MillStar and FloatStar advanced process control system at a PGM concentrator

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ABSTRACT

In 2016, the FloatStar and MillStar advanced control systems were commissioned at a platinum (PGM) concentrator in Rustenburg. Two levels of the FloatStar control system were installed for stabilisation and optimisation of the flotation circuit, namely, the FloatStar Level Stabiliser and the FloatStar Flow Optimiser. Initially, the FloatStar Level Stabiliser was installed on all 3 flotation sections; Roughers, low grade Cleaners and high grade Cleaners. The MillStar stabilisation control system was installed on the secondary mill discharge section of the plant, namely; secondary mill discharge sump, primary thickener and surge tank. Thereafter, when stability of the above mentioned sections of the plant was achieved, the FloatStar Flow Optimiser was later installed only on the Rougher section of the plant.

The objectives of the MillStar commissioning were to stabilise both the secondary mill discharge and primary thickener sections of the plant with an overall aim of stabilising and controlling the surge tank section, in particular the Rougher feed flowrate and Rougher feed density. The MillStar RNMPC (Robust Non-linear Model Predictive Controller) was used to take into account the multivariable interactions of the system. A significant improvement in density control to the flotation plant was achieved under MillStar control when compared to plant control with minimal variability being introduced in the Rougher feed flowrate.

The objectives of the FloatStar Level Stabiliser commissioning was to achieve stable level control on the flotation circuit. Thereafter, the main objective of the FloatStar Flow Optimiser commissioning was to achieve a constant, stable concentrate sump flowrate for two Rougher concentrate sumps, namely the high grade sump and low grade sump. The results prove that the FSFO was more consistent than plant control in stabilising the concentrate flowrate for both the high grade and low grade Rougher sumps. Furthermore, the sump levels of both sumps were maintained within limits, without the sumps overflowing or running dry.

APPLICATION OF MINTEK'S ADVANCED CONTROL PHILOSOPHY

Surge Tank Control

The secondary mill sump discharge flowrate and the thickener underflow feeds into the surge tank. It is therefore important to stabilise these flowrates with an overall aim of creating stability in the surge tank. The MillStar PID controller controls the Rougher feed flowrate using the pump speed. The Rougher feed flowrate setpoint is optimised by the RNMPC to control the Rougher

feed density to a setpoint and keep the tank level within the operating limits. The Surge Tank water addition valve is controlled by the RNMPC to keep the density and level within a stable operating region. The secondary mill discharge sump density is also optimised to enhance control of the Rougher feed density.

Rougher Flotation Optimisation

Typically, flotation circuits aim to produce a concentrate of a specified grade, while recovering as much of the valuable mineral as possible. The final grade and recovery of the circuit will be influenced by, amongst others, the level setpoints, aeration rates, bank residence times and reagent addition. The control of the Rougher concentrate flowrate to the operator flow setpoint is achieved by using the sump recirculation valve, together with the flotation level/air setpoints. There are fixed speed pumps operating on both sumps. Safety controllers ensure that the sump levels are steadily maintained within limits.

RESULTS AND DISCUSSION

Figure 1 shows the Rougher feed density histogram while under MillStar control as compared to plant control for a period of 1.5 days respectively. The density was controlled to a setpoint of 1.31 SG for a higher frequency while under MillStar control as compared to plant control.

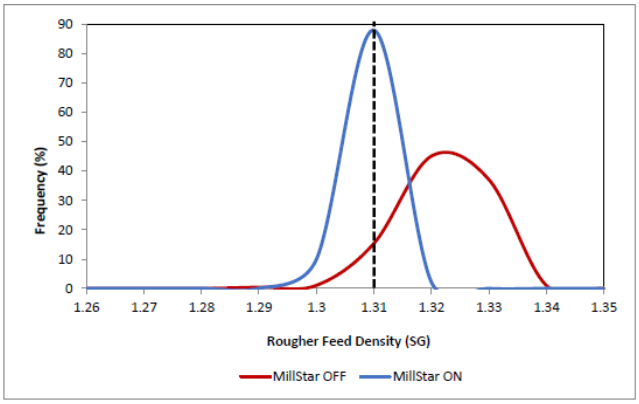

Figure 1: Performance comparison of MillStar control and plant control on the Rougher feed density

Figure 2 shows the Rougher feed flowrate error histogram plot for MillStar ON and OFF respectively for a period of approximately 1.5 days each. The flowrate is controlled to a setpoint and maintained within an error band of -1 to 1 while under MillStar control. Plant control is also able to maintain the flowrate within this error band, however the density control within a narrow band around the setpoint of 1.31 SG is compromised in this case as previously shown in Figure 1. When MillStar is ON, the flowrate is allowed to change within a band in order to control the density to a setpoint, for as long as the surge tank level is within the limits of 35-85 %. The flowrate was varied within the desired operating range for both plant control and MillStar control. The standard deviation for plant control and MillStar control was 13.34 m^3/hr and 16.25 m^3/hr respectively. This calculation shows that the MillStar controller had to introduce a marginal

additional variability of only 2.91 m^3/hr in order to maintain a stable density and a surge tank level within limits. This variability is insignificant when compared to achieving the targeted density feeding the flotation circuit.

