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АКЦИОНЕРНОЕ ОБЩЕСТВО «НАЦИОНАЛЬНАЯ АТОМНАЯ КОМПАНИЯ «КАЗАТОМПРОМ»
АО «ВОЛКОВГЕОЛОГИЯ»

СБОРНИК ТРУДОВ

IX МЕЖДУНАРОДНОЙ НАУЧНО-ПРАКТИЧЕСКОЙ КОНФЕРЕНЦИИ

АКТУАЛЬНЫЕ ПРОБЛЕМЫ УРАНОВОЙ ПРОМЫШЛЕННОСТИ

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Часть 2

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DEVELOPMENT OF NEW METHODS FOR CONCENTRATION OF RARE-EARTH METALS FROM KAZAKHSTAN PHOSPHOGYPSUM LEACHING SOLUTIONS

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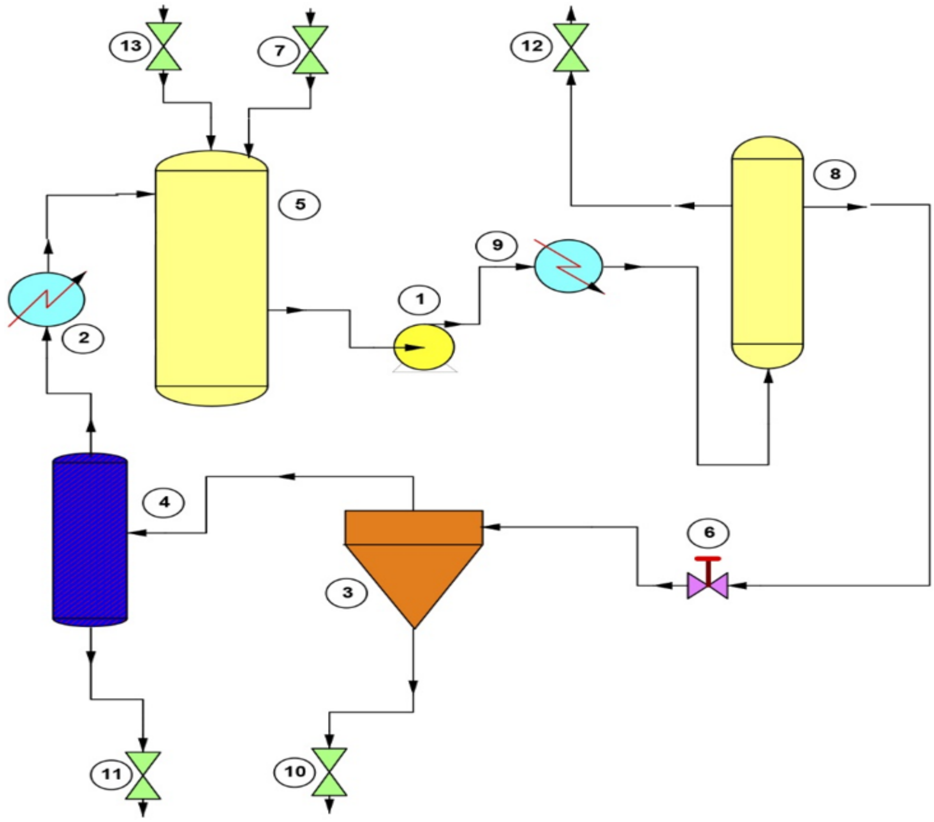
Today, one of the important sources of raw materials for the separation of rare-earth metals (REM) is industrial waste, one of which is phosphogypsum (PG). Phosphogypsum is a by-product of the processing of phosphorites in the production of mineral fertilizers. According to the source [1], in the Zhambyl region (Republic of Kazakhstan) there are about 30 million tons of PG, with its annual growth of 1.3 million tons, and total content of REMs of about 0.1-0,3 w. %. There are technologies for the utilization of PG with the production of gypsum, REM concentrate, as well as other by-products. According to the source [2], 75% of profits came from rare earth metals and only 25% from gypsum building plaster. However, there is a difficulty in processing PG due to the instability of the chemical composition, as well as its multicomponent nature. The aim of the study is to develop highly efficient, energy-saving supercritical technologies for processing raw materials and industrial wastes for the extraction of REMs. Currently, supercritical carbon dioxide (sc-CO_2) containing various complexing agents is widely used in this method. During decompression, sc-CO_2 goes into a gaseous state, which makes it easy to separate extracted substances [3]. This work shows the possibility of applying supercritical technologies in the extraction of rare-earth metals from model solutions and PG leaching solutions.

The Kazakhstan phosphogypsum of the enterprise “Mineral Fertilizers Plant” of Kazphosphate LLC was used as a feedstock. According to X-ray phase analysis, the main phase in the PG is bassanite - 73.3 w. %. The most prevalent of all rare-earth metals are yttrium, cerium, lanthanum and neodymium (table 1). The optimal conditions for their leaching from PG are determined. PG decomposition was studied under open conditions and in an autoclave mode with microwave preparation. The quantitative content of the elements was determined by the ICP-MS. HCl, HNO_3, H_2SO_4, H_2O_2 and mixtures thereof were used as decomposing agents. Variable parameters were: the composition of the decomposing mixture, acid concentration, process time, S: L ratio, microwave frequency, temperature and pressure in an autoclave mode. It was found that the use of hydrogen peroxide as an additive promotes a more complete translation of rare-earth cations into solution.

Table 1 - the Results of quantitative chemical analysis of phosphogypsum

Element	Y	La	Ce	Nd	F	P	Fe
C, w. %	0.0063	0.0043	0.0052	0.0040	7.3010	0.7750	0.9752

To carry out supercritical fluid extraction (SCFE) at the facility (Fig. 1), standard nitric acid solutions and leaching solutions with a maximum total content of Y, La, Ce, Nd of 280 ppm were used. Solutions of di-2-ethylhexyl phosphoric acid (DEHPA) and tri-n-butylphosphate (TBP) were used as extractants. The data obtained were compared with REM liquid-liquid extraction (LLE). The total LLE efficiency with TBP was 6.8%, and total SCFE efficiency 6.26% with a ratio of O:W = 1: 9, C_{HNO_3} = 11 mol/L. The total efficiency of REM with DEHPA was 5.46%, 45.7% for LLE and SCFE respectively. At this stage, optimization of the LLE and SCFE processes of rare-earth metals from standard solutions and PG leaching solutions is carried out.



1. High pressure CO_2 pump; 2. Cooler; 3. Separator; 4. Adsorber; 5. Receiver;
6. Backpressure unit; 7. Relief valve; 8. Reactor; 9. Heater;
10, 11, 13. Cranes; 12. Valve for the discharge of residual pressure from the reactor 8.

Figure 1 – Scheme of pilot plan for supercritical fluid CO_2 extraction

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