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SYSTEMATIC ANALYSIS OF THE STATE OF CONTROL OF THE TECHNOLOGICAL PROCESSES OF UNDERGROUND LEACHING

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Abstract:

Objective. to create optimal algorithms and programs that calculate the main geo-technological indicators of the mineral mixing process, to distinguish the factors affecting the management process in mine processing.

Methods. Fourier, Laplace, Bubnov-Galyorkin's substitution and finite-difference methods of approximation are used to solve the diffusion problem of the underground leaching (UL) process.

Results. One of the geo-technological methods used in the extraction of minerals, the method of mineral mixing, was systematically analyzed and the process of extracting useful components using this method was studied. Two-dimensional mathematical control models that are suitable for this process were developed. As a result of solving these models, the dynamics of concentration changes and the values of parameters affecting the effective course of the process were analyzed using various diagrams.

Conclusions. in order to calculate the decision-making parameters when conducting a computational experiment and process control, underground leaching and their mathematical models must be compatible with natural processes and the parameters involved in it, and software tools must also be developed to visualize the calculation results corresponding to the mathematical model.

Keywords: systematic analysis, useful component elements, erosive mixing process, suction and injection wells, concentration quantity, optimization factors, mathematical models, visualization of results, management process.

Introduction. It is known that geo-technology is a science that studies geo-technological methods of extracting various minerals without direct human intervention. It collects data on various physical and chemical processes occurring underground, the formation and movement of minerals, and geo-technological processes associated with environments in mountains. Its main task is to use the action of working reagents to convert the moving rocks into useful components and extract them upward using thermal, substance exchange, chemical, diffusion and hydrodynamic processes. Among such methods, the most widely used is the underground leaching method, the essence of which is to remove the mineral as a product from its location under the influence of a chemical reagent with a specific solution. UL refers to the filtration-diffusion process and is based on a solid-liquid chemical reaction. It is mainly used in the mining of non-ferrous, rare and radioactive metals.

UL is such a complex technological process that it usually consists of filtration, diffusion and kinetics. Leaching, as a filtration process, sends the solution from one point (pouring well) to another and sends the dissolved product together with the filter solution to the suction well. The leaching process takes place in a permeable ore medium and the filtration process takes place.

In UL, ore preparation and processing is done mainly through boreholes, and most of the mining is done above ground. Therefore, semi-products that are easy to turn into final products are obtained from the ground, and they go through many processes of ore processing on the ground.

In information technologies, today, the issue of adopting solutions in complex conditions is of utmost importance. Now, mathematical methods are widely used in the analysis complex systems and representing them. If the magnitudes consisting of random quantities move according to certain laws, it is clear to achieve success in technological processes, but the main difficulties arise when the parameters are completely uncertain, and they can significantly affect the solution. Specialists often have to work with imprecise parameters in equations or imprecise technological information. This situation is due to the lack of information about the studied object and the fact that a person is not directly involved in the management process.

The main feature of information technologies that support decision making is in qualitatively organizing human-computer interaction in a new way.

The UL process is a technological process because it is done by man. In UL, if wells were not involved, the process would take place only on the basis of natural hydrodynamic laws. However, human influence can either accelerate the process or vice versa. New information is obtained by observing and analyzing the dynamics of changes in parameters and quantities affecting the technological process. The need to create a knowledge repository containing all these changes creates the need to create a mathematical model and algorithms for decision-making in the appropriate management of the UL process.

Methods. One of the important features of the EQ process is the maintenance of the balance amount of the injected and extracted solution, which ensures the maximum (field) circulation of the solution at the boundary of the ore layer: $\sum_{i=1}^{N} q_i^H = \sum_{j=1}^{M} q_j^0$. Here, N is the number of wells into which solution is poured, the amount of productivity in the $q_i^H -$ well, M is the number of wells receiving the product, the amount of productivity in the $q_j^0 -$ well.

$\sum_{i=1}^{N} q_i^H < \sum_{j=1}^{M} q_j^0$ in this case, due to the upward movement of water from the ore-free part of the layer, the impoverishment of the technological solution is observed, and as a result, it causes the following tasks:

-permanent reduction of underground water level;

- collection of the used solution.

$\sum_{i=1}^{N} q_i^H > \sum_{j=1}^{M} q_j^0$ in this case, seepage of solution enriched with minerals is observed at the boundary of the ore layer, and it can lead to the following consequences:

-pollution of used fresh water at the border of the ore layer;

- constant increase of the level of ground water.

The EQ process is a hydrometallurgical phenomenon that occurs as a result of the interaction of subsystem elements. Therefore, in the mathematical modeling of the process, the equations of hydrodynamics, diffusion and kinetics of substance exchange are simultaneously considered.

To create a mathematical model representing the process, it is necessary to consider the following physical conditions. The UL process of metals in an ore permeable layer consists of chemical preparation consisting of saturation and mixing of the mixture. There is no significant border between them. They complement each other. On the one hand, intensive leaching occurs simultaneously during saturation of the ore layer with solution. On the other hand, increasing the reagent concentration in the saturation layer takes a long time, during which a significant part of the intensively extracted metal is extracted as a result of UL.

