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EVALUATION OF MINERAL PROCESSING AND METALLURGICAL PLANTS WASTES

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ABSTRACT – The mining process generates substantial waste containing various amounts of valuable metals. The conventional method for the disposal of waste is usually dumping. Mineral processing, pyrometallurgical, hydrometallurgical, and pyro-hydrometallurgical processes are applied to recover these metallic values. This study provides examples of studies conducted on evaluating wastes from some mineral processing and metallurgical plants in Turkey. Evaluation studies on mineral processing tailings such as iron, boron, and chromite, together with copper smelting and refining slags, are summarized. Related flow sheets developed as a result of experimental studies are also presented.

Keywords: Mining Plant Wastes, Mineral Processing Tailings, Metallurgical Slags.

INTRODUCTION

Mining waste includes the materials that are moved to gain access to minerals and the tailings, slags, and residues that result from the processing of the materials. During the production of metals from concentrates through the pyrometallurgical route, different types of products are accumulated and also contain considerable amounts of metallic values besides base metals.

The traditional method of waste disposal typically involves dumping. The increased dump of tailings not only occupies plenty of land, but also wastes resources and can potentially have an impact on the environment due to water pollution. Therefore, recovery of metals from the wastes and utilization of the wastes are important not only for saving metallic resources, but also for protecting the environment. Several processes used for the evaluation of such wastes are physical separation, flotation, and leaching. Thus, natural resources would be utilized more efficiently from the economic and environmental viewpoints.

EVALUATIONS OF WASTES

Some examples on the processing of mineral processing and metallurgical plant wastes from Turkey are presented in the following:

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Boron Tailings

As reported by Kistler & Helvacı [1] one of the few countries that have large resources of boron minerals is Turkey with five boron beneficiation plants. Various grades and fractions of concentrates of tincal, colemanite, kernite and ulexite are obtained from these plants [2]. Boron is beneficiated using scrubbing, washing, and classification following the size reduction step. Significant amounts of tailings and fines are generated as a result of the mining and processing steps, respectively. The fine fraction, classically less than 3mm is discharged to a tailing dam with associated process water, and this is a main cause of important storage problems and environmental pollution. Every year almost 600,000 tons of boron-containing fine clay tailings are produced in Boron Concentrator Plant in Turkey.

Processing techniques of boron minerals are generally related to the type of ore, the scale of the operation, and the type of the end product. Various dry (magnetic separation, pneumatic tabling, electrostatic separation, calcination) and wet (scrubbing and washing), jigging, tabling, flotation) concentration methods have been used alone or in combination [2].

All the boron minerals are floated using cationic and anionic collectors from tailings [3,4,5]. Some studies found that the scrubbing and flotation combination is an effective method to produce boron concentrate. For example, in a study, a colemanite tailings sample taken from a tailings pond was treated using scrubbing + screening followed by flotation to recover the lost boron. As a result of the experimental studies, a concentrate containing 44.5% B_2O_3 was produced with 68.4% B_2O_3 recovery [5].

Chromite Tailings

Turkey is an important producer in the world metallurgical-grade, high-chrome chromite market [6]. The chromite deposits are usually small in size, and chromite is generally concentrated by gravity methods such as shaking tables in mineral processing plants. The total amount of fine chromite gravity tailings in Turkey is around 3,000,000 tons with a quite high Cr_2O_3 content of about 9-20%. These fines are produced as a result of the inefficiency of conventional separation equipment at fine particle size due to finely grained feed and optimization problems [7].

According to a study using the Jones HIWMS (High intensity wet magnetic separation) followed by column flotation for minus 0.1 mm chromite tailings, a concentrate assaying 47.7% Cr_2O_3 could be obtained with a recovery of 66.4%. A tailings containing 5.84% Cr_2O_3 is discharged. Based on these studies, a flowsheet was developed, and a pilot plant was established to recover chromite from the tailings [8, 9]. The simple flowsheet of the pilot plant is given in Figure 1.

Iron Tailings

Iron ore tailings have become one of the most hazardous solid waste. In the Sivas-Divriği Iron Ore Concentrator, which is the biggest in Turkey, the total 600, 000 tons of tailings have been discarded annually. Huge amounts of tailings have already been deposited in ponds and stockpiles from previous production activities. Istanbul Technical University (ITU) researches on Divriği iron tailings [10-13]. included a detailed study on

mineralogy, beneficiation, and feasibility. As a result of these researches, a general flowsheet was proposed which is given in Figure 2. According to this flowsheet, after grinding of tailings, flotation, sulphatizing roasting of coarse concentrate, and leaching of calcine with sulphuric acid, the recovery of Co, Ni, and Cu from solution with H_2S precipitation. Also iron was recovered from the coarse flotation tailing with magnetic separation. Applying this flowsheet makes it possible to produce CoS, NiS, and CuS precipitates along with iron concentrate from the iron tailings.

