A crusher that offers grinding performance

Christian Ottergren of Sandvik Mining explains why the new Vibrocone crusher could be a game changer for mines looking to reduce their energy consumption and operating costs.

Would it not be a fantastic idea to combine the best comminution technologies into one ‘size-reducing super machine’?

This is what Sandvik has accomplished with its latest product release, the Vibrocone. The crusher, which was launched at MINExpo 2012 in September, incorporates a combination of existing proven mechanical solutions with the best rock-breaking principles.

The Vibrocone has a similar design to that of a cone crusher with a mantle acting against a concave/bowl liner. However, it has an unbalanced-weight drive mechanism similar to the type used to generate vibrations in screens and feeders and the machine is supervised by an advanced process-control system.

The robustness of the design has been confirmed by more than 11,000 hours of 24/7 commercial operation in copper, gold and iron-ore mine sites (as of November 2012).

COMBINED PRINCIPLES

Vibrocone combines the benefits from several rock-breaking principles: material is crushed using multiple compressions, and the machine accepts feed with a large top size like a traditional cone crusher. Feed is also crushed in a thick bed of material and exposed to a controlled optimum force that can be adjusted, as in high-pressure grinding rolls (HPGRs). To a high degree, the material is also crushed against other material, as in an autogenous (AG) or semi-autogenous grinding (SAG) mills.

The movement of the mantle in a set pattern in conventional cone crushers usually results in either a less than 100% optimised crushing force or machine overload. Vibrocone allows the mantle to swing with more compression in an unrestrained manner inside the crushing chamber.

As a result of this operating principle, the minimum size of the output is no longer determined by a fixed closed side setting. The product size is rather determined by the high pressure in rapidly repeated compressions, resulting in an considerably improved reduction ratio. Another effect is that the machine can easily start and stop with material inside the crushing chamber.

The Vibrocone design also makes it possible to automatically detect and react more safely to objects that cannot be crushed, such as tramp metal. As unwanted objects can restrict the movement of the mantle, the power draw will drop in real-time and Vibrocone’s control system will react. Crushing will continue until the object has passed through.

However, if by chance the object gets stuck inside the crushing chamber due to its size, the feed will be stopped and operation will be gently continued at a reduced speed and force to empty the crushing chamber of material, so that the object can be safely removed. This feature gives increased uptime and improved safety compared with the way in which tramp metal is handled in a traditional cone crusher.

PERFORMANCE

In terms of performance, Vibrocone can generate a much higher proportion of fines than a conventional cone crusher. The particles are not just crushed against the liner surfaces in the crushing chamber; they are also crushed against each other. The effectiveness of comminution depends on how much energy can be transferred into the ore. A conventional cone crusher will at most reach 0.8-1.0kWh per tonne, while Vibrocone (depending on the specific application) usually doubles this figure and has, in some cases, even reached 3kWh per tonne. This means that the Vibrocone’s crushing performance is moving into the grinding performance area.

Since crushers are typically much more energy-efficient than conventional grinding mills, there is an opportunity to reduce the energy needed for comminution. Depending on the actual flow-sheet, the energy savings on grinding alone can be more than 25%.

The product from the Vibrocone is so fine that new solutions for comminution are possible. For example:

- with a conventional comminution circuit with a rod milling stage, the rod mills(s) can be replaced by Vibrocone(s).
- The Vibrocone product size is suited for ball milling;
- in an existing plant with ball mills, the Vibrocone can be installed as a pre-grinding stage before ball milling. The performance of the ball mills will be considerably improved; throughput can be increased, and energy consumption and total cost per tonne can be decreased;
- at greenfield projects, a Vibrocone solution can challenge SAG mill or HPGR alternatives as the lowest-cost option and could show a considerable energy saving relative to the SAG option;
- within an AG or SAG comminution circuit with a rod milling stage, the rod mills(s) can be replaced by Vibrocone(s).

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circuit. Vibrocone can be used in place of a pebble crushe to efficiently grind hard pebbles and improve circuit capacity.

**PROVEN**

A comprehensive study was commissioned to compare the performance of Vibrocone with a conventional 7ft (2.1m) crusher for comminuting a porphyry copper ore in a full-scale plant.

The study was completed at the University of British Columbia (UBC), in Vancouver, Canada, and analysed: product size distribution; Bond's ball-milling work index measurements; BET surface-area measurements; and possible production of micro-cracks in grain sizes.

The study revealed that considerably smaller product can be obtained using Vibrocone. Furthermore, the surface area per mass unit produced for different size fractions is dramatically higher (up to five times) for the Vibrocone product.

Micro-cracks were observed in microscopic investigations, similar to the results reported for HPGRs. A reduction in Bond's ball-milling work index was also observed, suggesting that less energy is required to grind the Vibrocone product in downstream milling stages.

A recent installation of Vibrocone at a full-scale gold mine operation, where rod and ball milling are followed by a flotation circuit, has shown an increase in the plant's milling capacity by 10% due to the finer product created by the Vibrocone.

The management of the plant in question is considering converting the existing rod mill to a ball mill with possible further improvements in the circuit. Implementation of Vibrocone offers savings in energy consumption in milling, and also lower media and lining consumption cost per tonne of product. Having finer feed for milling reduces the circulating load in the mill, which in turn offers extra milling capacity.

In addition, calculated reductions in operational costs show that a Vibrocone investment payback period is measured in months rather than years.

The possibility of increasing production and cutting energy consumption in an existing comminution plant with marginal investment could help mining operations' profits in the current economic climate.

Replacing an existing conventional cone crusher with a Vibrocone will result in a more favourable mill feed, which can boost existing mills and concentrators. Lower operational costs, energy reductions and higher recovery are some other likely outcomes.