DEVELOPMENT OF A TECHNOLOGY FOR THE EXTRACTION OF LEAD AND ITS COMPOUNDS FROM TECHNOGENIC WASTE

Haqberdiyev Dilshod Qodir ugli
Assistant, Department of Geology and Mining Engineering
Karshi State Technical University
E-mail: dilshodhaqberdiyev5@gmail.com
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Abstract. This study investigates an integrated hydrometallurgical technology for recovering valuable metals from lead-bearing technogenic dust generated during copper production. The proposed process involves soda treatment, oxidative leaching, nitric acid leaching, selective lead precipitation, and subsequent recovery of metal compounds. The effects of technological parameters on metal extraction were evaluated. The results demonstrated that rhenium recovery into solution reached 95.4%, while the extraction of lead, copper, zinc, and cadmium reached 83.74%, 95.07%, 98.1%, and 95.5%, respectively. Lead precipitation efficiency as lead sulfate reached 99.99%. The developed approach supports comprehensive waste utilization and reduces the environmental impact of metallurgical residues.

Keywords: technogenic dust, hydrometallurgy, rhenium, lead, non-ferrous metals, metal recovery.

INTRODUCTION

The development of effective technologies for processing industrial waste and recovering valuable metals has become an important issue in modern metallurgy. Copper production generates significant amounts of metallurgical dust containing valuable non-ferrous and rare metals. If these wastes are not properly processed, valuable components may be lost, while their accumulation can create environmental problems. Therefore, the development of integrated processing methods for the recovery of valuable metals from metallurgical dust is of considerable scientific and practical importance.

Lead-bearing dust generated during copper production is a complex secondary raw material containing such valuable elements as rhenium, lead, copper, zinc, and cadmium. These metals occur in different chemical forms, which makes their selective separation and recovery a challenging technological task. In particular, the presence of metals in sulfate compounds requires the application of appropriate hydrometallurgical treatment methods to ensure efficient extraction and separation.

One promising approach involves the combination of soda treatment, oxidative processing, selective leaching, and precipitation methods. Soda treatment enables the transfer of rhenium into solution, while the use of hydrogen peroxide can improve its extraction efficiency. Subsequent nitric acid leaching allows other valuable metals to be transferred into solution. Lead can then be selectively separated through the precipitation of lead sulfate, followed by its further conversion into basic lead sulfate.

The purpose of this study is to examine the integrated hydrometallurgical processing of lead-bearing dust generated during copper production and to evaluate the recovery of rhenium, lead, copper, zinc, and cadmium. Particular attention is paid to the technological conditions of soda treatment, oxidative extraction, nitric acid leaching, and selective precipitation. The results are intended to demonstrate the potential of recovering valuable components from metallurgical waste and improving the efficiency of secondary raw material utilization.

RESEARCH METHODOLOGY

The study focused on the hydrometallurgical processing of lead-bearing dust generated during copper production. The chemical and mineralogical composition of the raw material was investigated using chemical, spectral, X-ray phase, and infrared spectroscopic analysis methods.

The experimental work included soda treatment of the dust using sodium carbonate (Na_2CO_3), oxidative extraction of rhenium with hydrogen peroxide (H_2O_2), and selective leaching of the resulting residue with nitric acid (HNO_3). The effects of reagent consumption, temperature, solid-to-liquid ratio,

and processing time were considered. Lead was subsequently separated from the solution by precipitation as lead sulfate ($PbSO_4$), followed by its conversion into basic lead sulfate.

The efficiency of the proposed processing stages was evaluated based on metal recovery rates, product composition, and material balance. Particular attention was paid to the recovery of rhenium, lead, copper, zinc, and cadmium from the industrial waste.

RESULTS AND DISCUSSION

The experimental results demonstrated the possibility of recovering valuable metals from lead-bearing dust generated during copper production through integrated hydrometallurgical processing. Soda treatment using sodium carbonate (Na_2CO_3) enabled approximately 80% of rhenium to pass into solution. The application of hydrogen peroxide (H_2O_2) increased the rhenium extraction rate to 95.4%, confirming the effectiveness of oxidative treatment.

The subsequent leaching of the carbonate residue with nitric acid (HNO_3) resulted in the transfer of other valuable metals into solution. The extraction rates reached 83.74% for lead, 95.07% for copper, 98.1% for zinc, and 95.5% for cadmium. These results indicate that nitric acid leaching is an effective stage for recovering non-ferrous metals from the processed residue.

Lead was selectively separated from the combined solutions through precipitation as lead sulfate ($PbSO_4$). Under the investigated conditions, up to 99.99% of the dissolved lead was precipitated, while rhenium and other non-ferrous metals remained mainly in the solution. Further treatment of lead sulfate with sodium hydroxide (NaOH) enabled the production of basic lead sulfate ($3PbO \cdot PbSO_4 \cdot H_2O$).

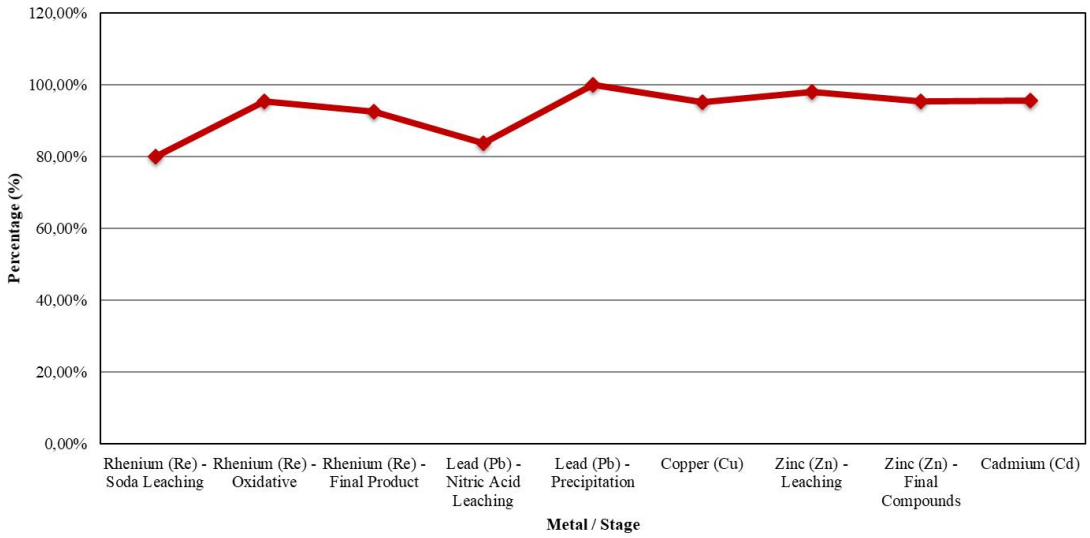


Figure 1. Recovery efficiency of rhenium, lead, copper, zinc, and cadmium at different stages of the integrated processing of lead-bearing technogenic dust.

The overall results showed that the proposed processing approach allows the recovery of several valuable metals from metallurgical dust. Rhenium recovery in the form of ammonium perrhenate reached 92.5%, while cadmium recovery was 95.4%. The reported recovery rate for zinc compounds ranged from 92.9% to 98.0%. These findings demonstrate the potential of integrated hydrometallurgical processing to improve the utilization of secondary raw materials and reduce the environmental burden associated with metallurgical waste.

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