Control and Optimisation of a Gold Milling and Flotation Circuit

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ABSTRACT

Björkdal Gold Mine's mill discharge circuit poses various challenges, due to it consisting of an interactive collection of sumps that feed the gravity separation circuit. For optimal gravity circuit performance, the hydrocyclones and spirals require a constant feed flowrate. This is attainable with a simple Proportional-Integral-Derivative (PID) controller, however, controlling only a sump's outlet to a constant flowrate requires an equally balanced inlet flowrate otherwise the sump will overflow or run dry. Therefore, a model predictive controller (MPC) was proposed, because it is able to prioritise the flowrate stability over sump level control, while predicting the movement of the level and pre-emptively, slowly changing the pump speed to avoid sump level limit violations that are predicted. This MPC strategy was implemented to balance the volume between four mill discharge tanks in order to attain a constant gravity feed flowrate. The increased stability in the mill discharge circuit has resulted in an increase of 1% recovery from the gravity separation circuit.

Further processing of the gold ore at Björkdal includes a Knelson separator which feeds a flotation circuit. Due to the flushing cycle of the Knelson separator, the flotation circuit experiences extreme volume fluctuations at intermittent times. Due to the lack of feedforward control on the flotation circuit, this disturbance resulted in the pulp level of all the flotation cells deviating drastically from setpoint. As a consequence the final grade and recovery was affected. Implementation of a model-based feedforward with stabilising PID controller compensated for these Knelson flush volume fluctuations, which resulted in the level not deviating from setpoint. Additionally, the controller considers all the levels simultaneously and is therefore able to mitigate disturbances from propagating further downstream. This resulted in a more stable flotation circuit and 0.96% increase in recovery around this section.

Once the flotation circuit had been stabilised, it was considered for optimisation. A flowrate measurement was installed on the combined Rougher-Scavenger concentrate stream. This information is being used to target a desired mass pull from the two flotation banks by manipulating the level and air setpoint values of the individual cells. Thus far, implementation of this flotation optimisation strategy shows promising results, however not enough data has been collected to make any substantial conclusions.