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Research Article

RESEARCH RATIONAL PARAMETERS OF SOLUTIONS DURING UNDERGROUND LEACHING OF URANIUM

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ABSTRACT

The article discusses the development of methods for preventing mechanical clogging of layers during underground leaching of uranium and the form of clogging.

KEYWORDS

Underground leaching of uranium, low-grade ores, mining, deposits, crushing, seam deposits, uranium, ore extraction, transportation, grinding, storage of dumps, off-balance uranium ores, tailings facilities.

INTRODUCTION

World reserves of natural uranium are estimated at 6.14 million tons, of which 28% are in Australia, 15% in Kazakhstan and 9% in Canada. They are followed by Russia and Namibia, which account for 8% and 7%, respectively. Uzbekistan with reserves of 132 thousand tons (2% of world reserves) ranks 11th in the world.

From 1994 to the present, all uranium mining in the Republic of Uzbekistan is carried out only by the method of underground leaching through systems of geotechnological wells. The developed uranium ores are characterized by low quality and extremely difficult mining and hydrogeological conditions of occurrence,

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which completely exclude their development by traditional mining methods.

In underground leaching, the most important factor is the permeability of the productive horizon, which can be natural or created artificially by applying special methods (hydraulic fracturing , explosion destruction, etc.). In addition, during IW, it is important to have partial or complete natural watering of ores, the confinement of ore mineralization to pores and cracks, which ensure the permeability of the ore, etc.

THE MAIN FINDINGS AND RESULTS

The IW method is widely used in the world for the extraction of uranium and there are a number of depleted uranium deposits, the development of which the reviewed methods will improve the efficiency of the IW method and the development of uranium deposits with difficult mining and geological conditions for mined and newly mined areas gives a complete description of the structure, an integrated approach to solution of the issue, an innovative application of the technical and technological aspect of the chosen technology [1].

List of countries by production of fuel uranium according to the World Nuclear Association (WNA)

No.	Country	2015, tons	2016, tons	2017, tons	2018, tons	2019, tons	Share in the world, 2019, %
one	Kazakhstan	23607	24586	23321	21705	22808	42%
2	Canada	13325	14039	13116	7001	6938	13 %
3	Australia	5654	6315	5882	6517	6613	12 %
four	Namibia	2993	3654	4224	5525	5476	ten %
5	Uzbekistan	2385	2404	2404	2404	3500	6%
6	Niger	4116	3476	3449	2911	2983	5 %
7	Russia	3055	3004	2917	2904	2911	5 %
eight	China	1616	1616	1885	1885	1885	3%
9	Ukraine	1200	1005	550	1180	801	one %
ten	USA	1256	1125	940	582	67	0.01%
eleven	India	385	385	421	423	308	0.6%
13	South Africa	393	490	308	346	346	0.6%
fourteen	Iran	38	0	40	71	71	0.01%

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fifteen	Pakistan	45	45	45	45	45	< 0.01%
16	Czech	155	138	0	0	0	0%
17	Romania	77	fifty	0	0	0	0%
eighteen	Brazil	40	44	0	0	0	0%
19	France	2	0	0	0	0	0%
twenty	Germany	0	0	0	0	0	0%
21	Malawi	0	0	0	0	0	0%
	Total in the world, tons	**60304**	**62379**	**59462**	**53498**	**54752**	**100 %**
	U_3O_8 production	71113	73560	70120	63087	64566	
	% of global demand	98%	96%	93%	80%	81%	

To effectively conduct the process of underground leaching of metals, along with the optimization of the technological regime, it is necessary to identify and design rational indicators of the parameters of the hydrodynamic regime - filtration rate, flow rate and network of technological wells, which directly affect the kinetics of the transition of a useful component into a productive solution.

Interest in underground leaching of uranium in situ has been steadily growing in recent years. In-situ leaching makes it possible to bring into profitable operation poor ores lost during stope mining, as well as deposits with difficult geological and hydrogeological conditions.

Leaching at the place of occurrence of ores is carried out either with preliminary crushing of ore bodies, or from reservoir deposits composed of loose water-saturated deposits. Approximately 90-95% of the uranium mined by in-situ leaching comes from in-situ deposits.

The method of underground leaching, in comparison with traditional methods of mining and processing of uranium ores, makes it possible to exclude the operations of extracting ore, transporting it, crushing, grinding, storing dumps of off-balance uranium ores, and constructing tailings ; the term for putting deposits into operation is reduced, the volume of construction is reduced, the hardware design of the process is simplified and working conditions are improved.

The experience of operating industrial sites of underground leaching revealed certain advantages of this method; specific capital costs and construction time are reduced by 3-5 or more times compared to conventional mining methods;

- Labor productivity increases by 2-3 times;
- The cost of uranium by 15-25%, obtained by mining and chemical mining methods.

At present, there are more than 22 uranium deposits in the industrial mining industry in Uzbekistan, including such as Southern and Northern Bukanai , Uchkuduk , Ketmenchi , Sabyrsay , Sugraly , 102-section PV , etc.

In recent decades, in the theory and practice of IP, numerous mathematical models have been created for calculating geotechnological parameters [1,2,3].

In the work, it is necessary to select leaching solutions for mining uranium from low-permeability ores. Therefore, we studied various reagents for the development of deep, low-permeable uranium deposits by the IW method. One of the solutions to the scientific and technical problem is to develop new technologies that ensure the completeness of metal extraction from the bowels and control the hydrodynamic regimes of leaching solutions. Involvement in mining of a low-permeable ore horizon is expedient, while increasing the concentration of metal in solutions, reducing the mining time and specific consumption of the reagent, and increasing the production capacity of the enterprise.

During the operation of pumping and injection wells during the development of the field by the IW method, as a rule, their production rates decrease. The main reason for such a negative technological factor is the process of clogging of the pore volume of rocks in the near- filter zone of wells, as well as the "overgrowth" of the perforation of the filters themselves.

