In equation (17), was $ab = 2k$. So,

$$ab = a'b'$$

In the above transformation, the product ab does not change. Namely, it is invariant.

Similarly, it is shown for $k < 0$.

Conclusion. The obtained results show that when a quadratic curve experiences the transformation (2), causing the product of their semi-axes remain constant. In transformation (2) of quadratic curves, this provides the deformation of the shape in Euclidean space. Therefore, in this deformation, the product of the semi-axes remains unchanged.

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EFFECTS OF A MULTICOMPONENT HEAT SOURCE ON AMBIENT DENSITY IN MULTIDIMENSIONAL FIELDS

Annotation. *This paper investigates the effect of heat dissipation on medium density in multicomponent nonlinear heat dissipation processes in multidimensional fields. In order to solve the equation of linear heat distribution, a density and heat source of the built environment, taking into account the characteristics of reaction-diffusion processes are observed. obtained results: an estimation for the double linear heat diffusion equation, a model by homogeneity was constructed. The program code is compiled in the Python programming language and the process is modeled.*

Keywords: *Heat temperature, system, ambient speed, heat source, the density of the environment, power of the heat source, parabolic equation.*

KO'P KOMPONENTLI CHIZIQLI BO'LMAGAN ISSIQLIK TARQALISH JARAYONLARIDA ISSIQLIK TARQALISHINING O'RTA ZICHLIKKA TA'SIRI

Annotatsiya. *Ushbu maqola ko'p o'lchovli sohalarda ko'p komponentli chiziqli bo'lmagan issiqlik tarqalish jarayonlarida issiqlik tarqalishining o'rta zichlikka ta'sirini o'rganadi. Chiziqli issiqlik taqsimoti tenglamasini hal qilish uchun reaksiya-diffuziya jarayonlarining xususiyatlarini hisobga olgan holda qurilgan muhitning zichligi va issiqlik manbayi kuzatiladi. Olingan natijalar: qo'sh chiziqli issiqlik diffuziya tenglamasini baholash, bir jinslilik bo'yicha model tuzildi. Dastur kodi Python dasturlash tilida tuzilgan va jarayon modellashtirilgan.*

Kalit so'zlar: *Issiqlik harorati, sistema, atrof-muhit tezligi, issiqlik manbayi, atrof-muhitning zichligi, issiqlik manbasining kuchi, parabolik tenglama.*

ВЛИЯНИЕ ТЕПЛООТВОДА НА ПЛОТНОСТЬ СРЕДЫ В МНОГОКОМПОНЕНТНЫХ НЕЛИНЕЙНЫХ ПРОЦЕССАХ

Аннотация. *В данной работе исследуется влияние теплоотвода на плотность среды в многокомпонентных нелинейных процессах теплоотвода в многомерных областях. Для решения уравнения линейного распределения тепла наблюдают плотность застроенной среды и источника тепла с учетом свойств реакционно-диффузионных процессов. Полученные результаты: оценено билинейное уравнение теплодиффузии, построена модель однородности. Программный код компилируется на языке программирования Python и моделируется процесс.*

Ключевые слова: *температура тепла, система, скорость среды, источник тепла, плотность среды, мощность источника тепла, параболическое уравнение.*

Introduction: One of the current processes is the process of heat diffusion, and the main phenomenon in this process depends on the area in which the heat is distributed. Heat diffusion in nature can be multidimensional or one-dimensional. Of course, in this process, we must draw up the evolutionary equation of the process, and the dependence on the heat coefficient of the environment. Transfer, It is known that the processes of heat propagation in multidimensional fields are non-linear. Given the initial temperature (Cauchy condition) for the heat diffusion process, quasi-linear diffusion models for non-linear heat diffusion, the spatial localization property and the effect of thermal diffusion with limited velocity have been studied by many scientists over the years. It was also applied to non-linear processes occurring in multidimensional areas of the studied mathematical models and found new solutions that are not characteristic of linear equations. A nonlinear system with different densities remains the main problem of scientific research today, which leads to the parabolic equations of heat transfer and convective transfer of the environment. To observe and control the multicomponent heat propagation process in multidimensional fields, we see the following equation [1;5 p.]. $K = \{(t,x): t \in R_+, x \in R\}$ area:

