PROBLEMS OF TUNGSTEN MINING AND REGENERATION OF ITS WASTE IN UZBEKISTAN

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Annotation: The shortage of tungsten and high prices for it create a need to increase its production and require the development of technologies with deeper extraction of tungsten. A large number of methods have been proposed to solve these problems. An analysis of industrially used technologies is provided. The results of the work of Almalyk MMC specialists on the creation and implementation of new technologies in production are presented. Thus, for the first time in our country, they developed and implemented a technology for processing tungsten-containing industrial waste from the Ingichka deposit on an industrial scale. As a result of a series of works, the first tungsten product was obtained, for which an international certificate was issued, which made it possible to resume tungsten production based on domestic raw materials. The results of research work on the development of domestic technologies for the reuse of worn-out carbide tools, as well as the regeneration of industrial waste, were discussed.

Key words: tungsten, cobalt, technology, extraction, ore, tungsten trioxide, hard alloy, precipitation, extraction, ion exchange, enrichment, leaching, regeneration, hard alloy scrap, man-made waste.

The increase in demand for tungsten-containing commercial products in recent years and, as a consequence, the multiple increase in prices on the world market served as an impetus for the development of the industry in question in various countries of the world [1]. In the last 20 years, the most intensive developments have been and are being carried out by leaders in this field: in the Russian Federation and the People's Republic of China. Research has covered almost all stages of bringing tungsten-containing materials to a commercial product, namely: physical enrichment (flotation, magnetic separation); leaching (acid and alkaline); hydrometallurgical methods (extraction, ion exchange, precipitation); obtaining ammonium paratungstate. In general, all these stages are combined into two successive stages: physical enrichment and chemical transformations New approaches to the efficient use of natural resources require the introduction of technologies with deeper extraction of tungsten. The trend observed in technology to reduce the tungsten content in the feedstock necessitates the commissioning of mothballed waste dumps of processing plants even with a minimum content of the target product (less than 1%) [3].

The reserves of mined and developed tungsten ore deposits in the Russian Federation, taken into account by the State Balance of Mineral Reserves, amount to more than 300 thousand tons in terms of tungsten trioxide (WO_3), which allows the country to rank third in the world after

China and Kazakhstan in terms of the size of the metal's raw material base [4]. However, the share of concentrate production in the world is about 3.6%. China has traditionally been the leader in the tungsten mining industry, providing more than 80% of global production [5].

With tungsten reserves estimated at more than 300 years, maintaining its production at the 2017 level in just fifty years will lead to the depletion of reserves of the largest deposits containing the highest quality ores. This could mean a more than two-fold drop in the production of tungsten raw materials in the world. Therefore, the issue of compensation for retiring capacity arises. In this regard, there is a need to use waste that is generated both in the production of hard alloys and during the operation of products made of hard alloys in industry. These wastes are secondary raw materials, which can significantly reduce material and energy costs compared to processing natural raw materials. The relative amount of hard alloy waste returned for recycling after use in industry is 30–85% [6]. In addition, during the production of carbide products, products are produced whose operational and cutting properties do not correspond to standard samples. Such products are rejected and sent for processing.

Processing of hard alloy scrap is an alternative to importing ready-made mixtures and other semi-products of hard alloy production for countries that do not have their own primary raw material base [5]. But even in countries with the world's largest deposits of tungsten and cobalt ores, such as China, the importance of scrap processing in terms of saving natural resources and reducing the anthropogenic load on the environment is increasingly realized [7]. In developed industrial countries, the market for the use of secondary raw materials has already reached a high level - for example, in 2000 in the USA, 46% of tungsten produced was obtained from tungsten-containing scrap [8]. The economic feasibility of processing scrap is due to the fact that its various types contain from 15 to 99% W, while tungsten ores usually contain 1% WO_3, and, in addition, scrap contains other valuable components, in particular, more expensive cobalt. New approaches to the efficient use of natural resources require the introduction of technologies with deeper extraction of tungsten. The main scientific, technical and technological trends in the development of modern technologies in the field of extraction of tungsten-containing substances, enrichment and bringing to a marketable product are:

– enrichment of initial mineral and technogenic raw materials (flotation, magnetic separation, gravitational enrichment);

– chemical transformations of enriched raw materials (electrolytic decomposition, acid leaching, alkaline leaching, sintering, fluorine leaching, autoclave soda leaching);

– processing of working solutions in order to obtain a commercial product (precipitation, extraction, ion exchange with low-basic anion exchangers, ion exchange with highly basic anion exchangers In accordance with the development program of the research and production association for the production of rare metals and hard alloys, Almalyk MMC JSC plans to enrich tungsten concentrate from the waste of the Ingichka deposit. In 2023, 100 tons of tungsten were produced worth 5 billion 700 million soums, in 2024 it is predicted - 285 tons worth about 14 billion soums. As a result of the launch of the enrichment plant, 82 new jobs were created at the first stage. The main goal of the project is to annually export products worth 2 million dollars. At the second stage, it is planned to create about 250 new jobs and increase export indicators by more than 2 times - up to 5 million dollars. And for this there is everything necessary. Tungsten-containing waste from the "Ingichka" deposit amounts to 19,771 thousand tons. Due to their processing, it is possible to obtain 9-10 tons of tungsten concentrate per month and produce new types of export-oriented products with high added value. Next year, it is planned to additionally produce 27 tons of tungsten posts worth $1.8 million from "Ingichka" waste, and within the framework of the Localization Program - 36 tons of tools (chisels, cutters, drills) from tungsten-containing hard alloys worth about 28 billion soums.