The main, if not the main condition for reducing the flow rates of geotechnological wells is the clogging of filters and near- filter zones of rocks of the productive horizon, which forms an increase in hydraulic resistance during the supply and pumping out of technological solutions.

In the process of mechanical clogging , the water intake openings of the filters and the pore sections of the solution -conducting channels are blocked by fine sandy-clay particles contained both in the drilling fluid during the construction of wells and during their operation as a result of the development of suffusion. So, when using high-clay muds with a density of 1.15 - / cm3 in the drilling process to strengthen 1,18 rthe walls of geotechnological wells constructed in hydrogenous deposits, represented by interbedded loose, mostly loosely bound sandy-clay varieties, leads to a decrease in their production rates by tens of times. In the process of claying the rocks of the productive formation of the near-filter zone, a clay cake up to 5 - thick is created on the wall of the wells 7 мм, the permeability of which is 4-5 orders of magnitude lower than the permeability of the rocks.

Swelling of clay particles of the drilling fluid filling the pore volume of the near-filter zone of the productive formation reduces the flow area of the effective pore channels, which also increases the hydraulic resistance of the driving liquid phase. With an increase in the contact time of the clay drilling fluid with the solid phase, the resulting clay cake is compacted under the action of adsorption processes and molecular forces of interaction, which leads to certain costs (construction pumping) for its removal. Based on the mechanism of the formation kinetics of such low-permeability clay screens, the contact time of the drilling fluid with the formation rocks should be minimal.

Along with mechanical clogging of the filter perforations and the pore volume of rocks in the near-filter zone of the productive formation, chemical clogging processes also occur , which is associated with a change in the chemical composition of the supplied and pumped solutions when they interact

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with groundwater and with a change in the hydrodynamic parameters of fluid filtration.

For example, a decrease in hydraulic pressure in the zone of pumping (discharge) wells leads to an imbalance in the solubility of gases and salts, which causes their separation from the liquid phase in the form of gel-like salt substances and in the form of gas dispersed undissolved bubbles.

Colmatation is a process of reducing the filtration properties of filters of technological wells and near - filter zones of an ore-bearing horizon due to the precipitation of substances dissolved in working solutions, or mechanical movement of particles of an ore-bearing horizon, as well as gas emissions .

The following forms of colmatation are known :

- Chemical, associated with the formation of chemical precipitates in the pores;
- Gas, due to the formation of carbon dioxide and hydrogen sulfide ¬in the ore-bearing horizon as a result of the interaction of acid with carbonate components of rocks;
- Ion-exchange, associated with a change in pore size in the presence of organic matter and clay minerals in permeable rocks under the influence of changes in pH and mineralization of filtered solutions;
- Mechanical, caused by blockage of the pore channels of rocks by mechanical suspensions and particles contained in filtered solutions.

Anisotropic in terms of filtration are rocks whose filtration coefficients in the direction of bedding (Kfx) and across (Kfz) are different. The ratio is commonly referred to as the filtration anisotropy coefficient.

Porosity - the ratio of the volume of voids in the rock to its entire volume (in% η). Distinguish:

- Total porosity (ηo) - the ratio of the volume of all pores to the volume of the rock;
- Active porosity (ηa) - the ratio of the volume of pores open for filtration to the total volume of the rock.

The intensification of leaching processes with the help of surfactants in solutions is the ability to lower the surface and interfacial tension due to the adsorption and orientation of molecules on the interfaces. This makes it possible to enhance the wettability of the ore during leaching and improve its chemical interaction with the reagent. The papers present studies on laboratory tests of some surfactants.

In this work, studies were carried out on the choice of surfactants in the development of uranium deposits with a low permeability of the ore-bearing horizon. According to the results of studies on the decomposition of a natural emulsion, the concentration of the solution must be selected as a surfactant for leaching uranium from low-permeability ores. OP-10, sulfanol , SJ-1, SJ-2, SJ-3, polyacrylamide are recommended when using leaching solutions.

To select chemical reagents for surfactants, studies were previously carried out on the dissolution of sedimentation in laboratory conditions. According to the results of the study, the effectiveness of chemical reagents in the complex was confirmed in terms of the dissolving power of the main carbonate and secondary sedimentation.

To intensify the process of underground leaching of uranium with the use of surfactant reagents, it will increase the speed of processing of technological blocks and reduce the cost of the final product.

Below is a description of the selected chemicals:

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1. A solution of polyacrylamide PAA (manufactured by Navoiazot JSC) (Fig. 1.). The following types of polyacrylamides are distinguished : non-ionic, anionic and cationic, which are used for water treatment, water treatment and are used in the mining industry. Polyacrylamides are used for the processing of gold, uranium, iron, aluminum, etc. The general formula is $(-CH_2CHCONH^{2-})n$.

