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Particle segregation associated with sub-sampling of feed at a typical UG2 concentrator

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Executive Summary

A particular Upper Group 2 (UG2) reef ore treating Concentrator Plant has been historically under-accounting in terms of 4T (Platinum, Palladium, Rhodium and Gold) content. It has been postulated that the main reason for the consistent under-accounting is due to the correct sub-sampling of finer particles and consequently under sub-sampling of the coarser particles present in the feed slurry streams into the plant.

The test work presented involved a series of experimental studies designed to gain an understanding of the presence and extent of particle segregation in the intermediate hopper of a typical UG2 feed vezin sampling system. A total of three stages of test work were conducted, including vezin credibility and chronological sub-sample tests, tests on a re-designed nozzle and mechanical hopper.

The tests on sub-sampling of the feed material from the intermediate hopper performed on the current sampling arrangement (Stage 1, Test 1) demonstrated that segregation occurs in the intermediate hopper of the feed sampling system. A consistent bias was observed between the reject and official samples with the official samples having more fine particles and being higher in 4T grade than the reject samples. By means of a paired t-test, the calculated bias for % mass retained was deemed significant at the 95% confidence level. This outcome together with the size by assay analysis performed indicated that an under-accounting scenario would result.

Stage 2 test work involved the use of an alternative nozzle design at the outlet of the current intermediate hopper as a way of optimizing the current arrangement. The sub-sampling tests performed after this modification resulted in a more random distribution of fine and coarse particles in both the reject and official samples. The PSD's for the reject and official samples were similar across all test runs however the 4T grade was not consistent. The calculated bias for % mass retained was not significant at the 95% confidence level.

Stage 3 test work involved the application of a new hopper design which was equipped with an agitator in an attempt to reverse the segregation observed in the old hopper design. The

new hopper also necessitated the introduction of an alternative sampling protocol where multiple primary increments were collected and the sub-sampling to produce an official and reject sample while agitation transpires created the platform for better suspension of all particles. The particle segregation in the intermediate hopper was reduced and the calculated bias for % mass retained was not significant at most measurements at the 90% and 95% confidence level. The change in nozzle and hopper design seemed to not have an impact on the overall 4T grade of the official sub-samples generated over the sampling campaign.

There was a slight improvement in the % COV for the % +38µm from Stage 1 to Stage 2. With the inclusion of the new nozzle design to the mechanical hopper, the % COV for the % +75µm improved from 26.7% to 14.5%.

In general, it is believed that the particle segregation which was so evident in the baseline test was significantly reduced with the incorporation of the alternative nozzle design and mechanical agitation. Compressed air agitation alone does not seem to keep all particles of varying size and density in suspension in the intermediate hopper.

A future mechanical hopper prototype should be redesigned and fabricated from a cheaper yet robust material and should also be ergonomically improved. The incorporation of internal baffles inside the mechanical hopper should also be considered to reduce the impact of vortexing. An inspection port should also be integrated into the design to be able to view the agitator in operation and observe for vortexing of the slurry material or retention of residual solids in the hopper after sub-sampling takes place. Multiple air agitation points may also be considered in future designs of the mechanical hopper (for instance, an air agitation point above and below the pneumatic valve).

It is recommended that any future investigation or test work around particle segregation in the intermediate hopper be conducted in a controlled testing environment. In this way, any random variation due to the process can be disregarded and the true bias (if any) can be determined and confirmed.