

THE COMPOSITION OF TECHNOLOGICAL SOLUTIONS CONTAINING LOW-CONCENTRATION METALS AND THE POSSIBILITIES FOR METAL EXTRACTION

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Abstract: The continuous growth in the production of precious metals has led to an increase in the generation of technogenic wastes and technological solutions, which has created the need for their processing. This process is considered not only as an additional source of metal recovery, but also as an important factor in reducing the production cost of final products. In this study, investigations were carried out on the sources of formation, composition, and processing methods of wash solutions generated in the sulfuric acid production unit of a copper smelting plant. The composition of the samples was analyzed using modern analytical techniques, including X-ray fluorescence (XRF), inductively coupled plasma–mass spectrometry (ICP-MS), and scanning electron microscopy (SEM).

Keywords: technological solution, SEM, XRF, dust, gas, sorption, extraction, ion flotation.

Introduction

At the copper smelting plant of Almalyk Mining and Metallurgical Combine, the dust and gases emitted from smelting furnaces contain valuable components as well as significant amounts of sulfur dioxide (SO₂); therefore, they are not discharged directly into the atmosphere. To separate the gas and dust phases, the off-gases pass through several treatment stages. Initially, the gas–dust mixture leaving the furnace is directed to cyclones, where coarse dust particles are captured. In the second stage, electrostatic precipitators are used to remove fine dust particles from the gas stream. However, electrostatic precipitators are unable to completely capture ultra-fine dust particles; therefore, the gas and residual dust are washed in 8 m³ scrubbing towers. As a result of gas washing, a portion of sulfur dioxide (SO₂) present in the gas is converted into sulfate ions. Under the influence of the formed sulfate ions, metals contained in the dust (Cu, Zn, Mo, Re, Se, and others) are transferred into the liquid phase.

Such technological solutions are generated in the sulfuric acid production unit at a rate of 80–110 m³ per hour. Initially, acidic wastewater streams containing 25–35 g/L of sulfuric acid, originating from the SKS-3 and SKS-4 sections, are collected in a specially constructed acid-resistant and leak-proof pond with a width of 35 m, a length of 35 m, and a depth of 3 m. Two

such ponds are available in the acidic wastewater treatment section; once the first pond is filled, the second is put into operation. In addition to collecting acidic wastewater, these ponds also serve to settle various suspended solids present in the wastewater and accumulate the sludge at the bottom. The sludge accumulation period for each pond is approximately two years.

In the acidic wastewater treatment section, neutralization is carried out using lime. Lime is supplied from the lime production plant of JSC Almayk MMC in an amount of 24–25 tons per day. After neutralization, the treated solutions are sent to the concentration plant for use as process water. Currently, the metal ions present in the solutions are discharged to the tailings storage facility together with flotation wastes. The metal ions contained in the tailings are toxic substances and pose a potential risk of infiltration into groundwater. Moreover, due to the commissioning of new copper–polymetallic ore deposits, the volume of such solutions is expected to increase by 3–4 times in the near future.

2. Materials and Methods

The technological solutions were filtered under laboratory conditions. The composition of the filtrate was analyzed by X-ray fluorescence (XRF) and

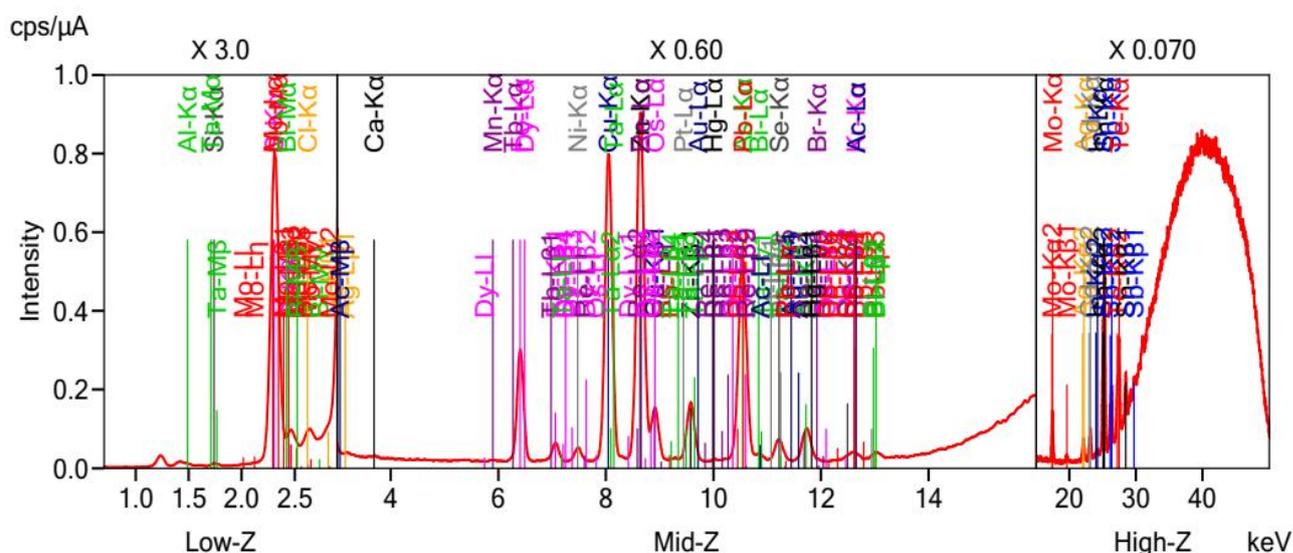


Figure 1. X-ray diffraction pattern of the technological solution

inductively coupled plasma–mass spectrometry (ICP-MS), while the sludge retained on the filter was analyzed using scanning electron microscopy (SEM). The composition of the filtered solution is presented in Figure 1 and Table 1.

