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Reducing the magnesium oxide content in Trojan's nickel final concentrates

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ABSTRACT

Trojan Nickel Mine in Bindura, Zimbabwe, produces nickel concentrates which, until 2008, were then processed at their smelter operations (Bindura Smelter and Refinery) and the subsequent product sent to the hydrometallurgical plant to produce nickel cathodes. However, due to economic challenges the smelter and hydrometallurgical plant operations were closed down in 2008. Currently, Trojan Mine produces nickel concentrates through flotation which are then sold to Glencore International, in China, for further processing.

Since 2002, the MgO (also known as talc) content in the Trojan Nickel Mine final concentrates has increased from around 12% to a peak of 22%. The average MgO content in the concentrates for the year ending in March 2015 was 16.14%. An offtake agreement of sale was made with Glencore International, in China, whereby a penalty is charged for all concentrates with MgO levels greater than 5%. In the year 2015 alone, monthly revenue due to smelter penalties amounted to an estimated total of US$141 000. Higher MgO levels in the concentrates are prevalent when processing low grade ores, with nickel content ranging from 0.65-1.2%. This research focused on reducing the MgO content of the Trojan's final concentrate to 12%; which was the smelter's set target while it was still operational.

In order to investigate the effect of pH and chemical depressants on the MgO levels in the concentrate, batch flotation tests were carried out at pH 8.95 and 10.2, using several guargum depressants namely: Betamin DZT 245 (standard), Cytec S9349, DLM PDE, DLM RS, and CMC (carboxy methyl cellulose) depressants namely: Depramin 177, 267 and 347, and ND 521, 522 and 523. The concentrates were collected at 1, 5, 15 and 25 minute intervals in order to understand the stage-wise recovery of nickel and MgO minerals. A flotation test, without a depressant, was also carried out in order to understand the kinetics of the gangue minerals. Stage addition of depressants was investigated, by adding another 50g/t dose of the DZT 245 depressant after 1 minute into the flotation test. Collector combination tests using SIPX, SIPX:NC228, SIPX:NC236 and SIPX:PNBX, were also carried out to determine the best reagent suite. To understand the recovery of nickel and MgO in the flotation circuit, a plant survey was carried out, and the particle size distribution (PSD) and assays of collected samples were determined.

Flotation tests results indicated that DLM RS and DLM PDE guargum depressants had better selectivity towards MgO and higher nickel recoveries as compared to the Betamin DZT 245 depressant that is currently used in the plant. It is recommended that a plant trial be carried out using the DLM RS depressant, which further reduced the MgO and mass of concentrate recovered by 3.79% and 32% respectively. The stage recovery of MgO for a test carried out without a depressant showed that 57.7% of the MgO was recovered during the first five minutes of the test. Thus, there is need to effectively depress the fast floating MgO during the early stages of the flotation process. Nickel recovery and grade were increased by 2.7% and 2.1% respectively, after adding the second dose of the depressant after 1 minute into the flotation test. The results indicated that the fast floating MgO can depress the valuable mineral if the depressing effect of the depressant is short-lived, which in turn leads to reduced nickel recoveries. Hence, reducing the time between the two stage additions of the depressant in the plant will help further supress the fast floating MgO silicates. It was also noted that at least 60% of the nickel was recovered during the first five minutes of the tests. Hence, reducing the residence time of the rougher flotation bank would reduce MgO recovery into the concentrates without adversely affecting the nickel recoveries.

Plant survey results showed that the scavenger bank feed that was deslimed, had less finer MgO particles and MgO content as compared to the rougher bank feed. This indicates that desliming before the coarse flotation process could reduce MgO slimes in the feed, reduce the recovery of MgO due to slime coatings in the final concentrates and the reagent consumption in the bank. Introducing the desliming unit could be beneficial since the desliming cyclones have low installation and operational costs.