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AN ATTAINABLE REGION APPROACH TO OPTIMIZING PRODUCT SIZE DISTRIBUTION FOR FLOTATION PURPOSES

Abstract

In this thesis, experimental and modelling techniques were used to investigate the breakage of a typical South African platinum group minerals ore in a ball mill to optimize product size distribution (PSD) for flotation purposes.

Batch milling experiments were conducted on three narrow-sized feeds using three different ball sizes to determine the milling parameters of the platinum ore. Verification of the parameters was done by doing additional tests beyond the previous experimental range. This confirmed that the parameters were good estimates for the ore. A scale-up procedure for batch grinding data was used to obtain parameters for an industrial mill on which a performance survey had been done. The survey data was used to verify the scale-up parameters. Following this, the effects of mill rotational speed, ball filling level, slurry filling and ball sizes on milling kinetics were explored and analysed using the attainable region (AR) technique.

The outcomes of the simulations showed that a finer product is achieved when small balls are used. Lower mill hold-up and fewer grinding balls were also shown to enhance finer grinding. However, factors that produced a coarser product as shown by the particle size analysis were shown to yield the greatest amount of the desired size class when analysed using AR.

Next, the AR technique was used to analyse simulation outputs of a continuous mill over a wide range of operating conditions. The analysis was limited to plug-flow and well-mixed mill transport models without exit classification. The AR analysis showed that industrial milling conditions could be tailored to the desired product by reducing residence time, mill speed while increasing ball size.

Extension of the AR framework to a more realistic transport model also produced similar results. The importance of optimally controlling the residence time of material inside a mill as well as energy was demonstrated when maximising the desired size range. The results showed that operating the ball mill at lower speeds and higher ball filling saves energy.

Finally, combining the population balance modelling technique and the AR enabled a better understanding and effective optimisation of milling for downstream processes, particularly for flotation.