

https://dspace.org/

Binary modelling the milling of UG2 ore

Kime, Méschac-Bill Ilunga Kabamba

2015-05-05
http://hdl.handle.net/10539/17616

Downloaded from a DSpace repository. https://dspace.org/

Resume

Platinum group elements (PGE) are mineral resources that serve as strategic economic drivers for the Republic of South Africa. Most of the known to date remaining reserves of PGM's in South Africa are found in the UG2 chromite layer of the Bushveld Igneous Complex. Platinum concentrators experience significant losses of valuable PGE in their secondary milling circuits due to insufficient liberation of platinum-bearing particles. The interlocked texture between chromite and the valuable minerals predisposes the PGM ores to an inefficient froth flotation and thereby leads to drastic problems at the smelters. Entrainment of fine chromite is a major problem, so the reduction of fine chromite content in the UG2 ore prior to flotation is therefore crucial. The Council for Mineral Technology (Mintek) has been aiming at improving the secondary ball milling of the Platinum Group Ores by optimisation of the ball milling parameters from the perspective of a preferential grinding of the non-chromite component in the UG2 ore.

To this end, we looked at determining which one amongst speed, liner profile and ball size better controls the energy consumed. Moreover, this work sought at determining which combination of the above variables maximises the reduction of the chromite sliming of UG2 ores. Prior to the experimental work, preliminary evaluations of the load behaviour and power draw under different milling conditions were performed by use of the Discrete Element Modelling (DEM). The DEM was also used to assess the distributions of tumbling mill's impact energy dissipated between balls and between balls and mill shell. The ability of the Discrete Element Modelling (DEM) to match selected experimental scenarios was appraised as well.

The actual ball milling test results indicated that variables, such as mill liner profile and ball size affect the milling efficiency and the size distribution of the products whereas, the mill rotational speed had little to no effect. Use of 45° lifters and small balls enhanced the grinding efficiency. These results agreed fairly well with the DEM simulation predictions.

A model describing the chromite content within the UG2 ore sample as a function of density and particle size was also developed. The model was found to be reliable in the range of data tested and proved to be a strong function of the ore sample density. The particle size was less relevant but nevertheless important.

The UG2 ore was then assumed to be constituted of a binary mixture: chromite and non-chromite components. The kinetics study was then conducted for each individual component, from the feed sizes: -600+425, -425+300, -300+212, -212+150 µm. With regard to the Selection Function ($\mathbf{S_i}$), when comparing the characteristic a values (slope of Si with respect to particle size), faster breakage was obtained for the chromite component, followed by UG2 ore and the non chromite component. The cumulative breakage distribution function ($\mathbf{B_{i,j}}$) values obtained for these two components were different in terms of the fineness factor **γ**. The value of γ was smaller for the chromite component, indicating that the higher relative amounts of progeny fines were produced from the breakage, while the value of γ was large for the non-chromite component, indicating that less relative amounts of fines were produced.

Finally, a matrix model transformation of a binary UG2 ore was developed for a basic closed ball mill-hydrocyclone circuit. The model described satisfactorily the grinding behaviour of the chromite and non-chromite separately. This model is useful for showing effects of the milling of a binary ore on the ball mill circuit output.