ANNOTATION

Dissertation for the degree of
Doctor of Philosophy (PhD)

Omarbekov Yernur Urazgalievich

"Development of uranium in-situ leaching in conditions of high-pressure pattern of groundwater"

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Relevance. In recently times, with the practice of intensive mining of deposit sites in conducive mining and geological conditions, areas with difficult conditions are being brought into exploitation. One of such factors is the high-pressure nature of groundwater. During the development of uranium reserves, at the stage of active leaching, the hydrodynamic equilibrium (balance) of injected and pumped solutions must be strictly observed, both by individual production cells and by blocks and sections. In this case, as a rule, optimum hydrodynamic mode of solutions filtration in block contour is provided. At development of deposits in conditions of high-pressure groundwater nature, provision of optimal hydrodynamic mode of solutions filtration in the block contour is very difficult. With an imbalance towards pumping (negative balance, pumping exceeds pumping) productive solutions are diluted due to formation water pulling up from behind the block contour. Imbalanced pumping (positive balance, pumping exceeds pumping) could lead to escape of technological solutions beyond ore deposits. In this case, uranium losses due to spreading and redeposition occur, and the consumption of leaching reagents increases. It should also be noted that when there is an imbalance of solutions in the production units, process solutions can overflow between adjacent units. This makes block-by-block accounting of uranium production (calculation of inventory movements) significantly more difficult and often impossible. Hydrodynamic equilibrium (balance) across individual production cells, blocks and sections leads to collimation and a reduction in well flow rate and injectivity. The use of the conventional in-situ leaching method results in significant material costs. Therefore, the development of uranium in-situ leaching technology in conditions of high-pressure nature of groundwater is of paramount importance.

The aim of the thesis is to develop a technology for uranium in-situ leaching under high-pressure groundwater conditions.

The objectives of the scientific work:

- Analysis of the mining and geological conditions of the Budenovskoye deposit and in-situ borehole leaching technologies;
- To investigate the impact of supplementary pumping well technology on the main indicators of in-situ uranium leaching;
- Develop technology for accelerated in-situ borehole uranium leaching under high-pressure groundwater conditions;

Methodological basis for research

The main research methods used in the thesis work include:

- collection and analyzes of statistical data as well as scientific and technical literature;
- pilot studies on the effectiveness of additional pumping wells on the efficiency of in-situ uranium in-situ leaching;
- processing the results of the study and issuing a recommendation.

Sample analyses from the pilot works were carried out in the Karatau mine's laboratory.

Propositions for the defense:

- With the usage of additional pumping wells in high-pressure groundwater conditions, the uranium recovery factor increases in a power-dependent manner and the uranium content in the productive solution changes similarly to the conventional technology.
- Acceleration of uranium in-situ leaching processes in high-pressure groundwater conditions is achieved by means of creating pumping wells in the form of injection wells and by selectively feeding reagents to individual specific wells. Under this condition the uranium content and recovery factor are increased, but the nature of their variability is maintained;
- The use of additional pumping wells and an improved solution intake and distribution unit reduce labour and material costs significantly.

Scientific novelty of the work:

- The dependences of uranium content in productive solution and extraction coefficient on L:S ratio when using additional pumping wells in conditions of high-pressure groundwater were established;
- When additional pumping wells are used, the acidification process is maintained and the uranium content is increased during leaching;
- The economic viability of using additional pumping wells and upgrading the solution intake and distribution unit is shown.

Practical significance of the thesis. The proposed technology using additional pumping wells and solution intake along with the distribution scheme under high pressure groundwater conditions make it possible to reduce the cost of uranium in-situ leaching, as confirmed in practice.

Implementation and introduction of work results. The proposed technology of additional pumping wells is applied at the mine "Karatau" Budenovskoye deposit site № 2 in the Sozak district, Turkestan region.

Author's personal contribution.

The major research results presented in this thesis were achieved by the author. The results published jointly with other authors belong to the authors in equal shares. The results of other authors, which were used as the secondary sources are acknowledged with references to the relevant sources.

Approbation of research results. Main results of the work have been approbated at three International scientific and technical conferences and forums, including "Rational use of mineral and technogenic raw materials in conditions of Industry 4.0" 14-15 of March, 2019, Almaty; "Proceedings of IV International Scientific and Practical Conference " Applied scientific and technical research " In

Two Volumes 2, April 1-3, 2020, Ivano-Frankivsk; "Ivano-Frankivsk. Almaty; "Proceedings of the IV International Scientific and Practical Conference " Applied scientific and technical research " In Two Volumes Volume 2, April 1-3, 2020, IvanoFrankivsk; "International Scientific Conference "Actual problems of modern science - 2021", Nur-Sultan, 12-13 April 2021; 14 International Scientific School of young scientists and specialists of IPCON RAS 2019, Moscow.

Publications. Mining of Mineral Deposits Volume 14 (2020), Issue 3, 112-118; Vestnik KazNITU, Almaty August 2020, №4 (140); Complex Use of Mineral Resources, №1 (316), Almaty 2021; Complex Use of Mineral Resources. No.2 (317), Almaty 2021.

Structure and scope of work. This thesis consists of introduction, 3 chapters, conclusion, bibliography of 92 references, including 63 pages of typewritten text, 20 figures, 12 tables, and 22 formulas.