The VeRo Liberator® technique - high-velocity impact breakage for improved energy consumption in dry comminution

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ABSTRACT

Traditional ball mills feature advantages as robustness and large unit size but are increasingly challenged by their highly inefficient, slow surface breakage, the dependency on process water, and especially the high and wasteful energy consumption. The inefficiency stems from single impact breakage being rare and most particle collisions resulting in abrasion only (Morrison et al. 2007). As a new alternative, the VeRo Liberator® solves these problems by highly efficient momentum transfer of kinetic impact energy into the material particle leading to highly efficient breakage and disintegration. The new VeRo comminution technique offers innovative dry comminution by mechanical high-velocity impact crushing. The machine operates in the high-speed comminution range and this technique moves the breakage away from inefficient low-velocity surface breakage to fundamentally more efficient impact breakage. The VeRo Liberator® achieves this fundamental change by featuring a unique, vertical, quadruple hollow axle system. The axles carry a large number of special steel tools of up to one meter length, on three tool levels with the fourth level controlling the air flow within the cylindrical comminution chamber. Extremely high impact speeds are achieved by the counter-rotation of the tool levels, which each can revolve with up to 1.600 rpm in a clockwise and anti-clockwise fashion against each other. Feed material < 120 mm diameter passes continuously and gravitationally from a feeding funnel at the top, through the comminution cylinder, typically within up to 25 seconds. Each particle of the feed material is hit by multiple impacts at a high frequency and at very high velocities, during this quick pass through the machine, a technique described in detail by Borg et al. 2018.

This innovative comminution process results in high particle size reduction ratios, e.g. 1,000 for massive base metal sulphide ores from Rio Tinto, Spain. The energy consumption is been between 35 % and over 50 % lower compared to conventional comminution systems, both during in-house testing and tests carried out by clients. The high-velocity impact crushing results also in strongly improved particle liberation from the preferential breakage along particle boundaries. Dry operation without process water, very low operational noise levels, scalability, modularity, and comparatively low wear on tools and liners are additional advantages of the VeRo Liberator® technique.

The operation principle of the VeRo Liberator® is based on the efficient momentum transfer of the kinetic impact energy into the impacted particles. The shock wave triggers a specific stimulation of the various mineral components according to their elasticity and compressibility moduli. The differential stimulation results in stress building up preferentially along particle boundaries, which leads to breakage nucleation on and fracture propagation along particle boundaries. The VeRo Liberator® achieves this style of breakage, in which the larger portion of the material is disintegrated from the efficient transfer of kinetic energy into the material, without physical contact with the tools and liners (Fig.1). Because of this 'contactless disintegration', the size reduction and particle liberation are achieved at significantly lower energy consumption and with relatively low wear.

So far, Anglo American has purchased three machines for full industrial-scale pilot testing at their operation sites. Anglo American supports the VeRo Liberator® technique and is cooperating closely with PMS GmbH to develop the technique to further technical levels. Advanced comminution testing with other industry clients is at an advanced stage and still ongoing.

References

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