Practical considerations in the design of flotation process twins for setpoint decision automation at MMG Dugald River Mine

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ABSTRACT

The combination of the increasing complexity of minerals processing operations, ongoing skills shortages and growing volumes of under-utilised plant data is resulting in increased demand for automation solutions aimed at improving decision-induced process variability. Since commissioning in 2017, Dugald River Mine (DRM) has implemented several improvements to their Zn flotation circuit resulting in a high baseline recovery performance. As with all flotation plants, some process variability remains, which is partly attributed to day-to-day setpoint decision-making. In this work, the authors present a process twin based approach to flotation setpoint decision automation and outline the design considerations applied to the DRM Zn rougher-scavenger. Process twins for flotation operations model process performance in near real time as a function of both feed properties and process control variables, and subsequently prescribe the optimal combination of process setpoints. Approaches to setpoint determination may vary from static ranges per variable, through to model predictive control (MPC). Traditional MPC installations are often limited by unrepresentative ore types during step-testing and the lack of a holistic multivariate process model which captures the combined interactions between multiple process variables. The authors followed a best-practice empirical modelling framework to examine a variety of machine learning techniques to model rougher-scavenger outputs as a function of both circuit inputs and control variables. As a “sense” check, the practical framework included multiple reviews against standard metallurgical theory and understanding, to ensure robustness and improve confidence in the determined value improvement. Following preliminary training, a pair of linked deep neural networks were able to model a large proportion of concentrate and tail grade test-set variability for the rougher ($R^2{}_{con} = 0.71, R^2{}_{tail} = 0.61$) and scavenger ($R^2{}_{con} = 0.77, R^2{}_{tail} = 0.72$). The models were embedded in a twin simulation environment which enabled evaluation of alternative setpoint combinations for various feed classes. The results demonstrate potential recovery improvement via more consistent setpoint determination, and the capability of such systems to be integrated within the control layer for advanced open-loop or closed-loop control.