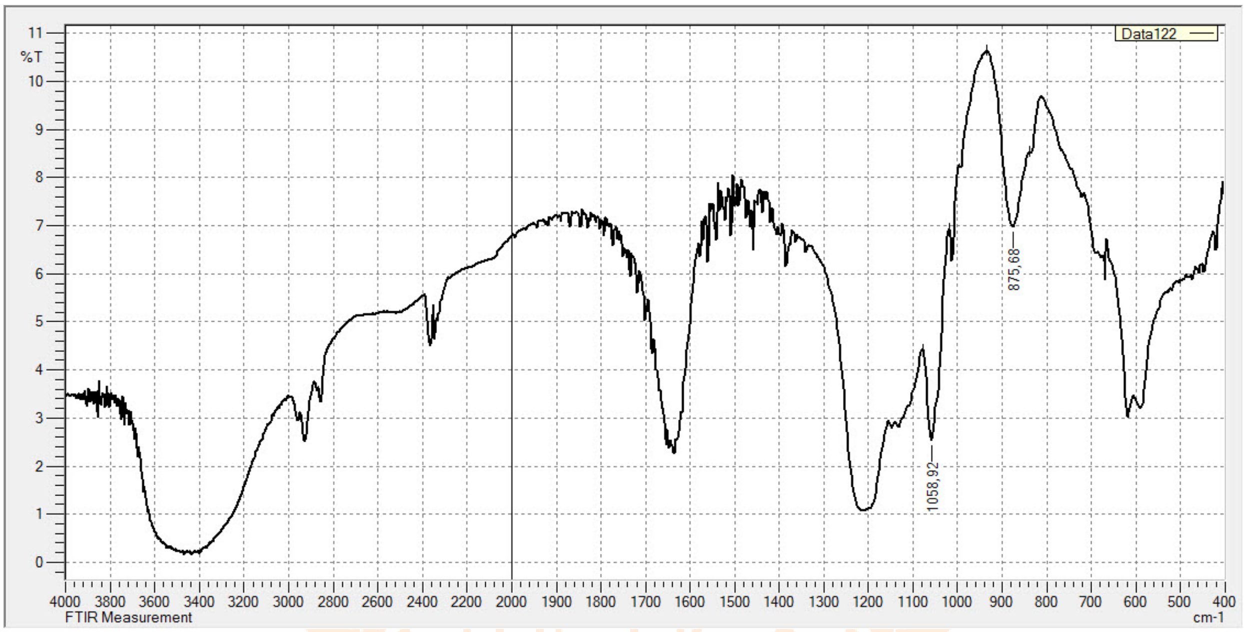

Figure 1. IR spectrum of the leaching solution using polyacrylamide

2. Solution OP-10. Auxiliary substances OP-7 and OP-10 are products of processing a mixture of mono- and dialkylphenols with ethylene oxide. They are used as wetting and emulsifying surfactants in oil-producing, oil-refining, chemical, textile and other industries; one of the advantages is that they are easily biologically treated in wastewater [4,5,6]. Chemical formula: $O(CH^{2-}CH^{2-}O)$ n $CH^{2-}CH^{2-}OH$. n=7-9 (for substance OP-7) and 10-12 (for substance OP-10). It dissolves well in water, completely decomposes, and is used to lower the viscosity of leaching solutions (Fig. 2) .

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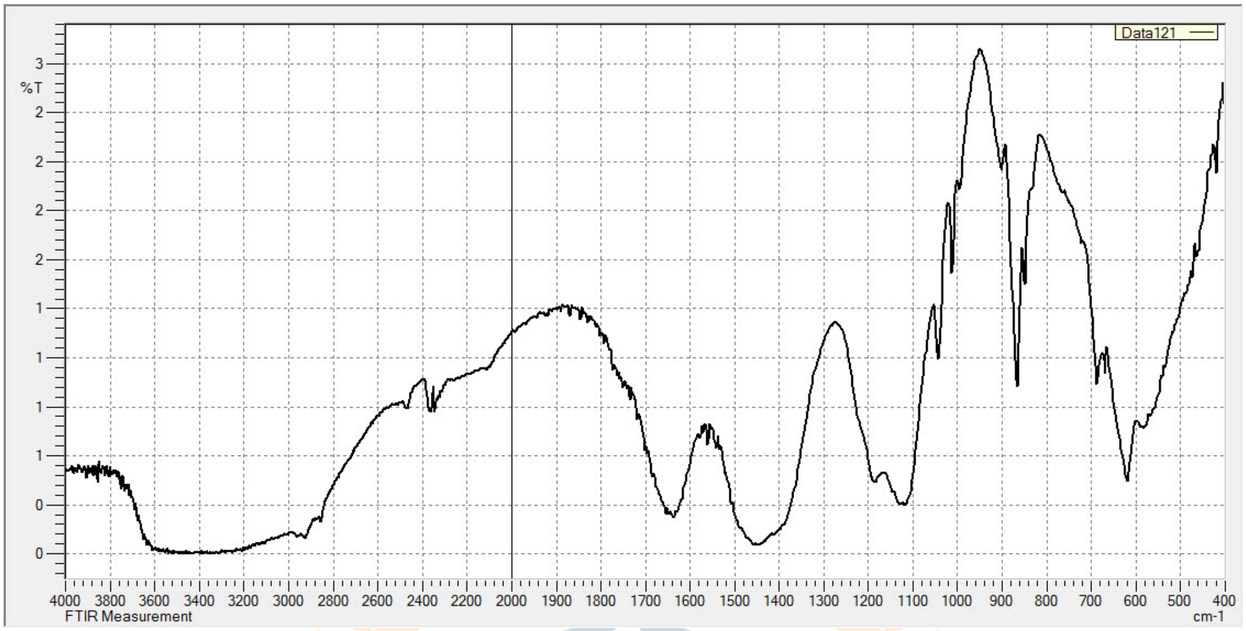
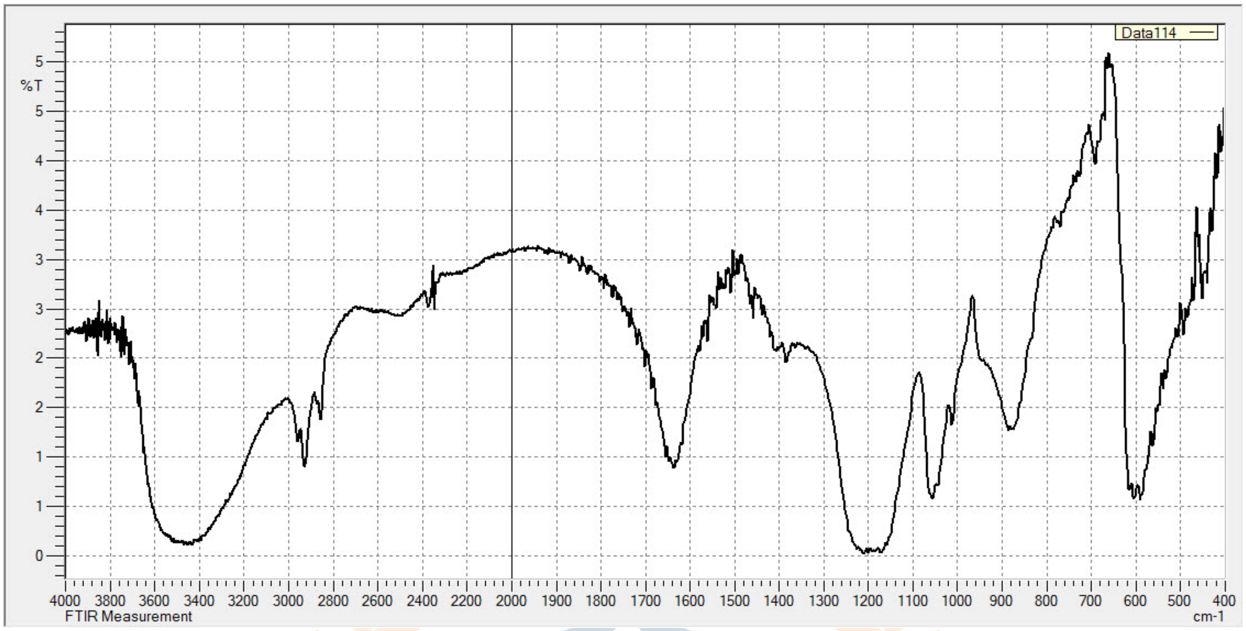