$$Bu \equiv -\rho_1(|x|)u_t + \nabla\left(\rho_2(|x|)u^{m-1}\left|\nabla u^k\right|^{p-2}\nabla u^l\right) + v\nabla u + \varepsilon\gamma u^\beta \tag{1}$$

initial (Cauchy state) $u(0,x) = u_0(x) \geq 0,$ (2)

condition be given. Here $u(x,t)$- heat temperature, $v(t) \in c(K)$ - ambient speed, $\rho_1(|x|) = |x|^{-n}, \rho_2(|x|) = |x|^q$ - The density of the environment, continuous function β- parameter, γu^β - represents the positive, $(\varepsilon = +1)$ or negative, $(\varepsilon = -1)$ power of the heat source. (1) This system of equations constitutes a mathematical model of a number of complex physical processes. Filtering processes based on the law of polytropy of liquids and gases, and other physical phenomena associated with non-linear changes.

Main part. The mathematical expression of these processes is described by a number of differential equations and boundary conditions. Equation (1) has been considered in many studies in the form of Cauchy problem and boundary value problems for one-dimensional and multi-dimensional cases [1-5]. There are various methods of analyzing and solving these problems, which are performed using spaces in functional analysis, differential operators in the theory of mathematical physics, and nonlinear differential equations. In applied mathematics, solutions to these problems are sought using methods based on the principles of self-similarity. Methods such as working in the field of functional indicators, studying the spectral properties of classical operators, and making changes are used to determine the solutions of the system of equations. Figure 1-2 illustrates the dynamic behavior of this equation at different parameter values.

If N=2, equation (1) can be written in the following general form:

$$\begin{cases} |x|^{-n}\dfrac{\partial u_1}{\partial t} = \nabla\left(|x|^q u_i^{m_1-1}\left|\nabla u_1^k\right|^{p-2}\nabla u_1^l\right) + v(t)\nabla u_1 + \gamma_i u_2^{\beta_1} \\ |x|^{-n}\dfrac{\partial u_2}{\partial t} = \nabla\left(|x|^q u_i^{m_2-1}\left|\nabla u_2^k\right|^{p-2}\nabla u_2^l\right) + v(t)\nabla u_1 + \gamma_i u_1^{\beta_2} \end{cases} \tag{3}$$

here, $\beta_i \neq -1; \beta_i \cdot \beta_{3-i} \neq 1$, $\gamma_i u_i^\beta$ - heat source, $u_i(t,|x|)|_{t=0} = u_{i0}(|x|) \geq 0, \quad x \in R^N$, $i = 1,2$ - balance.

(3) the system of equations that we have in the answer $m = k, n = 0, l = 1, 0 < \beta_i < 1$ position[3]

$$\beta_i = \frac{p - [m_i \cdot (p-1) - 1]}{p-1}, \; 1 < m_i < 2, \; p > m_i \cdot (p-1) - 1$$

When accumulation of heat in a certain place. the structure of the final thermal solution and its effect on the process, the effect of time on the rate of heat transfer, as well as the contribution of the ambient density to the temperature distribution. New process states and their interdependence. The effect of heat source intensity is also important in the process. (3) the following mathematical transformations were made:

$$|x| = r = \left(\sum_{i=1}^{N} x_i^2\right)^{1/2};$$

The size of the free space.

Substitutions are called radially symmetric.