Therefore, by solving the UL equation of hydrodynamics, it is possible to determine the amount of product in the ore-conducting boundary layer, the nature of leaching, the consumption of product in the internal parts, the capacity of wells where the solution is pumped, the maximum amount of debit of the wells where the product is extracted, and it is possible to show how external mixing causes changes at the expense of the natural speed of the flow in specific objects. Determining the value of the pressure at each point helps to form correct ideas about the movement of the liquid in the environment.

The problem of filtration-convective diffusion in the EQ process is expressed in the following sequence, taking into account the limit of reagent diffusion based on chemical kinetics.

Initially $G=\{(x,y,t)/\ a<x<b,\quad c<y<d,\quad 0<t\le T_k\}$

to determine the filtration flow characteristic in a confined area:

$(x,y)\in G$

$H(x,y,0)=H_0(x,y)$, primary: $(\theta\frac{\partial H}{\partial n}+(1-\theta)H)/_{\Theta}=\varphi(x,y)$, θ ={0 ёки 1} satisfying the boundary conditions are used (here Si –closed contour, h – height):

$$mh\beta\frac{\partial H}{\partial t}=\frac{\partial}{\partial x}\left(\frac{kh}{\mu}\frac{\partial H}{\partial x}\right)+\frac{\partial}{\partial y}\left(\frac{kh}{\mu}\frac{\partial H}{\partial y}\right)+f(x,y,t)$$

$$f(x,y,t)=\frac{\mu}{k}\sum_{i=1}^{N}\delta(x-x_i,y-y_i)q_i(t)$$

The filtration rate is determined by Darcy's law:

$$v_x=-k\frac{\partial H}{\partial x},\qquad v_y=-k\frac{\partial H}{\partial y}$$

Distribution of useful component concentration $C(x,y,0)=C_0$ - initial and $(\alpha\frac{\partial C}{\partial n}+(1-\alpha)C)\Big|_{\Theta}=\omega(x,y,t)$ - boundary and

$$C(x,y,t)\big|_{(x,y)=(x_i,y_i)}=C_i,\qquad \frac{\partial C}{\partial n}\bigg|_{(x,y)=(x_j,y_j)}=0$$

satisfying internal conditions is determined by UL:

$$m\frac{\partial C}{\partial t}=\frac{\partial}{\partial x}\left(D\frac{\partial C}{\partial x}\right)+\frac{\partial}{\partial y}\left(D\frac{\partial C}{\partial y}\right)-\frac{\partial(v_xC)}{\partial x}-\frac{\partial(v_yC)}{\partial y}-\frac{\partial N}{\partial t}\qquad(1)$$

Results. Figure-1 shows the isolines corresponding to the results. The analysis of the obtained results shows that the models proposed for decision-making in the control of technological processes of IL correspond to the physical properties of the process and can be used in the process of controlling them and in data processing.

There is a need to use numerical-approximate methods for solving the problem, since analytical solutions are formed only in special cases with certain restrictions. The reliability and stability of the results is verified by a computational experiment based on the trial function method.

For a task

$$D\frac{\partial^2 C}{\partial x^2}-U\frac{\partial C}{\partial x}-f(x,t)=m\frac{\partial C}{\partial t},\quad C\big|_{t=0}=1,\quad C\big|_{x=0}=1,\quad C\big|_{x=1}=1\qquad(2)$$

the results are obtained using a numerical-approximate method using finite-difference schemes.

To verify the reliability of the developed algorithms and software, the compliance of the calculation results with the specified mechanical and physical properties is given. Figure 2 shows the concentration distribution of the useful component at different time points for the case of single-injection x = 450 m and single-pump x = 400 m wells.

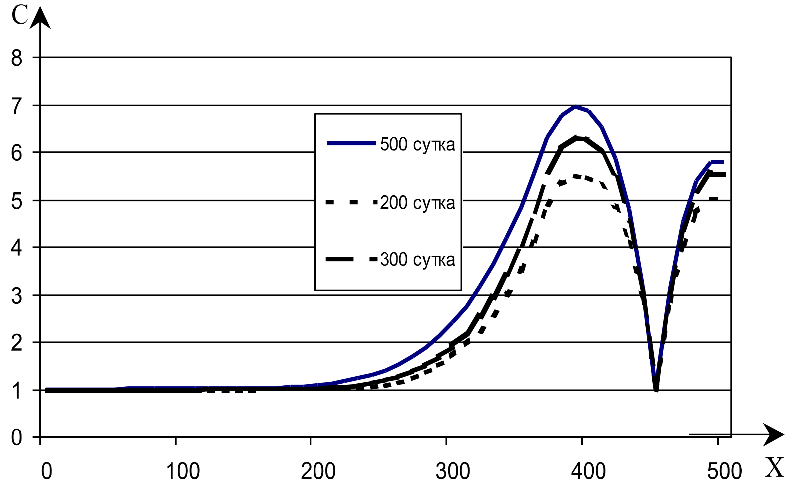

Figure 1. Linear concentration value

So, in order to make the necessary decisions in order to control the technological process of UL, the following tasks are solved:

• systematic study of the UL facility;

• creating a database for decision making and describing how it can be used.

