Conference Paper

Copper Recovery from Water of Soryinskoye Tailing Pond

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Abstract

The large volume of recycling waters from the Soryinskoye tailing pond (up to 1300 m^3/h) offers interesting possibilities for processing concentrates despite the low copper content (5.2-16.4 mg/l). Sulfides precipitation is the most efficient method of heavy metal ions removal from water. In this study, a sulfur solution in sodium hydroxide was used as a sulfidizing agent for precipitation. Commercial liquid alkali (NaOH – 46 % wt.) and commercial sulfur were the initial agents. Due to the concentrated alkali, dissolution could be carried out at 115-120°C, which is higher than the melting point of sulfur. Stable solutions were obtained at a weight ratio of NaOH: S = 1: 1 and a sulfur concentration of 350 g/l. During the laboratory and scale-up laboratory tests, the optimal consumption of sulfidizing agent was determined (110% of the stoichiometry for the formation of Cu2S, and copper extraction into the precipitate from the solution was more than 90.0% with high selectivity towards Zn and Fe). An extended analysis of the composition of the sediment (x-ray fluorescence spectrometer SPECTRO XEPOS) obtained during pilot trials showed that the main elements are, %: sulfur 58.4; oxygen 16.2; copper 8.9; iron 5.7; calcium 4.7 and arsenic 3.8. The total fraction of impurity elements does not exceed 2.3%. This study assumes use of the product conditioning to obtain concentrate with increased copper content and sulfur return to sulfidation stage.

Keywords: acid mine drainage, copper recovery, chemical treatment, sulfide precipitation

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1. Copper Recovery from Water of Soryinskoye Tailing Pond

Large volume of recycling waters of the Soryinskoye tailing pond (up to 1300 m3/h) even though low copper content (5.2-16.4 mg/l) generates interest in its extraction into concentrates suitable for processing. Due to the high content of Fe^{+3}, Ca, Mg in water and large volumes of water, sorption technologies do not provide sufficient extraction efficiency. Efficiency of copper extraction by cementation and galvanic coagulation methods is also low, because of low copper content [1–3]. From this point of view, reagent sulfidization of copper may be a promising trend [4–9].

Sulfur solution in sodium hydroxide was used as a sulfidizing agent for precipitation. Commercial liquid alkali (NaOH - 46 % wt.) and commercial sulfur were initial agents. Due to the concentrated alkali, dissolution could be carried out at 115-1200C, which is higher than the melting point of sulfur. Stable solutions were obtained at a weight ratio of NaOH: S = 1: 1 and a sulfur concentration of 350 g/l.

During the laboratory and scale-up laboratory tests, optimal consumption of sulfidizing agent has been found, which amounted to 110% of the stoichiometry for the formation of Cu_2S, and copper extraction into the precipitate from the solution was more than 90.0% with high selectivity towards Zn and Fe (see Table 1).

Table 1: Results of laboratory and scale-up laboratory tests.

Sulphidizing reagent consumption, %	Residual content of elements after sedimentation, mg/l		
	Cu	Zn	Fe
Feed water	5.2	52.0	44.0
110	< 0.2	32.0	35.0
130	< 0.2	27.0	34.0
150	< 0.2	19.0	34.0
Scale-up laboratory tests 110	0.5	50.0	37.0

Table 2: Results of industrial tests.

Name	Unit	Cu	Fe	Zn
Feed water	mg/l	5.85	59.58	64.83
Clarified water	mg/l	0.31	56.72	59.73
Sediment	%	8.94	10.36	0.37

Pilot tests for the selective deposition of copper from the water of the Soryinskoye tailing pond were carried out in a facility based on a 1.2 m^3 steel reactor with mechanical stirring. 10 m^3 of water were treated (see Table 2).

The electrokinetic potential of the resulting sulfide particles was evaluated. As a result of measurements, it was found that the resulting particles have a sufficiently high negative charge in the range 80 ÷ 100 mV. At the same time, a high settling rate is established – over 50 % in 15 minutes (see Figure 1). Therefore, it is possible to recommend horizontal thickeners.

An extended analysis of the composition of the sediment (x-ray fluorescence spectrometer SPECTRO XEPOS) obtained during pilot trials showed that the main elements are, %: sulfur 58.4; oxygen 16.2; copper 8.9; iron 5.7; calcium 4.7 and arsenic 3.8. The total fraction of impurity elements does not exceed 2.3 %. Particle size analysis is

