

TECHNOLOGY FOR SEPARATION OF MOLYBDENUM FROM TECHNOLOGICAL SOLUTIONS IN URANIUM DEPOSITS

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Abstract. This article studies methods for separating molybdenum elements from technological solutions formed during the processing of uranium deposits. It analyzes the leading technologies used in molybdenum separation—ion exchange, aqueous-organic extraction, and precipitation methods. The advantages and disadvantages of each method are given with examples. Based on the study's results, effective solutions adapted to existing technological conditions are proposed.

Keywords: uranium deposits, molybdenum separation, technological solution, molybdate ion (MoO_4^{2-}), ion exchange, organic extraction, precipitation method, in-situ leaching (ISL), sulfuric acid (H_2SO_4), resin, molybdenum trioxide (MoO_3), ferromolybdenum, industrial processing, environmental safety, regeneration process, man-made solutions, diluted minerals, metal separation technology from solution, component selectivity, industrial technologies.

Introduction. In the hydrometallurgical processing of uranium, in addition to the primary target element, the composition of technological solutions also contains valuable companion elements, including molybdenum (Mo). Molybdenum is essential in the high-temperature-resistant catalysts, special steels, and electronics industries. Therefore, the extraction of molybdenum from uranium deposits increases economic efficiency and serves to use resources rationally.

1. Composition of technological solutions

The composition of technological solutions extracted from uranium deposits with sulfuric acid (H_2SO_4) mainly includes uranium (UO_2^{2+}), molybdenum (MoO_4^{2-}), as well as metal ions such as iron, vanadium, manganese, zinc, and diluted red-brown or black minerals from the earth's surface. Molybdenum is present here mainly in the form of molybdate ions (MoO_4^{2-}) in a highly water-soluble form, which makes it very convenient to separate it from the process solution.

2. Methods for separating molybdenum. Ion exchange method

The ion exchange method is based on the selective separation of molybdenum from the process solution using special ion exchange resins. In this process, the solution is passed through a unique column, where the resin retains molybdate ions (MoO_4^{2-})

while other metal ions remain in the waste. Subsequently, the retained molybdenum is separated from the resin during the regeneration stage (for example, using alkaline or saline eluents). The main advantages of this method are its high selectivity, recyclability, and the possibility of easy automation of the process. However, its disadvantages include resins losing effectiveness over time and the requirement for significant financial investments in new equipment.

The organic extraction method is based on transferring molybdenum from the process solution to the organic phase using special organic reagents (e.g., amine extractants). The solution is mixed with an organic substance, and the molybdenum passes into the organic phase. Subsequently, in a step called "back extraction", the molybdenum is re-isolated from the organic phase. This method is very efficient on an industrial scale and has relatively low energy consumption. However, its main disadvantages are the requirement for expensive organic reagents and environmental hazards, especially the importance of safety measures when working with organic substances. The precipitation method is based on separating molybdenum from the solution by forming a precipitate and is one of the simplest and most economically effective methods. This process uses sulfides (e.g., H₂S or Na₂S) and organic precipitants (oxen). For example, molybdate ion reacts with H₂S to precipitate molybdenum disulfide (MoS₂):



This method's advantages include its affordability, ease of implementation, and effectiveness in laboratory and small-scale production environments. However, its main disadvantages are the low purity of the collected precipitate and the long processing time.

The separated molybdenum is usually recycled as molybdenum trioxide (MoO₃) and is subsequently used in various metallurgical processes in industry as ferromolybdenum or metallic molybdenum.

When choosing a technological method, depending on the main factors, ion exchange is recommended for obtaining high-purity molybdenum, organic extraction is recommended for processing large-scale solutions, and precipitation is recommended for low-cost and small-scale production.

In conclusion, separating molybdenum from uranium ore processing solutions allows for the full utilization of these resources and the full attainment of additional economic benefits. Today, ion exchange and organic extraction are the most effective and widely used methods. Introducing these technologies in uranium mines in Uzbekistan reduces imports and increases export potential in the molybdenum industry.

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