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ALKALINE LEACHING ILMENITE OF IRSHANSK DEPOSIT

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Significant reserves and resources of titanium are concentrated in 48 countries of the world, which according to the United States Geological Survey (2019) amount to 800 billion tons, the largest percentage of which is located in China and Australia [1].

The composition of ilmenite ore primarily depends on the geographical location of the deposit, and therefore differs in chemical and mineralogical composition. These factors directly affect the methods of its processing. Thus, Panzhihua ilmenite ore (China) contains a large amount of CaO and MgO and is in the form of vanadium-titanium magnetite, which complicates its processing [2]. Australia's ilmenite reserves are quite easy to exploit, as it is represented by placer deposits in the west of the country. However, the development of these deposits is somewhat restrained, as it contributes to limiting the use of land for other purposes, namely agriculture, the creation of national parks and the support of tourism [3]. Placer deposits are also represented in India, Brazil, and Sri Lanka. Ukraine is one of those countries in which titanium is mined from placer deposits.

Titanium reserves in Zhytomyr Oblast make up more than 85% of all explored reserves of titanium ores in Ukraine. A significant share in the extraction of ilmenite ore in Ukraine (40%) is occupied by the Irshan deposit. Ilmenite concentrate obtained by magnetic separation of ore differs not only in its mineralogical composition, but also in its chemical properties. According to [4], ilmenite from the Irshan deposit has inclusions of authigenic minerals, in particular, siderite, pyrite, and marcasite. The peculiarity of the ilmenite of this deposit is that it is leucoxenized (heavily altered, namely enriched in titanium), and its particles contain microcracks, which are characteristic of ores that are naturally enriched due to long-term weathering.

There are several methods of chemical processing of titanium ore in order to obtain more reactive compounds. The most common are chloride and sulfate methods of processing ilmenite concentrate. According to the authors [5], when using the acid method, complete extraction of titanium from ilmenite is achieved only in the case of an excess amount of acid and long-term heating (for several hours), which is a disadvantage of this method.

For the processing of ilmenites by the chloride method, the phase composition does not matter, since this technology requires smelting to slag. Also, the chloride technology of ilmenite concentrate processing has a shorter technological scheme, which reduces the economic costs of production.

One of the advantages of the sulfate method of processing titanium-containing raw materials over the chloride method is the possibility of using ore with a lower content of ilmenite. But for effective chemical processing of ilmenite concentrate by sulfate method, unchanged ilmenite is needed. Since the ilmenite of the Irshan deposit belongs to the altered ones, the acid processing technology is not effective for this ore and there is a need to find other processing methods. For example, the authors [5,6] suggest activating such ilmenite ores with fluoride additives.

An alternative to the use of fluoride activators is the process of alkaline extraction of titanium, which has recently been increasingly the subject of research. Potassium or sodium hydroxides are most often used for the processing of titanium ores by this method. Although the alkaline leaching method has not yet been widely industrially implemented, it has a number of advantages over other methods, including the high speed of the process of converting titanium into a soluble form of titanates and the level of efficiency in the use of raw materials [7-11].

Different approaches are used in the world to process ilmenite using the alkaline method. Most of the methods involve carrying out the reaction in an aqueous solution of alkalis. Thus, to study the process of alkaline extraction of titanium, the authors [8] used ilmenite concentrate produced by Kahnooj Titanium Complex, Kerman (Iran). The reaction was studied in an 85% solution of potassium hydroxide at a temperature of 493 K under atmospheric pressure and the presence of air oxygen.

The study of alkaline extraction of titanium from ilmenite of the deposit on the island of Bangka (Indonesia) was carried out in [9]. The interaction of ilmenite with a concentrated alkali solution (KOH) was studied in an autoclave at elevated pressures and a temperature of 473 K.

When studying samples of ilmenite separated from the black sands of the Rosetta coast (Egypt) [10], solutions of potassium and sodium hydroxides (70%) were used. Leaching was carried out in two stages. First, the mixture of alkali solutions and ilmenite was kept at a temperature of 393 K, and then the resulting ilmenite paste was subjected to acid leaching.

There are other approaches, namely conducting the reaction during the fusion of alkalis and ilmenite. Thus, the authors [7] using ilmenite from the Rosetta coast (Egypt) [10], solutions of potassium and sodium hydroxides (70%) were used. Leaching was carried out in two stages. First, the mixture of alkali solutions and ilmenite was kept at a temperature of 393 K, and then the resulting ilmenite paste was subjected to acid leaching.

There are other approaches, namely conducting the reaction during the fusion of alkalis and ilmenite. Thus, the authors of [7], using ilmenite from the Rosetta coast (Egypt), conducted studies on the fusion of ilmenite with KOH and NaOH at different molar ratios of the components in the temperature range of 623-723 K.

Although the alkaline leaching method is not yet widely used industrially, it has a number of advantages over other methods, including the high speed of the process of converting titanium into a soluble form of titanates and relatively low temperature limits for the course of the reaction.

Despite all the advantages of the mentioned methods, one of the significant disadvantages of these studies is a fairly high percentage of alkalis in the reaction mixtures, and accordingly in the obtained alloys, which subsequently requires neutralization with a significant amount of acid, as a result of which the cost price of the resulting product increases. In addition, each of the proposed methods reflects its own ilmenite processing scheme of a certain deposit. The optimal ratio of alkali-ilmenite in reaction mixtures and temperature regimes of reactions remain unsolved issues.

Thus, the analysis of technical literature shows that ilmenites from different deposits differ significantly in the content of titanium oxides, iron and other components. Therefore, there is a need to find an economically feasible method of alkaline extraction of the soluble form of potassium titanate from ilmenite ore of the Irshan deposit.

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ДИСТАНЦІЙНА ОСВІТА В ВИЩІХ НАВЧАЛЬНИХ ЗАКЛАДАХ ПІД ЧАС ДІЇ ВОЄННОГО СТАНУ

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Виклики сьогодення, які обумовлені дією воєнного стану і вливають на навчальний процес є суворою реальністю в нашому житті. Тому більшість вищих навчальних закладів почали оптимізацію освітнього процесу та більше включати до навчання сучасних інформаційних систем та засобів спілкування. При викладанні своєї дисципліни, викладач в сучасній системах має можливість дізнатися хто розбирався в питанні сумлінно, а хто навіть не