Discussion. Here, several specific decision-making problems for the appropriate control of the UL process are considered and the influence of several parameters on the change in concentration is studied. Below are some of them.

In the case when there are four injection wells and one extraction well located at the point (5, 5), the results are obtained for different flow rates in the extraction well. The calculation results were analyzed for T = 91; 200 days.

The results of the analysis for 91 days are shown in Fig. 8, which shows a graph of the relationship between the flow rate in the extraction well and the concentration value at points (10.10) and (10.20).

From the results obtained, it can be concluded that the concentration value at points located further from the injection well increases faster than at points located close to the injection well. The reason for this is the increase in the flow rate in the extraction well.

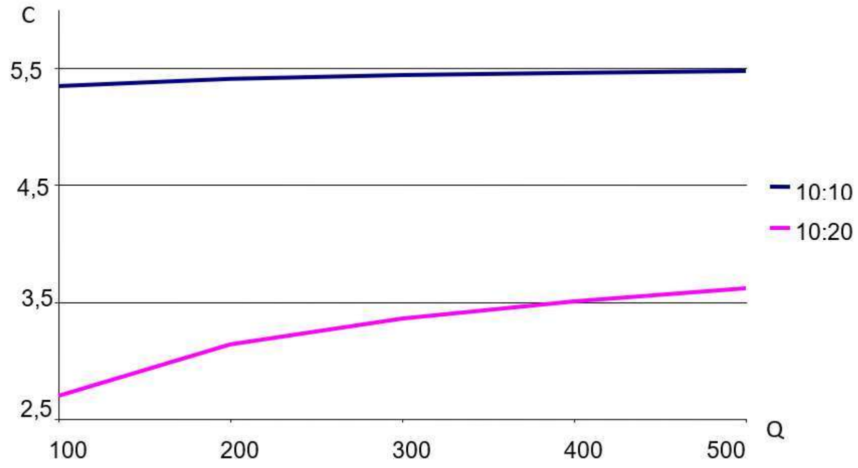

Figure 2. Computational values of concentration change for different production rates over time

It is required to control the UL process in such a way that after 360 days the average concentration of the useful component in the pumping wells reaches a maximum (i.e. Cav = 9.4 mg/m) by selecting criteria for the acid concentration in the injected reagent. To solve the problem from real factors, the limits of changing the acid concentration (γ) in the injected solution were determined. In our data, the dimensionless value of this parameter (γ) is determined within 0.05.10-7 < γ < 0.5.10-7.

Conclusion. Thus, the UL process is as human-made process as it is based on technology. In UL, if wells were not involved, the process would take place only on the basis of natural hydrodynamic laws. But, human influence can either accelerates the process or vice versa. New information is obtained by observing and analyzing the dynamics of changes in parameters and arguments affecting the technological process. The need to create a repository of knowledge that holds all these changes is realized by the appropriate management of the technological process of UL.

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ANALYSIS IN SOLIDWORKS SOFTWARE OF THE STRENGTHS GENERATED IN THE UNDERGROUND PART OF THE WAGONS AS A RESULT OF THE IMPACT OF FORCE ON THE ENTIRE WHEELS OF WAGONS

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Abstract:

Objective. The purpose In this article, the vertical and horizontal forces acting on the wheel of a freight car are calculated using formulas, and the calculated forces are determined by placing the wheel on a 3D model using Solidworks software.

Methods. The 3D model of the wheel is drawn using the Solidworks program according to GOST 10791-2011, and the forces calculated through the simulation section are placed on the rolling surface, and the results are tabulated.

Results. When the calculated forces were applied to the wheel through the simulation section of the SolidWorks program, the minimum stress on the bottom part of it was 10 MPa, and the maximum stress was 120 MPa. The stress results were calculated 60 times, that is, the forces were divided into 12 blocks and the wheel was turned five times. Efforts were made after each direction and results were obtained

Summary. The conclusion of the scientific article is that the tension generated in the wheel is related to the thickness of the tread. When the wall thickness was 70 mm, when the operational maximum force was applied to it, a stress of 80 MPa was generated. During the service life, the value of voltages in the calculation field changes in each direction

Keywords. Rolling surface, polzun, uneven rolling, wheel, solidworks, simulation, prosperity, computational area, mises stress.

Introduction. Pairs of wheels are considered the main part of the movement structure, and its durability and reliability are considered the most important issues when the wagon appears. Many scientists have worked on evaluating, analyzing and increasing the durability of the wheel [1,5,9]. The wheel is affected by vertical and horizontal forces (Fig. 1), and these forces are divided into static and dynamic types. When finding these forces, the loaded or unloaded state of the wagon is taken into account □2,3,7,14□. The following calculation diagram shows the cross section of the wheel and the direction of the forces falling on the rotating surface and its linear dimensions [4,8,11]. As we all know that there are many types of drivetrain wheel disc, in this work we will only do the calculations by putting the force values according to the calculation diagram below for flat disc all-round wheel. The

CONTENTS