

PROCESSING OF SULFIDE ORE AND CONCENTRATES BY THERMAL STEAM TREATMENT

¹S. A. Abdurahmanov, ²J. B. Sunnatov, ³E. M. Masidiqov
Almalyk branch of Tashkent State Technical University^{1,2,3}

ABSTRACT

The preparation questions of sulfide ores and concentrates for hydrometallurgical processing by thermo-steaming method, which is intended to heat treatment with warmed gas of flotation concentrate and cakes with getting good quality cinders for leaching release from sulfur, arsenic and organic substances considered in this article.

Key words: the thermo – steaming, the flotation concentrate, cake, slate coal, sulfur, cyanidation, leaching, burning, cinder.

INTRODUCTION

Currently, an urgent problem is the choice of an effective technology for the processing of refractory sulfide ores and concentrates, where an important role is played by the preparation of sulfide materials for hydrometallurgical processing.

We have analyzed the behavior of sulfide minerals of ores and flotation concentrates of Dauguztau and Kokpatas.

Fine association of finely dispersed gold with iron sulfides, in addition, the ores of the Kokpatas and Dauguztau deposits contain a sorption-active carbonaceous substance (0.3% to 1.0%). The sulfur content in the flotation concentrate after the flotation operation reaches 33.0% and the carbon content is 2.0%, which reduces gold recovery using the BIOX technology.

METHODOLOGY

At the same time, end-to-end gold recovery does not exceed 50-55%. NMMC specialists have developed a combined technology for extracting gold from these flotation concentrates, including bio-oxidation - biomass roasting - cyanidation, which increases gold recovery by 5-10%.

Quite a lot has been devoted to the problem of processing refractory gold-bearing ores and concentrates works. Most developers propose the preservation of the cyanide process as the main method for extracting gold [1].

Acceptable indicators in this case are achieved due to the inclusion of additional operations in the technological scheme or the inclusion of special techniques:

- leaching in the presence of ion-exchange resins;
- using the operation of superfine grinding to open dispersed gold before cyanizing quartz and some other varieties of gold ores and concentrates;
- conducting a flotation operation fine-tuning for additional carbon recovery from oxidative burning cinders [2] .

The most radical method of opening refractory gold-bearing sulfide concentrates has been considered to be oxidative roasting, which has become quite widespread in the practice of the gold mining industry. In this case, gold is extracted by cyanidation of the cinder. To obtain a high-quality cinder with a minimum content of sulfur and arsenic in it, a two-stage fluidized bed roasting was proposed. In this case, at the first stage of roasting, arsenic is distilled off (500-550 ° C), and at the second stage (650-700 ° C) sulfur is removed [3].

Removal of sulfur and arsenic from gold-sulfide concentrates by thermal steam treatment

Product name	Content of components								Removal rate,%	
	In the original				In a cinder					
	As,%	S,%	Au, g/t	Ag, g/t	As,%	S, %	Au, g/t	Ag, g/t	As	S
Flotation concentrate	8,12	28,4	17,3	13	0,89	2,04	18,6	47,1	89,1	92,8

An undesirable phenomenon in the process of oxidative roasting of gold-arsenic sulfide concentrates is incomplete removal of arsenic, due to the formation of a non-volatile arsenic compound - arsenate-iron, as well as easily fused substances of passing gold particles. In addition, the atmosphere may be polluted by toxic gases and gold losses due to dust formation. More promising in comparison with simple oxidative roasting is oxidative - chlorinating roasting and chloride sublimation. In the process of oxidative roasting in the presence of a chlorine agent, the possibility of the appearance of "thermal passivity" of gold due to the chlorination of metallic impurities and their surface oxidizing films on gold is eliminated [4].

The disadvantage of chlorinating roasting is the possibility of chlorination of gold itself, with its loss in the gas phase in the form of sublimates. The possibility of opening gold finely disseminated in sulfides in an autoclave was investigated. The oxidation of arsenopyrite at elevated temperature and pressure in the presence of oxygen occurs in both acidic and alkaline media.

In an alkaline medium, oxidation of arsenopyrite proceeds with a complete transition of arsenic and sulfur into solution. In an acidic environment, arsenic first goes into solution in the form of arsenic acid, and then precipitates in the form of iron arsenate [5].

It should be noted that, despite good technological indicators, the opening of refractory gold-bearing concentrates according to the above scheme is associated with the use of complex and expensive autoclaves operating at high temperature and pressure (up to 50 atm.).

