

Application of High Pressure Grinding Rolls in the Mining Industry

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The application of High Pressure Grinding Rolls (HPGR) in the mining industry, especially as a replacement for the conventional Semiautogenous (SAG) milling process, is receiving a great deal of interest with several of our mining clients considering the use of this process to reduce energy consumption and costs.

The HPGR technology has been in existence for many years. It was originally developed and applied in the cement industry and was introduced into the mining industry in the early 1980s for the crushing of kimberlite ore in diamond mines. The application and advantages of using these grinding rolls to extract diamonds is now well established. HPGR technology was also successfully introduced and applied in the iron ore and limestone industries and is now making in-roads into hard rock mining applications.

The Process

High Pressure Grinding Rolls consists of a pair of counter rotating rolls, one fixed and the other floating. The feed is introduced to the gap in between the rolls and is crushed by the mechanism of inter-particle breakage. The grinding force applied to the crushing zone is controlled by a hydro-pneumatic spring on the floating roll. Speeds of the rolls are also adjustable to obtain optimum grinding conditions.

Major Advances

Over the past few years, major advances have been made in wear protection technologies that have been applied to the roll surfaces and have reduced wear significantly and making it more attractive for hard rock mining applications. There are some restrictions or drawbacks when considering the HPGR process, as capital costs can sometimes be higher depending on the application, dust control is an issue, and the technology is not suitable for wet and sticky ores.

The main HPGR manufacturers are Polysius, KHD, and Koppern, all originating from Germany. Polysius favours a high aspect ratio design – large diameter, small width, and provides for a larger operating gap and reduced wear, while both KHD and Koppern prefer a low aspect ratio. Each of these companies has spent considerable time and resources to improve the technology to reduce wear and develop superior rolls which include the use of studs, segments, edge protection inserts, and advanced materials of construction.

Mining companies are now beginning to incorporate HPGR technology. Phelps Dodge is an example of a mining company that has taken the lead in introducing the HPGR to one of its large copper projects at Cerro Verde in Peru. The circuit at Cerro Verde incorporates four HPGR units (2.4 m diameter x 1.6 m wide, 5000kW) processing 2500 tph instead of the traditional SAG mill circuit. The Boddington and Bendigo gold projects in Australia have also included HPGR technology in their feasibility studies which are nearing completion. Freeport is another mining company that is considering using two HPGR units (2.0 m diameter X 1.8 m wide, 3600kW) to process 1450 tph of ore for one of its projects. Numerous other clients are considering the use of HPGR technology for their projects.

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The Benefits

Applying the HPGR process as a replacement for the conventional SAG milling circuit results in significant savings in energy costs, reduced grinding media consumption and operating costs, smaller footprint, faster equipment delivery schedules, and finer product.

It is estimated that energy savings of up to 20 percent can be reached and from 10 to 20 percent savings in operating costs is possible depending on the ore type and application. The savings in energy costs is also becoming better understood with more savings possible when additional HPGR stages are incorporated in grinding circuits. A further potential benefit of inter-particle crushing is improved recoveries from downstream processing as a result of micro cracking occurring within the particles. While the benefits of the HPGR in terms of lower energy costs and superior inter-particle crushing were well known, it has taken longer to embrace this technology especially for hard rock mining applications.

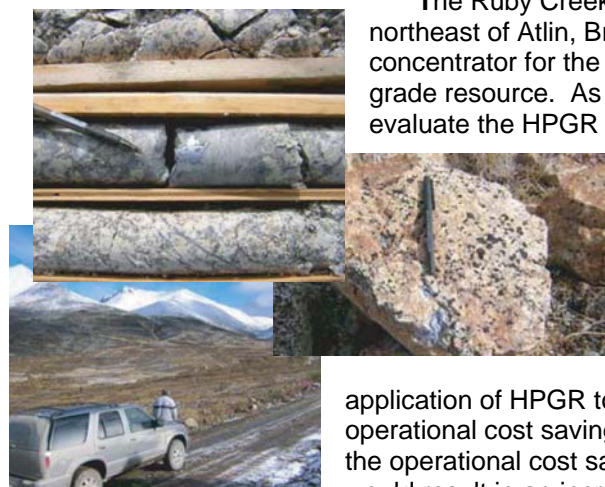
HPGR Trade-Off Studies

Wardrop recently completed three trade-off studies comparing the use of HPGR as a replacement for conventional SAG milling circuits. HPGR technology is now well known and the benefits and applications of using this technology will continue to become the focus of the mining industry as it strives to find the most efficient and cost effective technologies to process ore.