Figure 2. IR spectrum of the leaching solution using OP-10

3. Sulfanol solution free-flowing granular powder from yellow to light brown, odorless or with a slight smell of kerosene; sodium salt content alkylbenzene sulfonic acids - not less than 80%, sodium sulfate - not more than 15%. Aqueous solutions become cloudy in the presence of NaCl . It is highly soluble in water, solubility in water decreases significantly in the presence of 70% sulfuric acid. Reduces the surface tension of water, creates stable emulsions and foams. The product is non-toxic. At mining enterprises, uranium is successfully used in acid leaching of uranium. Allows you to improve the filtration characteristics, dissolve and loosen sediments in the well and increase the permeability of the bottomhole formation zone, which means it will increase the well flow rate. In Figure 3 . the IR spectra of the obtained leaching solutions using sulfanol are given [7, 8].



Picture 3. IR spectra in leaching solution using sulfanol

Sulfanols have a very characteristic absorption due to symmetric and antisymmetric vibrations of the SO_2 group . These bands are very intense and easily identified. In the spectra of solid compounds, they split, forming a group of strong bands with close frequencies. Typically, solids absorb 10 - 20 cm lower than substances in solution. The low-frequency band is shifted as a result of a change in the state of aggregation or the formation of a hydrogen bond somewhat less than the high-frequency band. In the spectra of sulfonic acids and their salts, the frequencies of symmetric and antisymmetric stretching vibrations of the SO_2 group are in the range of 1260 - 1150 cm for antisymmetric and 1080 - 1010 cm for symmetric vibrations. The difference in frequencies between salts and acids themselves is very small. In sulfochlorides and covalent sulfonates and sulfates, there is an increase in the frequency of stretching vibrations of SO_2 groups . Thus, methanesulfonylchloride has bands at 1370 and 1175 cm, and p - toluenesulfochloride has bands at 1366 and 1166 cm. Covalent sulfonates absorb in the ranges of 1420 - 1330 and 1200 - 1145 cm, and covalent sulfates - in the regions of 1440 - 1350 and 1230 -1150 cm -.

4. Solution SJ-1. To the main characteristics of the solution SJ-1 can be used as a reagent as an oxidizing agent in the field of metallurgy for the extraction of metals.

5. Solution + Sj-2 and Sj-3. Polycarboxylates are high molecular weight (Mr ≤ 100,000) linear polymers with many carboxylate groups. They are polymers of acrylic acid or copolymers of acrylic acid and maleic acid. The polymer is used as the sodium salt [9,10,11] .

However, physical and chemical phenomena, complex in their interdependence, formed in the reservoir when the reagent solution is supplied, have a direct impact on well productivity through the resulting processes of formation pore volume clogging and filter perforations. Whence it follows that in the calculation formulas used in assessing the parameters of the hydrodynamic regime, it is necessary to take into account the factor of change in well productivity, which depends on the values of the fluid filtration parameters.

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However, certain aspects related to increasing the efficiency of mining deposits by in-situ leaching have not yet been resolved.

To this way it is necessary to develop measures to prevent mechanical colmatation of formations, mainly due to the injectivity into productive horizons of suspended solids contained in injected solutions.

Even at the first stages of operation of sites for underground leaching of uranium from deposits composed of loose watered deposits, the phenomenon of a decrease in the injectivity of custom wells during their operation was established. In some areas, the decrease in injectivity was so significant that even in the conditions of its periodic restoration by pumping, drilling of additional custom wells was required to ensure normal operation. So, for example, in the PV-2 section, the average injectivity of injection wells decreased from 1.2 m^3/ h in 2019-2020. up to 0.26 m^3 / h. To date, more than 50 wells have been additionally drilled within the area of the production site to interfix the injection process.

At the same time, it was revealed that the main reason for the decrease in well flow rate is the clogging of the pore space with gases, sediments and suspensions.