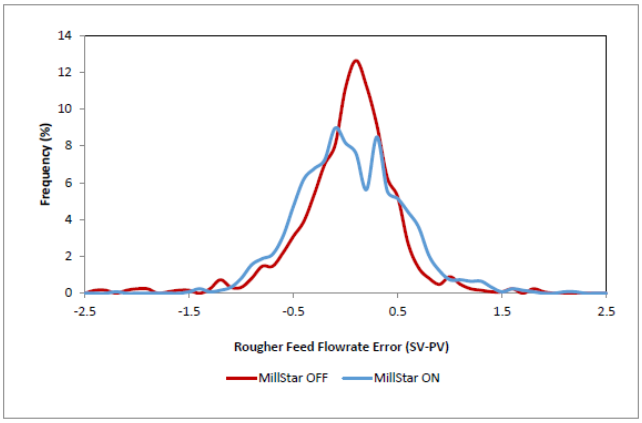

Figure 2: Performance comparison of MillStar control and plant control on the Rougher feed flowrate

Figure 3 is a concentrate flow histogram which shows the comparison of plant and FloatStar Flow Optimiser controllers on the high grade sump for a period of 6 hours each. The controller with the highest peak at the given setpoint is the one that has the most desirable performance. The desired mass-pull for this sump is 140 m^3/hr. For a deviation of 1 m^3/hr below and above the desired mass-pull, the FSFO was able to control the flowrate between 139-141 m^3/hr for 96 % of the time. Comparatively, the plant controller was able to control the flowrate in the same range for only 5 % of the time. This shows that the FSFO achieves a more consistent, less variable flowrate at the given setpoint as compared to the plant controller.

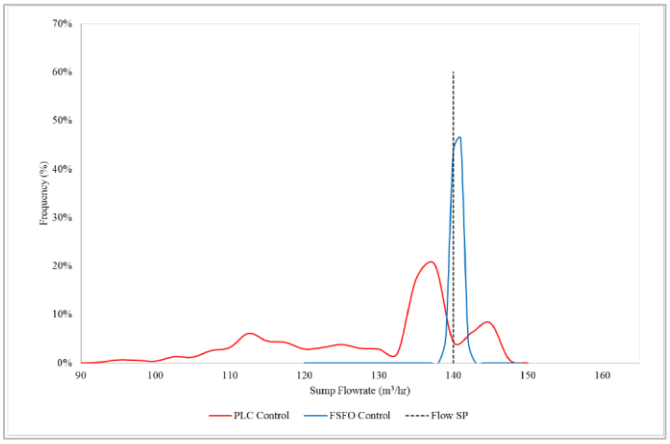

Figure 3: Performance comparison of the FloatStar Flow Optimiser and plant control for the High Grade Rougher concentrate sump

Figure 4 shows the concentrate flow histogram comparing the FloatStar Flow Optimiser and plant control on the low grade sump for the same period. The FSFO achieved a concentrate flow of around 245 m^3/hr which is below the required setpoint of 250 m^3/hr. This is due to the

limitation of the pump that was in operation during the period of analysis. It should be noted that the recirculation valve was fully closed throughout the period of analysis. Despite the limitation in the pump, the FSFO was able to obtain a consistent concentrate flowrate.

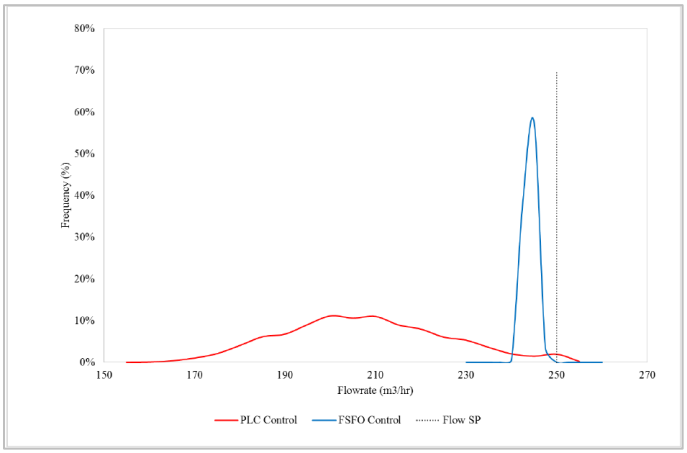

Figure 4: Performance comparison of the FloatStar Flow Optimiser and plant control for the Low Grade concentrate sump

CONCLUSIONS

The objectives of the MillStar controllers were achieved as follows:

- Maintain the level in the surge tank within the operating limits
- Maintain the Rougher feed flowrate within a specified operating region
- Control the Rougher feed flowrate to a setpoint in order to maintain the Rougher feed density at a setpoint

The results have shown that the Flow Optimiser improved the control of the concentrate flowrate on both the low and high grade Roughers sumps. Due to some limitations with the low grade sump pumps it was not always possible to achieve the required flowrate, however, despite the challenge, the flowrate was still stabilised resulting in a more consistent flow close to the setpoint for a long duration of time which was an improvement compared to the plant controller. Lastly, the Flow Optimiser ensures that there are no sump overflows or emptying of the sumps since it keeps the level within required bounds.