Development of an integrated processing scheme for the recovery of chromite and platinum group metals (PGMs) from fine chromite tailings

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With conventional gravity separation techniques used from chromite beneficiation, a large percentage of valuable mineral is lost in the tailings, due to the fine particle size of material [1]. These methods show reduced efficiency in the fine particle size range, given that as particle size decreases (<100 μm), the force related to water flow becomes dominant over gravity.

Another important characteristic of chromite deposits is that they contain Platinum Group Metals (PGMs). Studies have shown that the application of magnetic separation to chromite ores results in the concentration of chromite grains in the magnetic fraction, while PGMs and other associated metals are concentrated in the non-magnetic fraction [2]. Therefore, in cases where magnetic separation techniques are already being used for the beneficiation of chromite ores, additional methods for the recovery of PGMs and other valuable elements could also be integrated into the process.

Given the above, the effectiveness of an advanced gravity separator, namely the Mozley Multi Gravity Separator (MGS), in the recovery of chromite from fine tailings was investigated in this study. Furthermore, a Wet Magnetic Separator (WMS) was applied, and the recovery of PGMs from the non-magnetic fraction was studied in order to improve overall resource recovery.

A tailings sample containing 5.0% Cr_2O_3 collected from the disposal facilities located at Vourino area, Greece was used in the study. The main crystalline phases identified in the material include lizardite, $(Mg,Fe)_3Si_2O_5(OH)_4$), olivine [$(MgFe)_2SiO_4$], chromite ($FeCr_2O_4$), and pyroaurite ($Mg_6Fe_2CO_3(OH)_{16}\cdot 4H_2O$). Considering the results of the liberation study, grinding to a particle size below 0.125 mm was performed to achieve a satisfactory degree of mineral liberation. The experimental procedure followed is shown in Figure 1.

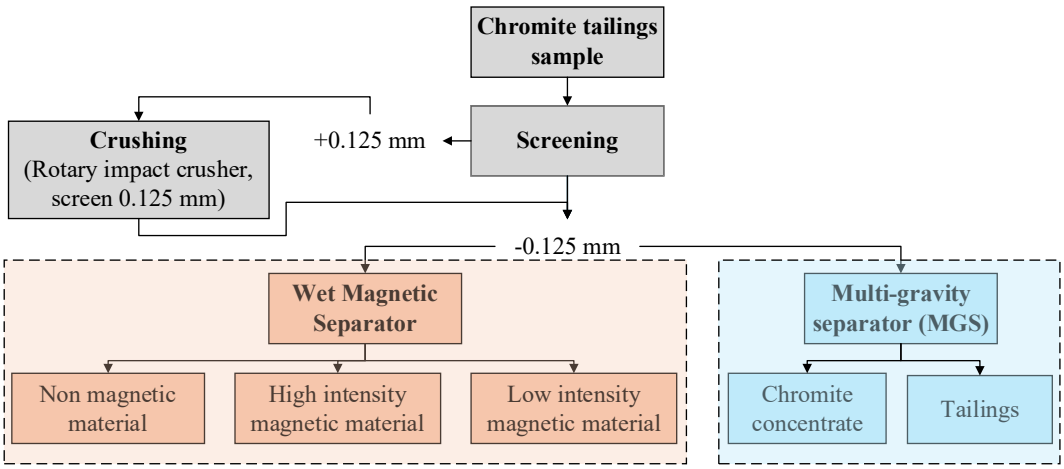

Figure 1. Processing scheme for the chromite tailings

Magnetic separation was conducted at two intensity levels: a) Low intensity, aimed at separating chromite from olivine and serpentine, and b) High intensity, for the separation of olivine from serpentine.

A laboratory Micro MGS supplied by Gravity Mining Limited (GML) with a capacity of 10 - 25 kg/h was used for the tests. The Multi Gravity Separator consists of a slightly tapered, open-ended rotating drum that turns clockwise and is subjected to a sinusoidal axial shake (Figure 2). Due to the high centrifugal forces generated by the drum's rotation, combined with the shearing effect of the shaking motion, denser particles within the slurry migrate toward the drum wall, and transported by rotating scrapers toward the open end of the drum, where it is discharged into the concentrate launder. The lighter particles are carried by the wash water flow toward the rear of the drum, exiting through slots into the tailings launder. The rotational speed (250 to 270 rpm) and tilt angle (0° to 9°) of the drum were changed during the tests, whereas the other operational parameters were kept constant as follows: slurry density: 20%, Feed slurry flow rate: 0.2 L/min, wash water flow rate: 0.2 l/min and shaking amplitude: 12.5 mm.

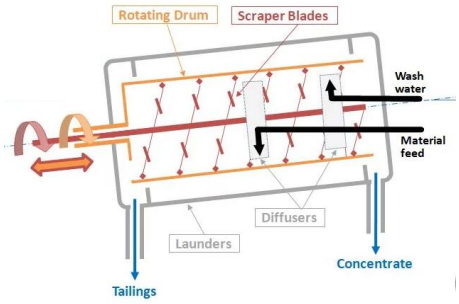

Figure 2. Multi Gravity Separator [3]

Based on the results, wet magnetic separation in the -0.125 mm particle size fraction, at low intensity, yielded a magnetic product separation rate of 26.29%. At low intensity, the chromite grade increased from 5.0% to 14.9%, with a recovery reaching 77.8%. At high intensity, a slight increase in chromite content, from 5.0% to 6.5%, in the magnetic product was observed.

The results of MGS tests are shown in Figure 3. Under optimum conditions (tilt angle: 4.5°, drum speed: 260 rpm), a concentrate grade of 51.2% Cr_2O_3 was achieved with 84% Cr_2O_3 recovery from the tailings.

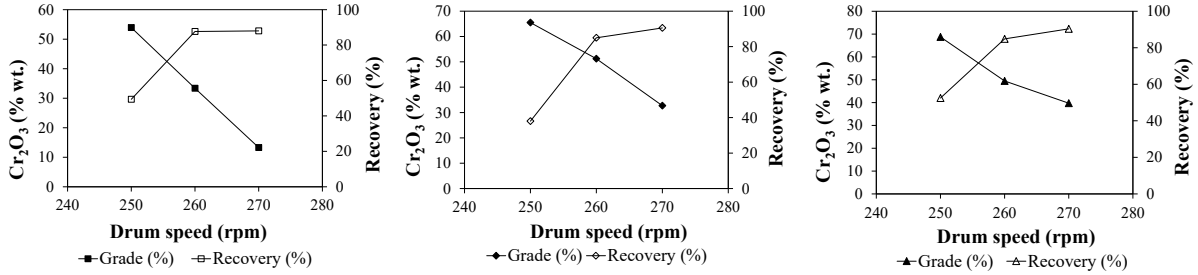

Figure 3. Effect of drum speed on the grade and recovery of chromite from tailings
Tilt angle (a) 0°, (b) 4.5° (c) 9.0 °

The initial tailings samples and the residues from the beneficiation processes were analyzed for PGMs using the nickel sulfide fire-assay method [4]. To enhance PGM recovery, the samples were subjected to pyrometallurgical treatment at 1550 °C in an electric furnace following the ConRoast process [5]. Subsequently, both untreated and thermally treated samples underwent leaching to extract PGMs. Preliminary results from leaching experiments—comprising atmospheric leaching with HCl/H_2O_2 or HCl/NaCl at 90 °C in a glass reactor, as well as pressure leaching using NaCl in a titanium autoclave (Platsol process [6])—indicate promising potential for efficient PGM recovery from tailings.

References

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