Table 2
Results of gold extraction by cyanidation from starting materials and products of thermal vapor treatment

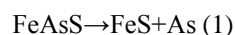
Name of gold-bearing materials	Content in the starting material, g / t		Direct cyanidation				Thermal vapor treatment - cyanidation						Leaching time, h
			Content in tails of cyanidation, g / t		Extraction, %		Content in the cinder, g / t		Content in tails of cyanidation, g / t		Extraction, %		
	Au	Ag	Au	Ag	Au	Ag	Au	Ag	Au	Ag	Au	Ag	
Flotation concentrate	17,3	13	14,8	11,6	12,2	9,5	21,9	19,5	4,7	4,28	79,3	76,6	8
									0,9	0,8	92,4	93,5	15
Biokek	17,9	13,9	8,2	6,1	56,6	58,5	22,3	18,4	3,8	4,3	83,8	81,2	8
									0,8	0,85	94,3	95,1	15

Due to certain shortcomings, the above methods have not been introduced into production. In this regard, studies were carried out on the possibility of processing refractory ores and concentrates by thermal steam treatment with subsequent leaching of the cinder [6].

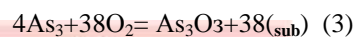
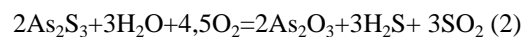
The results of experiments carried out to compare the degree of extraction of noble metals during cyanidation of starting materials and materials after thermal steam treatment show high efficiency of thermal steam treatment as a method opening of refractory gold-bearing sulfide arsenous ores and concentrates [7].

At the same time, the extraction of gold and silver, with cyanidation of the product of thermal steam treatment, is more than 92%.

In the process of thermal steam treatment of the flotation concentrate, arsenopyrite decomposes at above 3000C by the reaction [8].



And metal compounds interact with water vapor with the participation of oxygen and sulfur dioxide according to the reaction:



RESULTS

The results carried out during express laboratory studies on the preparation for cyanidation of flotation concentrate of ores of the Kokpatassky and Daugyztau deposits and BIOX cakes, providing for thermal treatment with heated steam of flotation concentrates and BIOX cakes to obtain a good quality cinder for cyanidation, freed from sulfur, followed by arsenic and organic substances are given in table. 1 and 2 [9].

Thus, during thermal steam treatment of oil shale, a complex process occurs, the stages of which are the interaction of elemental sulfur with water vapor and the products of this reaction - sulfur dioxide with sulfide minerals, and the product of the reaction of a sulfide mineral - elemental sulfur reacts with water vapor, etc. ... It follows that, to start the reaction, elementary sulfur is needed in small amounts, and then the vaporous sulfur formed as a result of the reaction between sulfur dioxide and sulfides re-enters into interaction with the sulfide mineral [10].

The highest extraction of organic matter under equal experimental conditions occurs when the particle size of the shale particles is $-2.0 + 1.2$ and $-1.2 + 0.315$ mm [11].

The temperature of thermal steam treatment has a significant impact on the degree of removal of organic matter from shale. At 25⁰C, the weight loss is 2.9%; the share of the volatile part of the shale remains 1.1%. As the temperature rises, the degree of organic matter removal increases and the bulk of it is removed at 350⁰C and then remains practically unchanged. At the beginning of the process, together with water vapor, a white mist is distilled off, which condenses in the refrigerator and forms an almost colorless thin layer and an emulsion in the condensate on the surface. Then the brown oil begins to distill off, darkening towards the end of the process [12-18].

Carrying out this process at 400⁰C and creating a vacuum (40-50 mm water column) in the system intensifies the process and by the end of the experiment, dark brown, thick and heavy oil ($\rho = 1,000 \text{ g / cm}^3$) settles down to the bottom of the condensate. It turns out that in the adopted mode of thermal steam treatment,

the removal of the bulk of the organic part of the shale occurs in the first 15-30 minutes, and further continuation of steam treatment has no practical meaning, because it leads to the consumption of energy and water vapor. Over time, the release of hydrogen sulfide sharply increases, rather than the removal of organic matter from shale, the consumption of water vapor is reduced and amounts to 20 ml / g [19-24].

Thus, the optimal mode of the thermal steam treatment process was identified, which meets the conditions: temperature 350⁰C, process duration 0.5 h, particle size -2.0; 0,315 mm, steam consumption 20 ml / g [14].

Long-term laboratory experiments on the low-temperature process of dissociation of sulfide minerals by thermal steam treatment show highly efficient distillation of sulfur, arsenic and organic materials from various sulfide ores and concentrates in comparison with other methods. This contributes to an increase in the extraction of useful components during further hydrometallurgical processing of thermal steam treatment products [15].

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