In the process of mechanical clogging , the water intake openings of the filters and the pore sections of the solution -conducting channels are blocked by fine sandy-clay particles contained both in the drilling fluid during the construction of wells and during their operation as a result of the development of suffusion. So, when using high-clay muds with a density of 1.15 - 1.18 g/cm 3 in the drilling process to strengthen walls of geotechnological wells constructed in hydrogenous deposits, represented by interbedded loose, mostly loosely connected sandy-clay varieties, leads to a decrease in their flow rates by tens of times. In the process of claying the rocks of the productive formation near the filter zone, a clay cake up to 5–7 mm thick is created on the well wall, the permeability of which is 4–5 orders of magnitude lower than the permeability of the rocks [12].

Swelling of clay particles of the drilling fluid filling the pore volume of the near-filter zone of the productive formation reduces the flow area of the effective pore channels, which also increases the hydraulic resistance of the driving liquid phase. With an increase in the contact time of the clay drilling fluid with the solid phase, the resulting clay cake is compacted under the action of adsorption processes and molecular forces of interaction, which leads to certain costs (construction pumping) for its removal. Based on the mechanism of the formation kinetics of such low-permeability clay screens, the contact time of the drilling fluid with the formation rocks should be minimal.

Along with mechanical clogging of the filter perforations and the pore volume of rocks in the near-filter zone of the productive formation, chemical clogging processes also occur , which is associated with a change in the chemical composition of the supplied and pumped solutions when they interact with groundwater and with a change in the hydrodynamic parameters of fluid filtration.

For example, a decrease in hydraulic pressure in the zone of pumping (discharge) wells leads to an imbalance in the solubility of gases and salts, which causes their separation from the liquid phase in the form of gel-like salt substances and in the form of gas dispersed undissolved bubbles.

In the filtration front band of the supplied acidic solutions, the carbon dioxide balance is disturbed:

$$2HCO_3^- \rightarrow CO_3^{2-} + CO_2\uparrow + H_2O. \quad [2.1]$$

Calcium and magnesium cations that have passed into solution earlier as a result of carbon dioxide imbalance fall out, filling (colmatizing) the pore volume of the rocks of the productive formation in the form of gel-like (gelatinous) sparingly soluble sediments - $CaCO_3$, $MgCO_3$. In this case, at the same time, such salt substances "overgrow" the perforations of the filters of injection and discharge wells, which causes a decrease in their flow rates.

In the filters of unloading wells, when the water intake holes become clogged, the values of hydraulic resistance increase . While maintaining flow rates at a constant level, the hydraulic pressure in the wells and on their outer surface decreases, which also ensures an increase in the intensity of salt precipitation and, accordingly, an increase in the filtration resistance of the filters.

An increase in the carbonate content of the rocks of the productive horizon intensifies the process of colmatation . In the practice of SPV ores, processes of rock colmatation by iron-bearing sediments are also observed. Such a process occurs in the presence of ferrous iron in groundwater and rocks. The presence in the supplied solutions of dissolved oxygen (oxidant) iron from ferrous turns into oxide:

$Fe(HCO_3)_3 \rightarrow Fe(OH)_2 + 2CO_2$,

$4Fe(OH)_2 + O_2 + 2H_2O = 4Fe(OH)_3$,

The precipitated iron oxide precipitate, having the structure of a gelatinous substance, is deposited on the filter surface, fills the perforations of the filter column and the pore volume of rocks in the near- filter zone of the productive formation. The most active overgrowth of filters with iron-containing sediments occurs during the development of free-flow ore aquifers, especially if the dynamic level in the well decreases below the upper zone of the filter column, when perforations (water intake holes) are contacted with the atmosphere. The intensity of such precipitation increases in the process of uneven hydrodynamic operation of pumping wells. The use of an airlift or an injector as solution -lifting means also increases the intensity of oxygen supply to the pumped solutions.

The first studies of colmatation phenomena in relation to the conditions of underground leaching of uranium date back to 1965-1969 [3]

These studies have established (and confirmed by operating practice data) a significant development at the initial stage of mining (the stage of saturation of the leached stratum with an acid solution) of two forms of clogging : chemical and gas, which, however, at subsequent stages of mining do not have a decisive effect on the overall decrease in the filtration parameters of the productive horizon. In contrast to the varieties discussed above , clogging of filters and near- filter zones of injection wells with suspended substances contained in leaching solutions is carried out constantly from the beginning of mining to its completion, growing with time, and is irreversible. A decrease in the filtration properties of the leached stratum due to clogging of the pore channels with particles of suspended solids causes an increase in the dynamic level in the injection well and pressure gradients in the area immediately adjacent to it. This circumstance, in turn, contributes to the development of suffusion.

Laboratory studies were carried out on the basis of the approved program of the Navoi Mining and Metallurgical Combine , together with the scientific staff of the Navoi State Mining Institute.

The increase in the flow rate of pumping wells in the process of in-situ leaching depends on the permeability of rocks; to improve the efficiency of rock filtration, it is necessary to use surfactants. The surfactant helps to reduce the viscosity of leaching solutions, thus improving their throughput, as well as increase the extraction of uranium from the ore seam and the crack is cleared of the filtrate and increases the productivity of wells.

The use of surfactants is increasing every year. Their use gives not only a technological effect, but also cost savings, given its relative availability in the Navoi region, produced by Navoiazot JSC.
The use of surfactants was studied on a filtration column, as well as on cores at the KFOM unit.

To perform laboratory studies to determine the parameters and influence of surfactants on the

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filtration of rocks, a research methodology, which was carried out at the laboratory base of the Navoi State Mining Institute.

A study on the effect of surfactants on the filtration coefficient was carried out on a low-permeability core material (monolith). A site of the Ketmenchi uranium deposit with a low ore permeability was selected and exploration drilling of one well was carried out in order to study the lithological composition of the earth's crust.

Geological exploration wells were drilled to a depth of 100 m, 14 core samples were taken. The chemical and mineralogical compositions of core samples were determined. The geometric parameters of the core samples are 40 cm in length and 90 mm in diameter, taken from the ore horizon [6].

