

Advances in Stirred Milling

Improving Profitability of Copper Ore Processing

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The vertical stirred media mill is a proven technology that offers considerable savings in media and energy operating costs that will lower the cost of producing copper significantly. Also, the environmental impact of a copper concentrator is significantly decreased.

Vertical stirred media mills are recognized as energy-efficient grinding machines, but reduced media consumption, lower installation costs, minimal maintenance, and minimal liner wear make the Metso Vertimill solution the lowest total cost of ownership in many applications, substantially improving the profitability of copper concentrators.

The systems has become wide spread in regrind applications, but they have been slow to be adopted in coarser applications. The mill has been proven to grind more efficiently than ball mills even with feeds as coarse as 6 mm.

Much of the hesitation to advance these mills in primary and secondary grinding is the requirement for large quantities of systems to perform the same task as a single ball. While there are still cost advantages with multiple mills of that type compared to a single ball mill, the newly developed 2240 kW) Vertimill lowers the total cost of ownership even further.

System Comparison

By replacing ball mills in power-intensive grinding applications such as grinding SAG mill and HPGR products, the savings that have been experienced in regrind applications can be multiplied further. Typically, the total cost of ownership of vertical stirred mill compared with traditional ball mills significantly lower – or the Vertimill Metso claims a reduction of 35 per cent.

Potentially every Megawatt of ball mill power saved in a primary or secondary application means net present value cost savings of USD 10 million and 80000 tonnes of carbon saved over a ten-year mine life. With increasing energy costs and environmental consciousness, it is an economic inevitability that Vertimills will become the standard in secondary grinding, further lowering the processing costs of copper concentrators.

The vertical stirred mills are primarily selected because of the operational cost savings they have over other grinding mills. The total cost of ownership is almost

Fig. 1: Vertical stirred mills offer energy efficient grinding.



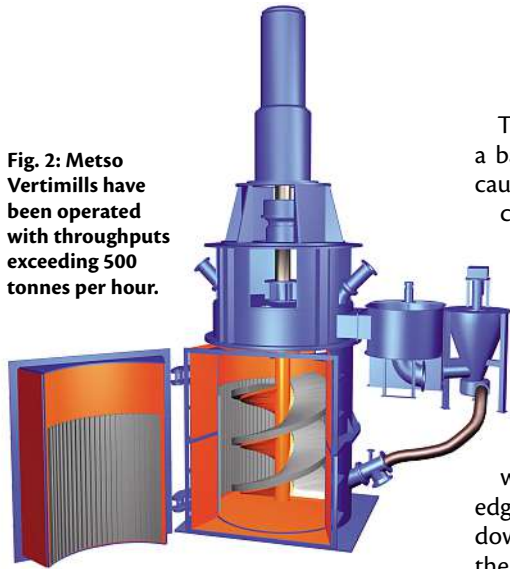


Fig. 2: Metso Vertimills have been operated with throughputs exceeding 500 tonnes per hour.

The most efficient grinding zone inside a ball mill is known as the “kidney”, because of its shape, and it is efficient because the grinding media and particles are constantly in contact with one another and grind by attrition.

Fig. 2 shows the flow of the grinding media inside a Vertimill. The screw rotates slowly enough that the media is not fluidized but settles by gravity. The screw pulls the media up the centre of the mill, which eventually cascades over the edge of the screw creating a general downward flow at the mill perimeter. As the figure illustrates, the velocities of the particles are quite low because the media stay in contact with one another, while in a ball mill media can be in free fall through open space. The entire grinding action inside the mill closely mimics the attrition grinding in the “kidney” of a ball mill.

always significantly less than a traditional horizontal ball mill solution. The advantages of vertical stirred mills include:

- reduced energy consumption,
- reduced media consumption,
- reduced maintenance due to machine simplicity,
- lower installation costs,
- high availability, and
- long wear life.

Energy Consumption

The most significant of these advantages in terms of total cost of ownership are energy consumption and grinding media consumption (which is directly related to energy consumption).

The improved grinding energy efficiency is due largely to the effect of the vertical arrangement. A horizontal ball mill relies on the tumbling action of the slurry and media for both impact breakage and attrition grinding. However, impact energy is generally not as efficient as attrition grinding since much of the impact energy is wasted if the grinding balls impact the liners or other steel balls.

Reduced Over Grinding

The vertical arrangement also contributes to minor internal classification of particles, which reduces over grinding and thus increases efficiency. As the feed material enters the top of the grinding chamber, the downward travel of the material into the grinding media is influenced by the uprising velocity created by the recycle flow. This uprising velocity removes or “washes” out fine product size material before entering the grinding media and exits the mill to the external classification step where it is removed from the system with very little energy applied.

The second reason for the improved grinding efficiency is that this type of mill effectively uses finer media. Since a ball mill relies partially on impact breakage, a certain size grinding ball is required to generate enough kinetic energy while

tumbling. In a vertical stirred media mill the larger ball size is not required because impact isn’t the grinding mechanism. Therefore, the mill can be charged with a smaller media top size creating an overall smaller size distribution.

Media Considerations

Media consumption is directly related to energy efficiency. At a concentrator in Mexico, Vertimills were set up in place of existing ball mills. In addition to a 35 per cent decrease in grinding energy, they experienced reduced media consumption from a previous average of 821 to 429 g/t, or a 48 per cent reduction.

There are two reasons for the savings in media consumption: first, less energy is consumed with grinding, so it follows that less grinding media will be consumed. Second, since the wasteful impact breakage of ball-to-ball or ball-to-liner is eliminated, there are fewer ball fractures and the media inside the Vertimill can maintain its shape and usefulness. If the consumptions above are normalized into Kilowatt-hours per Kilogram, they become 0.065 kg/kWh for the ball mill and 0.05 kg/kWh for the Vertimill.

The difference in these two figures is due to the reduction of impact energy and ball fracture, and when actual consumption per ton is calculated, the 35 per cent savings in energy is realized.

Conclusions

The Vertimill is proven technology that offers considerable savings in media and energy operating costs that will lower the cost of producing copper significantly. Also, the environmental impact of a copper concentrator is significantly decreased. In the future, it is extremely likely that more sites will adopt this technology for more of their grinding needs to improve their profitability. ■

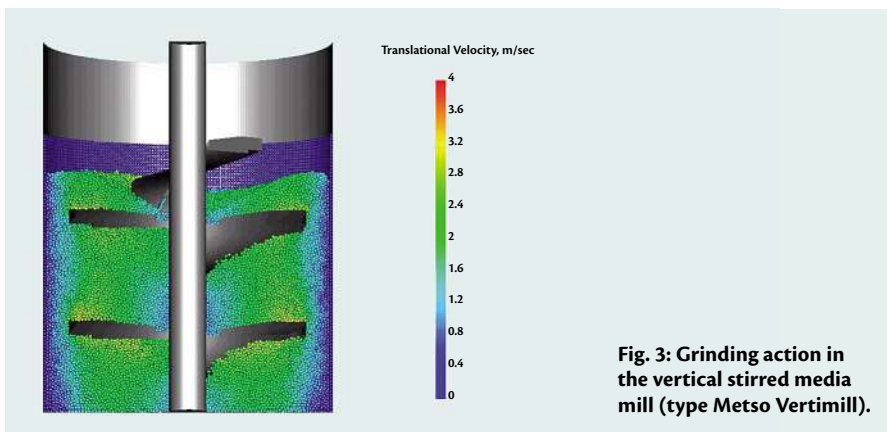


Fig. 3: Grinding action in the vertical stirred media mill (type Metso Vertimill).

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