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Effects of slurry concentration and powder filling on the net mill power of a laboratory ball mill

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Abstract

The tests covered a range of slurry concentrations from 30 to 55 vol.% solid and fractional interstitial bed filling (U) from 0.3 to 1.75, at a fixed ball load (30% of mill volume) and 70% of critical speed, using batch grinding of a feed of −30 mesh (0.6 mm) quartz. At a fixed slurry concentration, the net mill power versus U went through a maximum, and both the optimum value of U for maximum power and the maximum power varied with slurry concentration. A slurry concentration of about 40 to 45 vol.% solid and a U of approximately 1 gave the maximum power. An empirical equation is given that fits the data reasonably well. It was concluded that the fraction of the slurry that rotates with the balls, the inclination of the resulting rotating charge, and the expansion of the rotating charge are all factors that affect the power; the data were too limited to obtain precise descriptions of these effects. At a constant powder load ($U=1$), the specific rates of breakage of the quartz were linearly proportional to the net mill power for the different slurry concentrations. However, this was not true if the mill power was changed by using water–glycerine carrier liquids to vary the viscosity, at a fixed solid concentration (45%). Thus, mill power alone does not define the breakage action.

Keywords: Mill power; Ball milling; Wet grinding; Slurry density; Powder filling