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CONCENTRATION OF URANIUM FROM SOLUTIONS USING NANOMEMBRANES

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INTRODUCTION

Ensuring the effectiveness of the processes of natural uranium mining and processing is associated with the introduction of innovative methods and technologies that provide cost optimization and efficient use of resources, in particular, lower specific consumption rates of chemical reagents.

Underground uranium leaching involves dissolving of the metal under the action of sulfuric acid at the site of the ore and subsequent extraction through the wells. Ground processing of the obtained productive solutions is carried out with the use of sorption technology. At the first stage uranium has sorbed on anion-exchange sorbents then desorption process has carried out with sulfuric solutions of ammonium nitrate. Obtained eluate has precipitated by hydrogen peroxide or sodium hydroxide solutions. For the selective uranium precipitation preliminary neutralization of excess acidity contained in eluate is required. This leads to a permanent loss of sulfuric acid and an increased consumption of sodium hydroxide.

The actual task is to separate and return to the process the sulfuric acid contained in the eluate before the uranium precipitation. This problem can be solved by membrane separation and concentration processes.

Relative simplicity of instrumentation, lack of the use of additional reagents, small volumes of liquid waste generated are the advantages of membrane processes. In addition, membrane processes have a number of undeniable advantages over other separation processes (rectification,extraction, adsorption, etc.):
- continuity;
- low energy costs;
- convenience of combination with other technological processes;
- soft technological conditions;
- scalability.

There are many membrane separation processes based on different principles or mechanisms applicable to the separation of objects with different sizes, from heterophase particles to molecules. The basis for separation during nanofiltration is the negative charge of the membrane surface. This makes it possible to retain multivalent anions as well as associated cations, to preserve electroneutrality. Positively charged ions, such as hydrogen, aluminum, sodium must pass through the membrane. Neutral molecules, as well as some cations having a large size, for example, uranium, will be retained by the membrane.

In this connection prerequisites are created for the preliminary processing of eluate using membrane processes for the purpose of sulfuric acid separating and uranium concentrating.

METHODS AND RESULTS

A baromembrane nanofiltration method was chosen to optimize the composition of eluate (acidity reduce and increase uranium content). In this method the transfer of matter through the membrane occurs under the action of a pressure difference.

A pilot installation which work is based on the action of the principle of tangential filtration was constructed. The main working element of the installation are membrane modules consisting of enclosures capable of withstanding pressures up to 70 bar, and directly of the membranes connected to each other. As a result of

the solution passing through the installation, two constant fluxes are formed: a filtrate, also called permeate and a retentate, or a concentrate.
To perform the tests, semipermeable (selective) membranes manufactured by DOW Company were chosen. In these membranes during the solutions flow motion under pressure, a positive transmembrane pressure is created across the surface of the membrane, which causes the passage of hydrogen protons and other components smaller than the pore size of the membrane through the membrane.

To prevent nanomembranes clogging with mechanical suspensions located in eluate, a preliminary filtration of eluates through a fine filter with a pore size of 5 microns was envisaged in the technological scheme.

Studies on the nanofiltration of eluate were carried out at an average pressure of
22 bar. The eluate with a uranium content of 37,21 g/dm3 and sulfuric acid of 23,73 g/dm3 was used as the basic solution. The basic solution was pumped by a low pressure pump to a fine filter, then a high pressure pump to the membrane module. Permeate and concentrate obtained with separation on the membrane module were taken from the installation to special tanks of the final product. The pressure at the outlet from the membrane module was 6 bar. The total capacity of the installation for permeate and concentrate was 250 l/h. At the same time the yield of permeate was 180 l/h, the concentrate yield was 70 l/h. The installation had worked for 720 hours in this mode.

The average uranium content in the permeate obtained during the entire operation of installation was 2,32 g / dm3. The acid content in the permeate was on average 21,66 g / dm3.

The average content of uranium in the obtained concentrate was 126,93 g / dm3, the acid content was 29,11 g / dm3.

The experiment has showed that the maximum operating time of nanomembranes at the separation of eluate of the test compound is 64 hours. After this time it is necessary to rinse the membranes with process water for 10 minutes. After washing the membranes restore their throughput.

The obtained concentrate was sent to peroxide precipitation. For comparison, uranium precipitation was also carried out from the initial eluate.

Precipitation was carried out under the following conditions:
- draining time of reagents is 30 minutes;
- volume of eluate - 0,5 dm3;
- excess of reagent-precipitator - from 0 to 100%;
- precipitation time - 60 min;
- neutralizing reagent - NaOH solution

It was found that the permissible content of uranium in the mother solution (no more than
30 g/dm3) could be achieved with a 20% excess of H_2O_2. The efficiency of peroxide precipitation is higher the lower the salt composition of the processed eluate. The amount of uranium recovery (with other equal things) is significantly affected by the initial concentration of uranium in the desorbate. With an increase in the content of the target metal, the recovery rate increases.

When uranium is precipitated from the concentrate obtained by nanofiltration, the specific rate of NaOH consumption for neutralization of excess acidity decreases in
2 times. This corresponds to a total saving of 0,35 kg of sodium hydroxide per 1 kg of uranium.

CONCLUSION

The conducted experiments of the eluate nanofiltration has showed the principal possibility of uranium and sulfuric acid separation. Nanofiltration of the eluate makes it possible to achieve an increase the uranium concentration of 4 times with a simultaneous decrease in the relative acid content by 63%. The extraction of uranium into the concentrate is 93,76%. Concentration of uranium with a simultaneous decrease in the excess acid content leads to an increase in the efficiency of peroxide precipitation and a decrease the specific consumption of sodium hydroxide.

Country or International Organization

Kazakhstan

Primary author: Ms KOPBAYEVA, Mariya (Institute of High Technologies)

Co-authors: Mr DIRAKKA, Anselm (JV Inkai LLp); Ms DZHEMISOVA, Mariam (JV Inkai LLP); Mr LESKIN, Mikhail (Institute of High Technologies); Mr BEKBAYEV, Zhandos (JV Inkai LLP)

Presenter: Ms KOPBAYEVA, Mariya (Institute of High Technologies)

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