A variation of the solution from substitution (3):

$$\begin{cases} r^{-n}\dfrac{\partial u}{\partial t} = r^{1-N}\dfrac{\partial}{\partial r}\left(r^{q+N-1}u_1^{m_1-1}\left|\dfrac{\partial u_1^k}{\partial r}\right|^{p-2}\dfrac{\partial u_1^l}{\partial r}\right) + r^{1-N}v(t)\dfrac{\partial}{\partial r}\left(r^{N-1}\dfrac{\partial u_1}{\partial r}\right) + \gamma_1 u_1^{\beta_1} \\ r^{-n}\dfrac{\partial u}{\partial t} = r^{1-N}\dfrac{\partial}{\partial r}\left(r^{q+N-1}u_2^{m_2-1}\left|\dfrac{\partial u_2^k}{\partial r}\right|^{p-2}\dfrac{\partial u_2^l}{\partial r}\right) + r^{1-N}v(t)\dfrac{\partial}{\partial r}\left(r^{N-1}\dfrac{\partial u_2}{\partial r}\right) + \gamma_2 u_2^{\beta_2} \end{cases} \tag{4}$$

(4) we look for the first solution as follows:

$$u_i(t,r) = v^{\alpha_i}\cdot w_i(\xi);\ \ \xi = r\cdot v^{-\mu};\ \ i = 1,2 \tag{5}$$

here α_i - the number being searched, w_i - an unknown function, ξ - parameter, $\mu = const.$ v - we define the conditions for the following function:

$$v'v^{\alpha_i - 1 - n\mu} = v^{\alpha_{3-i}\beta_i}$$

$$v^{-n\mu+\alpha_i-\alpha_{3-i}\beta_{i-1}}dv = dt$$

$$v(t) = B_0(T_0+t)^{\frac{1}{\lambda_0}}$$

it is here $\lambda_0 = \alpha_i - \alpha_{2-i}\beta_i - n\mu \neq 0;\ B_0 = (\lambda_0)^{\frac{1}{\lambda_0}}$. If: $\lambda_0 = 0$, $v(t) = c_1 t:\ c_1 = const$ we will have a new solution

$$\mu(q-p)+\alpha_i(m_i + k(p-2)+l-1) = 1+\alpha_i - 2\mu = \alpha_{3-i}\beta_i \tag{6}$$

The system of linear equations was derived from equation (6) as follows:

$$\begin{cases} \alpha_1(m_1 + k(p-2)+l-2)+\mu(q-p+2) = 1 \\ -\alpha_1 + \alpha_2\beta_1 + 2\mu = 1 \\ \alpha_1\beta_2 - \alpha_2 + 2\mu = 1 \end{cases} \tag{7}$$

If we replace (5) with (4), we get a new system of equations:

$$\begin{cases} \xi^{1-N}\dfrac{d}{d\xi}\left(\xi^{q+N-1}w_1^{m_1-1}\left|\dfrac{dw_1^k}{d\xi}\right|^{p-2}\dfrac{dw_1^l}{d\xi}\right) - \alpha_1\xi^{-n}w_1 + \mu\xi^{1-n}\dfrac{dw_1}{d\xi} + \xi^{1-N}\dfrac{d}{d\xi}\left(\xi^{N-1}\dfrac{dw_1}{d\xi}\right) + \gamma_1 w_1^{\beta_1} \\ \xi^{1-N}\dfrac{d}{d\xi}\left(\xi^{q+N-1}w_2^{m_2-1}\left|\dfrac{dw_2^k}{d\xi}\right|^{p-2}\dfrac{dw_2^l}{d\xi}\right) - \alpha_2\xi^{-n}w_2 + \mu\xi^{1-n}\dfrac{dw_2}{d\xi} + \xi^{1-N}\dfrac{d}{d\xi}\left(\xi^{N-1}\dfrac{dw_2}{d\xi}\right) + \gamma_2 w_2^{\beta_2} \end{cases} \tag{8}$$