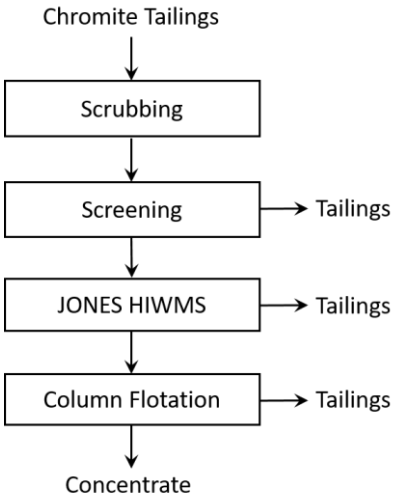

Figure 1 The pilot plant flowsheet of Üçköprü chromite tailings

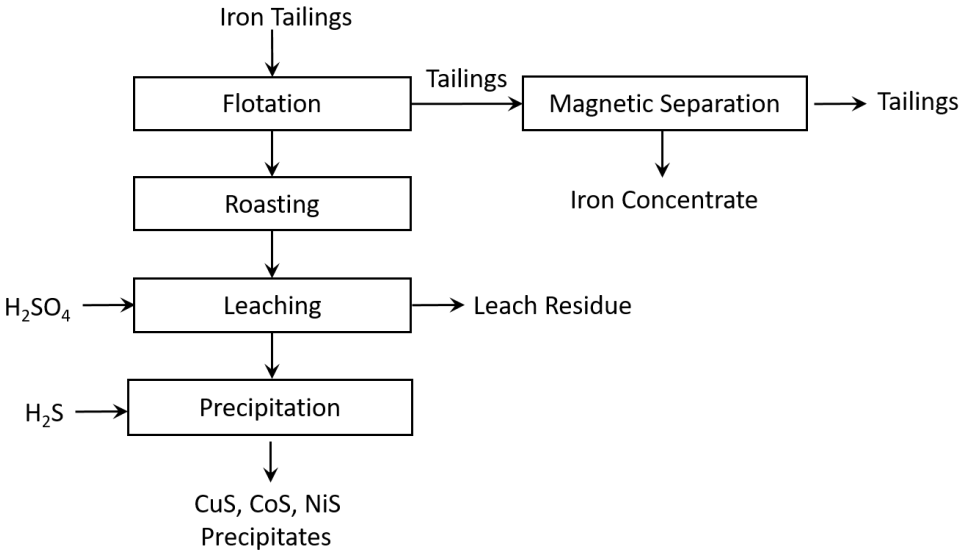

Figure 2 A proposal flowsheet for Divriği iron tailings

Copper Slags

During the production of metallic copper from copper concentrates and rafination of blister copper through a pyrometallurgical route, different products (slags, dusts, fumes, etc.) are accumulated and they contain considerable amounts of metallic values besides copper [14,15]. Mineral processing, pyro-, hydro-, and pyro-hydrometallurgical processes are applied to recover these values [14]. The flotation process plays an important role in the beneficiation of metal values from slags and is utilized in many copper smelting processes**.** In principle, copper slag flotation is the same as sulfide ore flotation [14, 16-18]. This means that only metallic Cu and sulfide minerals can be floated effectively. Because in some slags Cu occurs in the oxide form (Co is in homogenous distribution) and is disseminated in small amounts in the slag matrix, the application of flotation to copper slag processing could be limited, and the flotation method will not be effective for the recovery of Co, Ni and oxide Cu. Therefore, roasting and leaching processes need to be applied. Metals from leach liquors can be recovered by solvent extraction, precipitation, and electrolysis.

A study has been conducted on the recovery of copper, cobalt, and zinc from copper smelter and converter slags by roasting with sulfuric acid. Acid roasting of slags followed by hot water leaching was carried out to bring the metal values into solution. A total of 88% of copper, 87% of cobalt, 93% of zinc, and 83% of iron were extracted in 2 h of roasting at 150 °C and 3:1 acid/slag ratio [19]. The other study, 20 a combination process, such as flotation + roasting with pyrite + leaching (Figure 3).

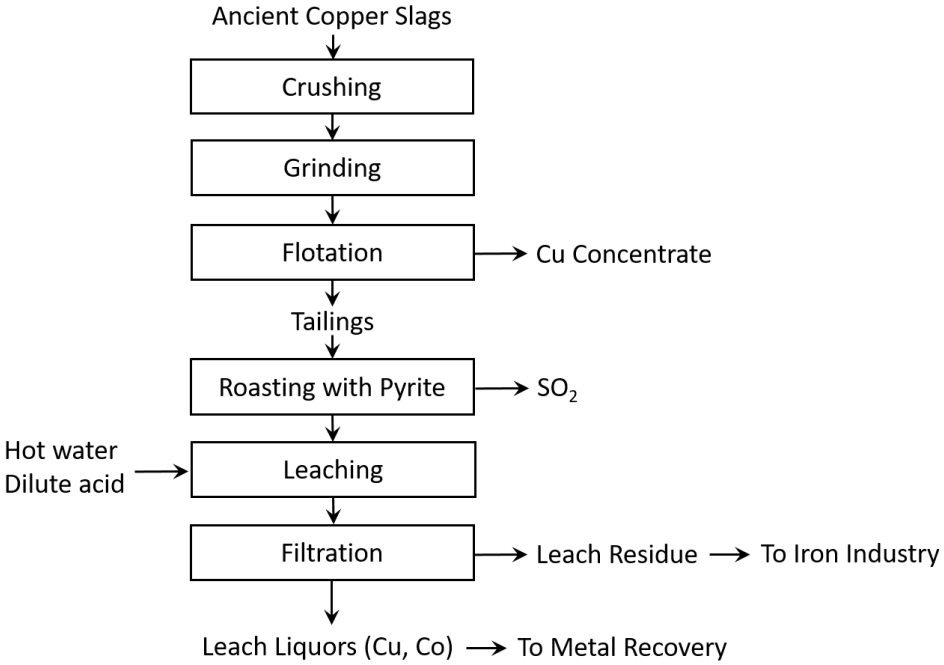

Figure 3 Proposed flowsheet for the evaluation of Küre ancient copper slag

CONCLUSION

In Turkey, 26 million tons of tailings are produced every year after mineral processing works. a lot of research has been done about the evaluation of tailings, there is no serious investment in this area because of still obtaining valuable metals from the potentially available reserves. In the future, evaluation of these tailings will be inevitable. All research about mineral tailings such as boron, chromite and iron, which are the subject of this paper, showed that tailings still contain valuable minerals that need to be explored. As a result, these tailings must be re-concentrated before using other purposes such as ceramics, cement, construction, and landfill.

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