ahmad Donish wanted to change the mechanism and structure of society. He put forward the idea of creating a system of a just state and wrote a special brochure about it. Ahmad Donish proposed a modern system of social governance, not just Sharia law. Another task of the ruler is to attract able-bodied people to work, to provide pensions for the disabled, the scientist believes.

Therefore, since the first days of independence, our country has been training proactive, enthusiastic, courageous, nationally qualified leaders who have formed a professional culture and worldview. In this regard, while studying our rich political heritage, we need to improve public administration, to pursue the internal and foreign policy of the republic without mistakes and shortcomings, to correctly and effectively solve the current tasks facing the preparation, selection and placement of modern leaders. We will have recommendations and instructions. As Ahmad Donish rightly admits by the scholars who have studied his work and creativity, all his work is saturated with a just ruler and society, civil liberties and equality, political consciousness, and democratic ideas.

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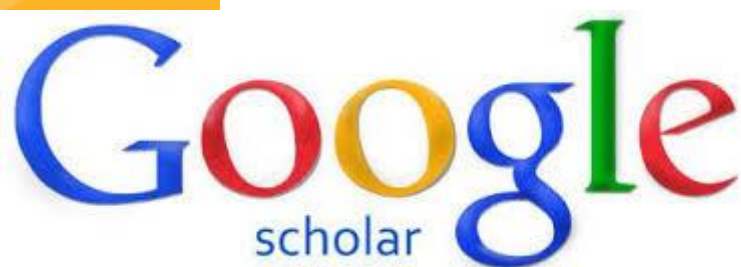
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