Seabridge Gold Inc - Courageous Lake Project

Wardrop has recently completed a HPGR trade-off study for Seabridge Gold Inc. The trade-off study was carried out to evaluate the application of HPGR as an alternative technology to the conventional SAG milling process for the Courageous Lake project. The Courageous Lake Gold Project is located approximately 240 kilometers northeast of Yellowknife, Northwest Territories.

Adanac Moly Corporation - Ruby Creek Project



The Ruby Creek Molybdenum Project located approximately 24 km northeast of Atlin, British Columbia, is a proposed open pit mine and concentrator for the production of high quality molybdenite from a low-grade resource. As part of the feasibility study, a trade-off study to evaluate the HPGR as an alternative technology to the conventional SAG milling process for the Ruby Creek project was completed.

The plant was designed with a conventional SAG milling process to operate at a capacity of 20,000 tonnes per day with an availability of 91 percent and an overall plant recovery of 90 percent. Results of the trade-off study indicated that the

application of HPGR to the Ruby Creek project would result in significant operational cost savings amounting to more than 25 percent. In addition to the operational cost savings, the introduction of a second on-line HPGR would result in an increase in the availability of the plant from the conventional SAG mill process availability of 91 to 96 percent. With HPGR in place, the power requirements of the grinding circuit would be reduced by more than 4kWh/tonne. The impact of this is a significant reduction in power requirements for the project.

This trade off study indicated significant benefits for the project through more energy efficient crushing/grinding. It is now included in the updated bankable feasibility.

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Eureka Mining - Miheevskoye Project

A trade-off study was completed comparing the capital and operating costs of using HPGR technology to the SAG milling option in the comminution circuit for the Miheevskoye project. This project is located in the Urals region of Russia, close to the border of Kazakhstan. It covers the Miheevskoye copper porphyry deposit, which is part of the Chelyabinsk project. The plant is capable of processing 21 million tonnes of ore per annum.

A significant savings in capital costs, particularly in the operating costs, was indicated from the trade-off study in favour of using the HPGR option.

Pacific Booker Minerals Inc. - Morrison Project

The Morrison porphyry copper/gold project located 35 km north of the village of Granisle in Central British Columbia, is a proposed open pit mine and mineral processing plant, for the production of copper, gold and molybdenum concentrates. A trade-off study was completed to evaluate the efficacy of using High Pressure Grinding Rolls (HPGR) as an alternative technology to the conventional Semi-Autogenous Grinding (SAG) milling process, for this project.

The processing plant was designed to operate at 30,000 t/d capacity with an availability of 92%. Results of the trade-off study indicated that the application of HPGR to the Pacific Booker Morrison Project would result in significant operational cost savings (amounting to CDN 0.67/t/yr) compared to the SAG option, through a gross installed power reduction of 3.67 MW, as also a reduction in consumables, estimated to be CDN 0.59/t.

International Molybdenum Plc - Malmbjerg Project

The Malmbjerg porphyry molybdenum project is located in extremely rugged and mountainous terrain in the central portion of the east coast of Greenland. The processing plant is designed to operate at 30,000 t/d capacity with an availability of 92%. A trade-off study was done to evaluate the use of HPGR as an alternative technology to the conventional SAG milling process.

Results of this study indicated that the application of HPGR to the Malmbjerg project would yield significant operational cost savings in the comminution circuit, amounting to more than 24%, due to gross power consumption reduction of 4.5 MW (in the combined crushing-grinding circuits), which translates into an operating cost saving of USD 1.14/t.

Imperial Metals Corp. - Mount Polley Project

Mount Polley Mine is an open pit copper-gold mine located approximately 56 km north east of Williams Lake in Central British Columbia. The grinding circuit consists of two rod and ball mills followed by pebble mills, with a capacity of 20,000 t/d and reported availability of 92%.

Imperial Metals Corporation (IMC) intends to expand the mill capacity to 30,000 t/d and commissioned Wardrop Engineering (Wardrop) to develop a scoping study using HPGR in the comminution circuit. Based on this study and the suitability of IMC ore to high pressure comminution, it has been shown that the introduction of the HPGR into the process flow sheet and converting the existing rod mills to ball mills, will allow the plant capacity to increase by 50%. The availability of the HPGR is 95%.