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Determination of Mineral Behaivior in Ball Mills at Chilean Copper Minning Using Radioactive Tracers

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Minera Los Pelambres (MLP) is located in the IV Region of Chile, with a mine located at 3100 masl and a concentrator located at 1600 masl. MLP started its operation in the year 2000 and by 2015 it was one of the 10 largest producers of copper concentrate in the world, achieving 405.300 tons of copper and 9.000 tons of molybdenum concentrates in 2013. MLP has established within its goals to improve the process efficiency and to increase the concentrate production. For these reasons, all the process stages are being evaluated, including the comminution circuits (crushing and grinding), which are the more intensive in terms of energy consumption.

The MLP grinding circuit consists of three parallel SAG mill lines, each one formed by a semi-autogenous mill (SAG) and two parallel ball mills. The first two SAG mill lines have ball mills of 10.500 HP, and the third has one ball mills of 10.500 HP and another of 20.700 HP. The ball mills operate in a closed-circuit (direct circuit) with a hydro cyclone battery, which allows the adequate particle for the flotation process to be obtained. In this paper the fluid dynamic characterization of ball mills by means of the residence time distribution (RTD) is presented. The RTD were obtained at industrial scale by using direct measurements of radioactive tracers in the input and output streams of the ball mills.

Dried mineral samples from the hydro cyclone underflow were used as a solid tracer. This material was irradiated by neutron activation in La Reina Nuclear Center, Chilean Nuclear Energy Commission. The RTD determination was obtained by measuring the solid tracer in the input and output streams of the ball mills, employing scintillation detectors for real-time measurements. The tracer activities were of 15 mCi of Na-24 in each injection, which contained between 15 and 30 grams of solid. A pneumatic system was designed for the tracer injections. This system allows the tracer injection to be carried out remotely.

The measurements demonstrated that a significant percentage of tracer recirculation to the input stream exists. Therefore, the use of parametric deconvolution methods for the RTD determination were required. The model of N perfectly mixed reactor in series was employed for the RTD descriptions, where the N parameter ranged from 2.1 to 3.9 with effective mean residence times between 1.9 and 9.5 minutes. The RTD estimation by the use of radioactive tracers is a powerful tool to characterize the mixing regime in large industrial machines from the mining processes and other productive industries.

Country/Organization invited to participate

Chile

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