$w_i(\xi)$ - when we look for a function

$$w_i(\xi) = f_i(\varphi);\ \ \varphi = \varphi(\xi); \tag{9}$$

(9) - (8) into the equation system

$$\xi^q\left(\frac{d\varphi}{d\xi}\right)^p\frac{d}{d\varphi}\left(f_i^{m_i-1}\left|\frac{df_i^k}{d\varphi}\right|^{p-2}\frac{df_i^l}{d\varphi}\right) + \frac{d}{d\xi}\left(\xi^{q+N-1}\left(\frac{d\varphi}{d\xi}\right)^{p-1}\right)\xi^{1-N}f_i^{m_i-1}\left|\frac{df_i^k}{d\varphi}\right|^{p-2}\frac{df_i^l}{d\varphi} -$$

$$-\alpha_i\xi^{-n}f_i + \mu\xi^{1-n}\frac{d\varphi}{d\xi}\cdot\frac{df_i}{d\varphi} + \left(\frac{d\varphi}{d\xi}\right)^2\frac{d^2f_i}{d\varphi^2} + \xi^{1-N}\frac{d}{d\xi}\left(\xi^{N-1}\frac{d\varphi}{d\xi}\right)\frac{df_i}{d\varphi} + \gamma_i f_{3-i}^{\beta_i} = 0. \tag{10}$$

when equal $\varphi_\xi = \xi^{-q/p};\ \ \varphi(\xi) = \begin{cases} \dfrac{p}{p-q}\xi^{\frac{p-q}{p}};\ q \neq p \\ \ln|\xi|;\ q = p \end{cases}$.

Lemma 1. Let $u_0 \in C_0(R^1)$. There are constants $a_2 > 0$, $T > \exp(1 + S(\mu - 1))$

$$s > \frac{S(\mu-1)}{2(1-(1+S(\mu-1)))/\ln T} > 0$$

function is as follows

$$u_+(t,\varphi)=\left[(T+t)\ln(T+t)\right]^{-\frac{s}{s(\mu-1)+2}} f(\psi(\tau)\xi;a_1),$$

where $\psi(\tau)=\left(1+\frac{s}{T}\right)^{-\frac{1}{2}}$, solutions to problems (1)-(2).

Theorem. For optional function $u_0 \in C_0(R^1)$, there is a constant $a_- > 0$, $a_+ > 0$, and $T > 1$ this is the solution to the problem (1)-(2) in $(T,+\infty)\times R^1$ a solution that satisfies the inequality

$$\left[(T+t)\ln(T+t)\right]^{-\frac{s}{s(\mu-1)+2}} f(\xi;a_-) \le u(t,x) \le \left[(T+t)\ln(T+t)\right]^{-\frac{s}{s(\mu-1)+2}} f(\xi;a_1)$$

Proof. From the theorem, the answer is a proof of the existence of a lower and upper solution as shown in Lemma 1, and the corresponding solutions are obtained. $u(T,0)>0$, the constants a_- and a_+, for example, as quoted:

$$a_- = a_1,\ a_+ = a_2\sqrt{1+\frac{s}{\ln T}}.$$

As stated in the condition of the theorem

$$f(\xi;a_-) \le K(\tau,\xi) \le f(\xi;a_+)$$

everywhere in $(\ln T;\infty)\times R^1_+$.

Analysis and results. After considering Theorems (9)-(10) and (4)-(5). In finding the numerical solution of the equation, it was adapted to a special mesh structure and the solution was sought. In this process, the balance method was chosen as the main calculation principle. Iterative processes are built on the basis of Picard's method, Newton's method and their special modifications [2;5 p.].

Heat accumulation (localization) in the process of heat propagation, the effect of the final solution form on the process, the effect of the time factor on the rate of temperature change in the heat medium are determined. In addition, the contribution of the ambient density to the limitation or acceleration of heat transfer, as well as new physical phenomena that appear as a result of the local effect of the heat source, are taken into account. The solution is obtained as shown in Figures 1 and 2, and we have shown their interrelation.