The core material coming from the ISL site was subjected to visual inspection with sampling for mineralogical analysis. Then it was crushed to a particle size of less than 2 mm and tested. The mixing of the material was carried out by the rolling method and was taken to study the granulometric and chemical composition of ores.

After the core samples were delivered to the Central Scientific Research Laboratory of the NMMC, the moisture content was determined using geotechnological research methods. The research results are shown in Table 2.1.
By combining core samples identical to the material and granulometric composition, characterizing the main lithological and filtration types of rocks and ores.

Table 1 - Results of determining the moisture content of core samples according to the methods of geotechnological research

No. of samples	Humidity, %	Bulk density, g / cm ^{3}
one	fourteen	1.18
2	fifteen	1.19
3	17	2.22
four	twenty	2.47
5	twenty	2.57

Laboratory studies were carried out in order to obtain geotechnological parameters of the leaching process for the design of a pilot industrial complex for the extraction of metals by this method. The research is based on the method of studying fluid filtration in a porous medium, known from the practice of laboratory hydrogeological work. To date, this technique, with some changes taking into account the characteristics of the chemical process, has found wide application in the leaching of metals from loose sandy deposits.

Laboratory geotechnological studies were carried out on core samples. Samples were taken at the maximum core recovery and represented a geological section of the productive aquifer of the field.

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Studies on uranium leaching were carried out in agitation and percolation modes. In the agitation mode (static for underground leaching conditions), the technological parameters of ore leaching with sulfuric acid solutions and with the use of surfactants were mainly determined. The experiments were carried out while stirring the pulps with mechanical mixers and the specified parameters - the temperature of the leached solutions, the density of the pulp, the concentration of sulfuric acid, the time of the experiment, etc.

Picture 4 . Experiences of the process of uranium leaching in statics.

In the percolation mode (dynamic conditions in relation to the process of underground leaching), the experiments were carried out on models that are modern close to the conditions of underground leaching (Fig. 4).

During the leaching process, the following parameters were controlled: the volume of the solution that passed through the model per unit time, pH and their redox potential, and the content of uranium and bicarbonate ions in solutions was determined.

The study of technological and hydrodynamic parameters of ores under static and dynamic leaching conditions was carried out on the material of a group sample, which was formed from 14 core samples.

RESULTS OF EXPERIMENTS AND THEIR DISCUSSION.

Interval sampling of core samples from wells. From April 2021 to September 2021 in the Central Scientific Research Laboratory of NMMC, a group of core samples was analyzed.

According to the core material of well No. 3, a comprehensive sampling was carried out at intervals, the results of which are given in Table 2.2.

As can be seen from the table data, in the studied interval of 147.5-157.4 m, the uranium content in the ore layer ranged from 480 to 650 g/t (Fig. 2.3.), the content of carbonate minerals varied from 0 to 2, 2%. The acid capacity of rocks averaged over the interval was 37 kg of sulfuric acid per 1 ton of ore, and for individual samples it ranged from 20 to 66 kg per 1 ton of ore.

The acid capacity of rocks, as a rule, depends on the content of carbonate minerals in them. However, for the studied ores, this regularity is not always observed. With excess acidity of 35-45 g/l of sulfuric acid, the dissolution of uranium minerals was easy and practically applicable. But in the range of 156.5-157.4 m, the extraction of uranium from samples 4 incompletely extracted was about 36-64%. Whether this is natural for the whole or this is a single case will be established

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during a comprehensive technological testing of core samples from other wells.

According to table 2.2. The content of iron in solutions after leaching fluctuated over the sampling interval over a wide range, and the results of uranium leaching are shown in Fig. 2.4.

For most samples, the content of ferric iron is lower than that of ferrous. In the content of ferric ions in solutions after leaching, a sharper, average value of the redox capacity of the ORP of rocks was 38 mV over the studied interval. The largest deviations from the average value are (+7mV) (-13mV). The chemical composition of the solutions is given in table.2. 3 . and in Figure 2.5.

The results of the determination of rare earth elements in the composition of solutions according to the spectral profile are shown in Figs. 6.-2.17.

Table 2. - Testing of core material

No.	Interval, m	Content , uranium g/t	Content % CO_2	Fe^{+3} concentration , g/l	Uranium concentration, mg/l	Eh, mV
one	147-151	650	2.20	0.025	630	460
2	147-151	590	0.88	0.025	500	470
3	147-151	580	1.20	0.077	480	480
four	147-151	570	0.66	0.032	440	490
5	153 -156	550	0.33	0.116	420	440
6	153 -156	500	0.22	0.030	410	470
7	153 -156	450	0.44	0.027	400	450
eight	153 -156	400	0.54	0.045	380	400
9	153 -156	350	0.56	0.90	220	470
ten	154-156	360	0.44	0.19	225	400
eleven	156-158	380	0.45	0.348	220	510
12	156-158	360	0.44	0.132	230	470
13	156-158	450	0.44	0.066	400	460
fourteen	156-158	460	0.32	0.084	400	450
fifteen	156-158	420	0.33	0.052	410	400
16	156-158	430	0.35	0.058	400	420
17	156-158	440	0.35	0.056	400	430
eighteen	156-158	450	0.36	0.046	400	460
19	156-158	460	0.25	0.045	410	450
twenty	156-158	470	0.23	0.046	410	420
21	156-158	480	0.25	0.048	410	420