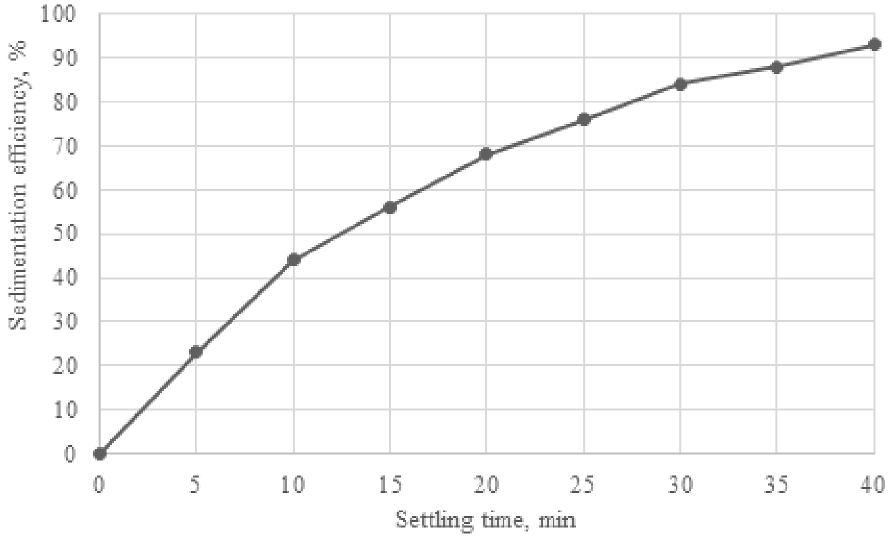

Figure 1: Settling rate curve.

performed on a laser analyzer HELOS/SYMPATEC. According to particle size analysis, 90.0% of sediment is composed of particles under 68.9 microns. The fraction of particles under 1.0 μm is 0.38%. The median particle size is determined to be 26.2 μm, and the average size is 28.9 μm. The average sphericity coefficient was 0.567, and the symmetry was 0.873.

As per results of the above tests, the flowchart has been proposed for copper recovery from recycling solutions of Soryunskoye tailing pond (see Figure 2).

Sulfides precipitation is the most efficient method of heavy metal ions removal from water. One of the main advantages of sulfidization is lower sulfides solubility versus hydroxides solubility and sulfide sediments are not amphoteric. Thus, sulfide sedimentation can provide highly efficient metal removal within a wide pH range as compared to hydroxide settling. Metal-sulfide pulp versus corresponding hydroxide one shows better characteristics of thickness and dewatering. The further studies assumes use of the product conditioning to obtain concentrate with increased copper content and sulfur return to sulfidation stage. The preliminary estimated payback period based on cost-efficiency of the method is 4.5 years.

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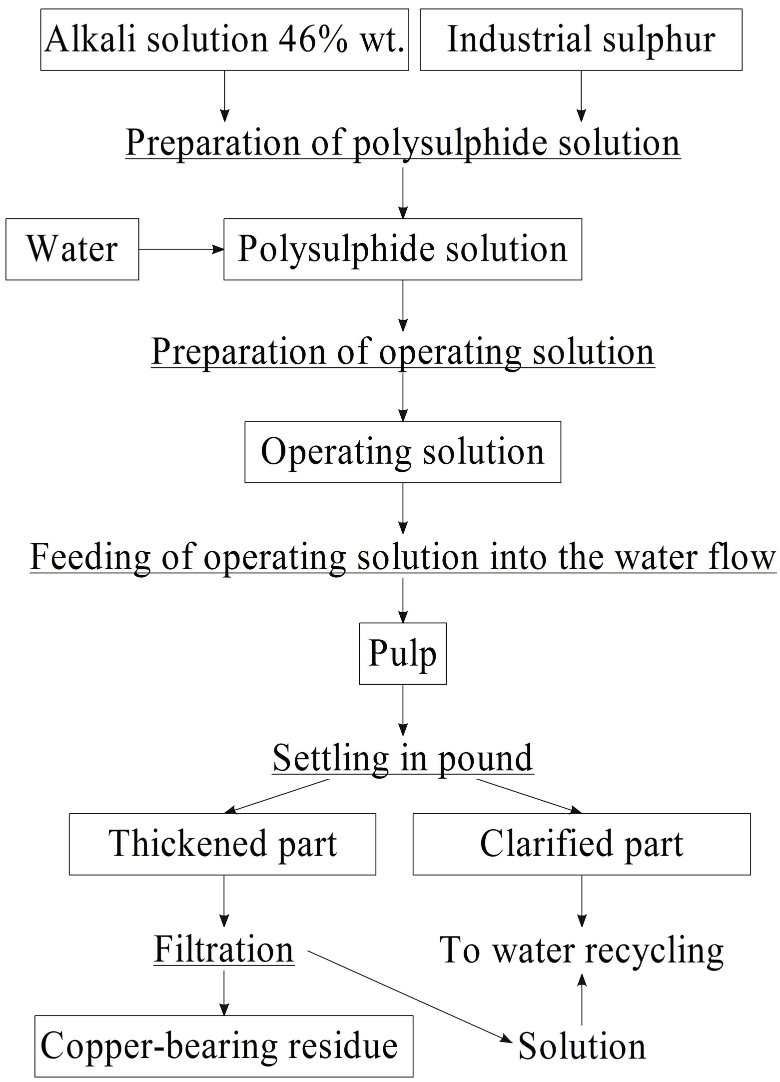

Figure 2: Copper recovery flowchart.

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