Table 1.

Analytical results of the initial SKS washing solution, mg/l

Cu	Pb	Zn	Se	Re	Mo	Fe	Te	Pd	Ag
445,0	1,0	700,0	8,0	8,5	8,3	75,0	-	-	-

The results presented in Table 1 were obtained based on XRF and ICP-MS analyses. The analytical results of the sludge composition are shown in Figure 2.

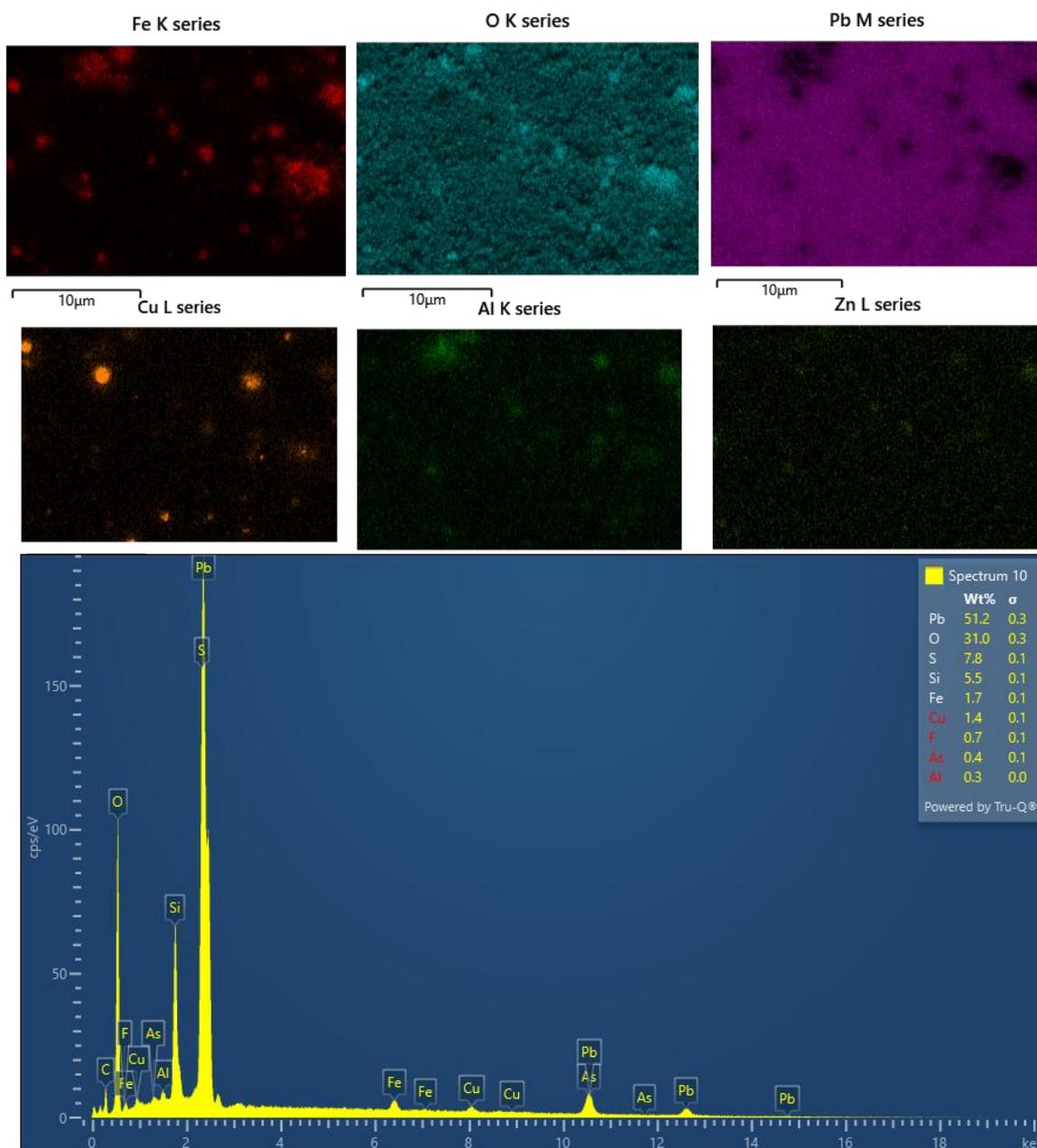


Figure 2. Scanning electron microscopy (SEM) image and composition of the sludge

4. Discussion

Based on experimental studies, it was determined that the concentration of sulfuric acid in the SKS acidic wastewater varies within the range of 25–35 g/L, while the concentrations of rhenium, molybdenum, and selenium range from 5 to 10 mg/L, and those of copper, zinc, and iron vary between 50 and 800 mg/L. In addition, small amounts of other elements are also present, and the pH value of the solution was determined to be 1.34. It is well known that sorption, extraction, and ion flotation are considered effective methods for the recovery of metals from solutions with low metal concentrations.

5. Conclusion

In conclusion, the analysis of the data presented in Table 1 indicates that technogenic solutions contain non-ferrous and rare metals at concentrations sufficient for their recovery by sorption-based separation methods. Annually, approximately 400–600 tons of copper and zinc, as well as 2–3 tons of selenium, rhenium, and molybdenum, are lost from technological processes in ionic form through the generated acidic solutions. Therefore, the efficient utilization of such solutions and the development of technologies for the recovery of valuable metals from their composition represent one of the most urgent tasks.

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