At NPO JSC Almalyk MMC, after processing tungsten concentrates by autoclave-soda leaching, tungsten-containing dumps were formed. Man-made wastes occupy about 12 thousand hectares of land, which includes well-developed arable lands, urban areas, and rain-fed pastures. The natural landscape is changing and unique relief forms are formed, represented by dumps, tailings dumps filled with massive technogenic waste, which negatively affects the natural environment. In the area of operation of tailings dumps, the chemical composition of soils changes, easily soluble compounds are washed out, groundwater is polluted, and thus irreparable harm is caused to nature. The problem of processing waste tailings from enrichment plants and extracting useful components from them with their subsequent use as secondary raw materials is one of the most pressing [9].

When enriching the cake of NPO Almalyk MMC JSC using the gravitational method on screw separators with cleaning and on a concentration table, a tungsten middling product containing 10-11% WO_3 was obtained. When enriching the cake according to a combined scheme, that is, initial enrichment on a screw separator and concentration table followed by flotation of the resulting middling product, after the main control flotation and cleaning operations, it is possible to obtain tungsten middling product containing 25-30% WO3.Chemical transformations of tungsten-containing raw materials are one of the final stages of obtaining a commercial product of the corresponding technological cycle. The trend in chemical processing is directed towards the transition to production with a minimum amount of industrial waste, including liquid (acidic wastewater), since in practice, preference is given to technologies with the help of which the most efficient and careful use of natural resources is carried out. This is achieved by eliminating acid leaching and opening raw materials using alkaline reagents: NaOH, $Na(K)CO_3$ [2]. At the same time, the autoclave soda leaching method is characterized by lower process temperatures compared to sintering technologies with alkaline reagents and reduction with coke. It is also proposed to open tungsten-containing raw materials using fluorination [3]. To isolate tungsten from productive solutions, methods for the extraction separation of tungsten are proposed [11], and through its sorption on anion exchangers. AM brand anion exchanger is proposed as a sorbent [12], but there is a need to acidify the solution, which leads to the loss of carbonate ions and the formation of acidic waste. It is also proposed to use bentonite clay and bone char for the sorption of tungsten [12], but these methods relate more to the purification of water from tungsten and have no industrial significance.

Taking into account the above literature data, we took as a basis the technology for processing tungsten-containing waste from the metallurgical industry [13], which involves the extraction of tungsten into a solution using autoclave soda leaching (ASL). Subsequent processing of a tungsten-containing solution involves the use of an ion exchange process using highly basic anion exchangers.For processing tungsten-containing solutions obtained using ASV, the best method is ion exchange using highly basic anion exchangers, since there is the possibility of regenerating the opening reagent and there are no waste solutions, since the initial solution is not neutralized with acids. To carry out ion exchange, as well as for extraction, no additional heating of the reagent mixture is required. In this case, in contrast to extraction, the time of the ion exchange reaction is significantly longer, since long-term contact of the anion exchanger with the solution is required. Technological indicators of the main methods of opening raw materials and chemical transformations are presented in the table.

Table 1. Comparative indicators of various methods for recycling technological solutions of production based on tungsten extraction are presented in

Showers	**Opportunity Regeneration**	**Discharge solutions**	**Time reactions**	**Temperatur e process, °C**	**Degree Extracted values**
Precipitation scheelitis	No	Acid wastewater	Average contact	80–90	99-99,5
Extraction	no	Acidic wastewater, impurities amines, higher alcohols, kerosene	Short contact	Short contact	96
Ion exchange with low basic anion exchangers	No	Acid wastewater	Long contact	Room temperature	97
Ion exchange with highly basic anion exchangers	have	no	Long contact	Room temperature	97

Comparison of the table data allows us to draw a conclusion about the advantages of using DIA: high security; relatively high degree of opening; relatively low temperature of all stages of the process; possibility of regeneration of the opening reagent; closed technological cycle (no waste water).

Based on the conducted research, we can conclude that modern technology for producing commercial tungsten product must include complex enrichment of feedstock, autoclave soda leaching followed by ion exchange using highly basic anion exchangers.

It was noted that one of the urgent tasks facing industrial enterprises not only in Uzbekistan, but throughout the world is the processing of man-made waste accumulated over the years of their operation.

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