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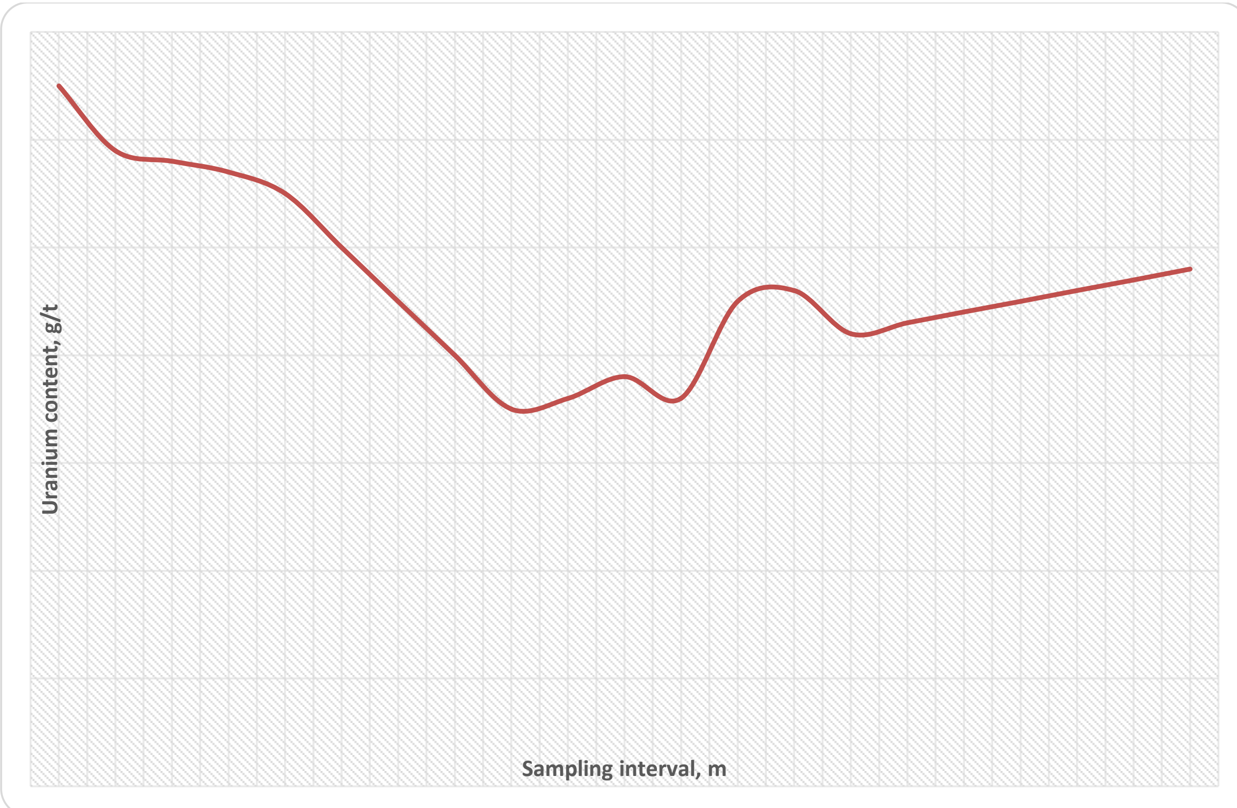
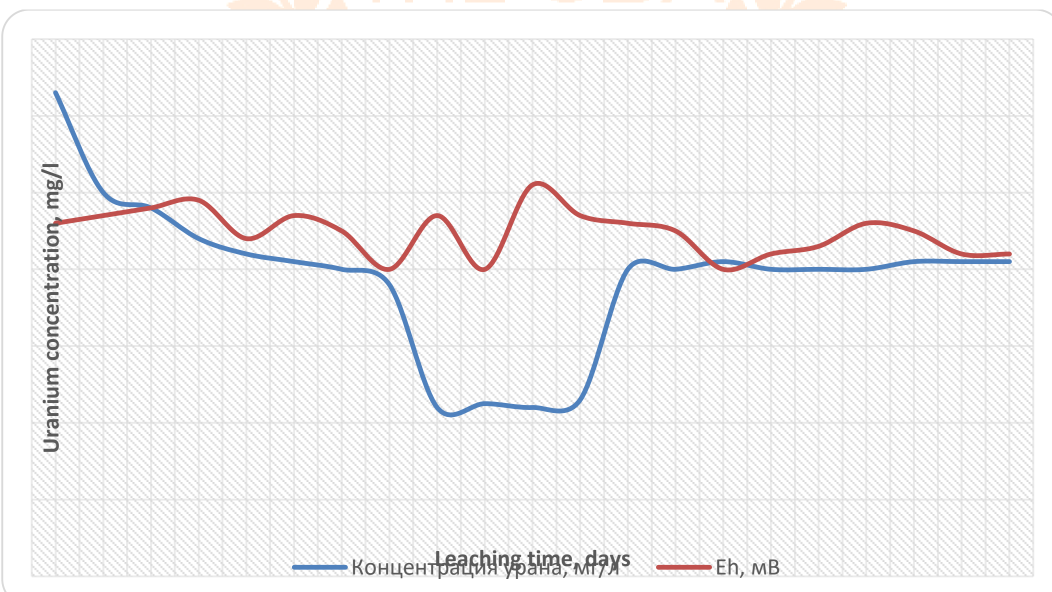