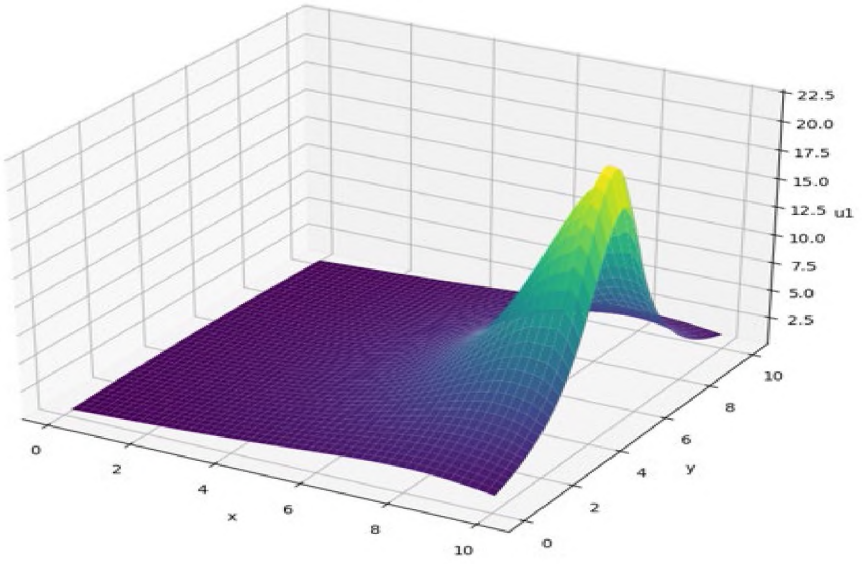


Fig.1.

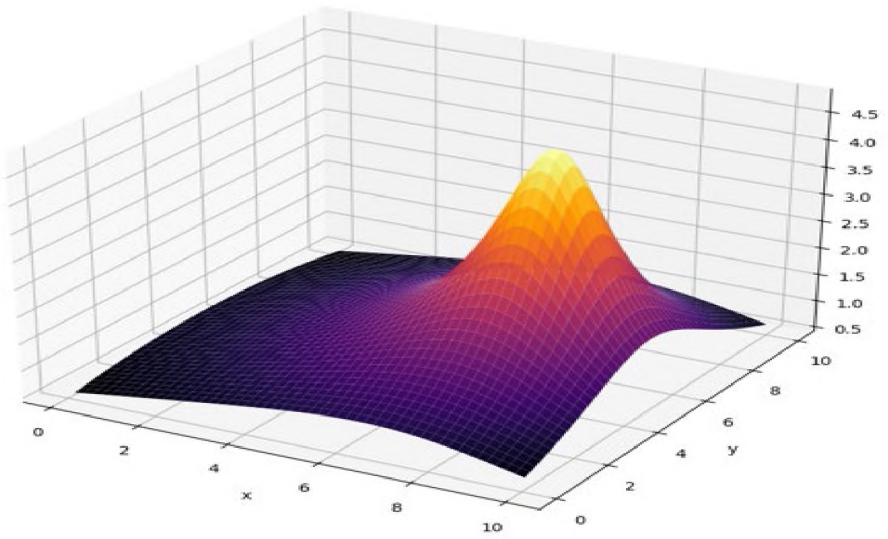


Fig.2.

Conclusion. Solving the Nonlinear Heat Dissipation Equation Using Iterative Methods: The iterative methods used to solve the problems have shown high efficiency, especially when self-similar solutions obtained from the standard equation and nonlinear separation methods are used. These approaches make it easier to incorporate complex nonlinear effects into the model. In the calculation process, the initial approximate value of the solution is important, and this method was chosen based on the developments of [2;4 p.].

The results show that Picard's iteration requires fewer iterations than Newton's specialized method to achieve the desired accuracy. The reason for this is related to the correct selection of the initial guess [3-5]. At the same time, in each analyzed case, Newton's method ensures the selection of particularly accurate initial values.

Computational results show how a finite perturbation rate affects the distribution and localization of the solution. These results show sensitivity to changes in model parameters. The received information is presented in the graphs, with all the graphs explained in a visual form.

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