Picture 6. Results of core material sampling by horizon intervals



Picture 7. Results of uranium leaching under laboratory conditions

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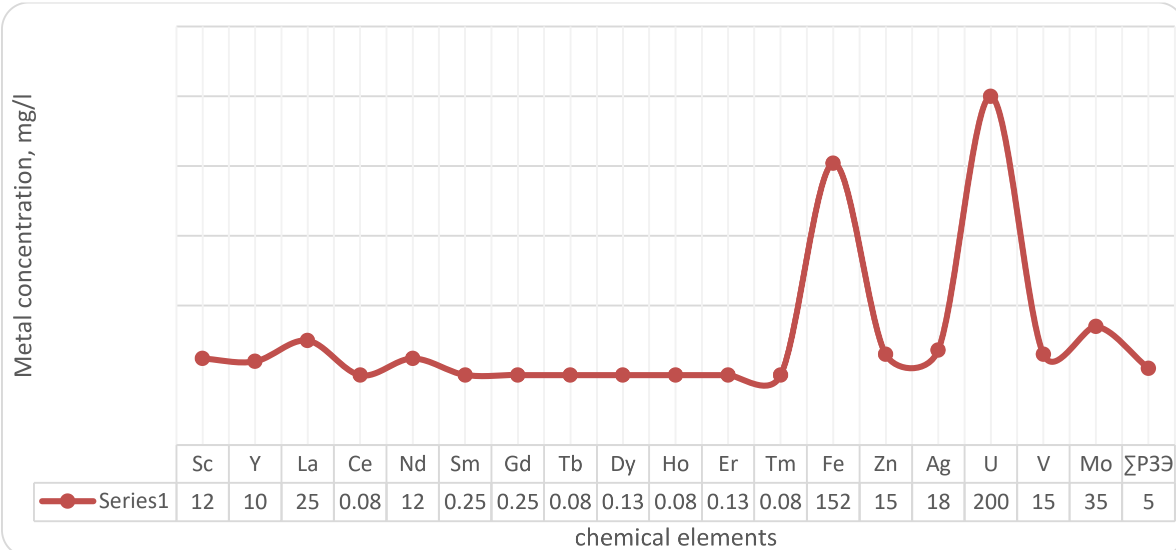

Picture eight. The results of determining the chemical composition of the productive solution

Table 3. Results of determining the chemical composition of productive leaching solutions

No.	Concentration, mg/l											
	S with	Y	La	Ce	Nd	sm	Gd	Tb	Dy	Ho	Er	Tm
one	< 0.13	< 0.08	< 0.08	< 0.08	< 0.25	< 0.25	0.2	< 0.08	< 0.13	< 0.08	< 0.13	< 0.08
2	< 0.13	< 0.08	< 0.08	< 0.08	< 0.25	< 0.25	0.25	< 0.08	< 0.13	< 0.08	< 0.13	< 0.08

Sample code	Concentration, mg/l										
	K	Na	Fe	Ni	co	Cu	Zn	Pb	Cr	Mn	Ag
1-50-30 Before I	23	610	152	0.21	<0.2	<0.2	0.14	< 0.1	< 0.2	1.59	< 0.1
1-50-30 Before II	27	495	149	0.2	<0.2	<0.2	0.23	< 0.1	< 0.2	1.92	< 0.1
Sample code	**Concentration, mg/l**										
	U	V	P	Al	Ca	mg	As	Mo	∑ REE	Re	W
1-50-30 Before I	15 5.0	<5.0	< 1.0	<10.0	488	163	< 20.0	< 10.0	< 5.5	< 0.2	< 6.0
1-50-30 Before II	1 6 5.0	<5.0	< 1.0	<10.0	526	172	< 20.0	< 10.0	< 5.5	< 0.2	< 6.0

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Studies of geotechnological factors influencing the processes of filter clogging and in the filter zone of technological wells were carried out in the experimental block of the Tokhumbet field in 2008.

To conduct research to identify the dependence of the decrease in the water permeability of the rocks of the productive horizon on the filtration parameters and the chemical composition of leaching solutions at the Tokhumbet field , a block was selected, the natural (geological) indicators of which corresponded to the average for the field.

REFERENCES

1. Batashov B.G., Mikhlin S.G., Veselova Jl.H. " Semi-industrial testing of the in-situ leaching process at the Devladovskoye deposit " . Report of the enterprise , mailbox R-6449, Inv. 7962ss, 1963 .
2. Shchepetkov A.P., Belichenko A.M., Esaulov V.N. " Summary report on experimental work on underground leaching of ores at the deposit Uchkuduk " . Enterprise report, PO box A-l372, Inv. 8580p, 1964.
3. Shchepetkov A.P., Sedykh V.N., Shcheglov Yu.N., Morozov E.P. "Development of deposit 28 of the Uch to uduk deposit by in-situ leaching". Report of the enterprise , mailbox A-1372, DNSHG, inventory 344s , 1968.
4. Sadykov R.Kh., Kotlinskaya O.P. "o some patterns of changes in the filtration properties of rocks as a result of chemical clogging ". Spec. questions of atomic science and technology, enterprise PO Box A-1997, inv. 18148s, 1975.
5. Smirnova R.N., Sadykov R.Kh. "Features of the chemical interaction of acid with uranium-bearing carbonate rocks in the process of in-situ leaching in deposits composed of loose deposits." Spec. questions of atomic science and technology, series: "Ore enrichment and uranium metallurgy", issue 1 (18), enterprise p / o A-1997, inv. 18932s, 1975.
6. Goldberg V.M. "Influence of water mineralization on the filtration properties of rocks". Bulletin of Scientific and Technical Information of the Geological Committee under the Council of Ministers of the USSR, L 2, 1965.
7. Kuprina G.A. " Colmatization of the sands". Moscow State University, 1968.
8. Eronin V.A., Litvinov A.A., Krivonosov I.V. etc. "Operation of the waterflooding system ". M., Nedra, 1967.
9. Vodolazov L.I., Drobadenko V.P., Lobanov D.P., Malukhin N.G. Geotechnology . _ Heap leaching of poor minerals. M.: ed. Moscow Geological Prospecting Academy, 1999, 300 p.
10. Arens V.Zh. etc. Physical and chemical geotechnology . M.: MGGU, 2010.
11. Tolstov E.A. Physical and chemical geotechnologies for the development of uranium and gold deposits in the Kyzylkum region.- M.: MGGU, 1999.
12. Duisebaev B.O., Malimbaev M.S., Saykieva S.Kh. et al. Investigation of the behavior of silicon in the preparation of uranium-containing raw materials. Report at the 3rd International Conference "Actual Problems of the Uranium Industry". - Almaty , Republic of Kazakhstan, 2004.