

Circulating-Oil Flow Monitoring in a Harsh Mining Industry Environment

In today's mining operations, conveyor technology has a major role to play – not only transforming what were once enormously demanding manual processes, but also offering significant benefits over other methods of handling and transportation.

Key to the uptime of a long-haul conveyor system is maintaining its mechanical components. For example, conveyor gearboxes are lubricated by oil. If the amount of oil is too little, the lifetime of the gears is shorter due to insufficient heat dissipation and lubrication, but if the amount of oil is too much, it creates significant load. To find an appropriate oil level inside a gearbox, understanding of the flow is needed.

The following case study describes the use of precision flow measurement technology by a leading iron ore producer in Western Australia. This application required turbine flow meters for monitoring circulating-oil system flow under harsh conditions at a remote mining facility.

Background

Headquartered in Melbourne, Australia, BHP Billiton is one of the world's largest diversified resources companies. The firm traces its roots to two small mining endeavors, Broken Hill Proprietary (BHP) and Billiton, founded in the mid-1800s. Billiton became a major producer of aluminum and alumina, chrome and manganese ores and alloys, steaming coal, nickel, and titanium minerals. BHP was engaged in the production of iron ore, copper, oil and gas, diamonds, silver, lead, zinc, and other natural resources.

BHP Billiton's principal iron ore operations are based in the Pilbara region of northern Western Australia. The production facilities comprise an integrated system of seven inland mines, more than 1,000 kilometers of rail line, stockyards and two separate port facilities (See Fig. 1).



Figure 1. BHP Billiton's principal iron ore operations are based in the Pilbara region of northern Western Australia.

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Challenge

- Monitor fluid in a circulating-oil system for long-haul conveyor gearboxes in harsh environment with changing conditions
- Extreme temperatures of 140...176°F (60...80°C) dust and debris, and wide fluid flow ranges of 0...26 gpm (0...100 lpm)
- Reliability, minimal maintenance and easy installation

Solution

Blancett Turbine Flow Meters

- High accuracy $\pm 1\%$ of reading
- 316 stainless steel housing, CD4MCU stainless steel rotor, abrasion-resistant tungsten carbide rotor shaft, and journal bearings
- Easy to install, no special fittings required
- Interchangeable monitor head separate from the turbine body



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BHP Billiton's Mt. Whaleback iron ore mine in Newman, Western Australia, is located 12 hours north of Perth. The complex is the largest single-pit open-cut iron ore mine in the world, spanning 1.5 kilometers in width and more than 5 kilometers in length. The mine will eventually reach a depth of 0.5 kilometers.

Gearbox Application

In iron ore mining, like other mining and minerals operations, there are two ways to move material from the pit to the processing plant: trucks or long-haul conveyors. As mines are constructed in more remote locations, there is a trend to move away from trucks and rely solely on conveying systems to move ore.

Mechanical breakdowns of conveyors can cause significant disruptions to a mine's normal production. Replacing one of the many conveyor drive train components may require an extended outage, costing millions of dollars in lost revenue (See Fig. 2).



Figure 2. A long-haul conveyor moves materials from the pit to the processing plant.

The gearbox is a critical component of the conveyor drive and one of the most expensive to replace. Proper lubrication is essential to maintaining long-term performance. The oil has two main purposes: preventing the equipment from wearing prematurely and keeping it cool.

In addition to lubricating, circulating-oil systems perform a range of other functions, including maintaining the lubrication points at a proper temperature, filtering out wear particles from friction points, and preventing corrosion.

Mining facilities rely on flow measurement instrumentation to monitor circulating-oil systems for their long-haul conveyor gearboxes. This application demands a flow meter able to withstand extreme temperatures, dust and debris, and wide fluid flow ranges.

Choosing the Right Solution

For BHP Billiton, finding a robust and cost-effective solution for oil flow monitoring was essential to the success of the preventive maintenance program for its iron ore conveyors. The previous flow measurement devices used with the system were unreliable and difficult to maintain. They had no IP rating and required specialized adapters for installation. Worse yet, adjusting the meter settings to suit changing oil conditions was difficult for site personnel.

Engineers at the Mt. Whaleback mine decided to replace their flow meters with instruments providing superior performance even in the harsh mining environment. This included flow rates at 0...100 liters per minute and oil operating temperatures of 60...80° C. Reliability was key in this case due to the mine's remote location.

BHP Billiton consulted with GTS Gauges, Transmitters, Switches Pty. Ltd. (Midvale, Western Australia) for assistance in selecting an appropriate flow meter for their application. GTS Gauges is one of Western Australia's largest instrumentation distributor organizations, supplying products for pressure, temperature, level, flow, force, and speed applications.

After considering alternative flow measurement technologies, BHP Billiton chose Blancett turbine flow meters from Badger Meter. The company initially purchased two of the units for testing and evaluation. It subsequently bought another 24 meters for use throughout the mine's conveyor system (See Fig. 3)



Figure 3. Blancett model 1100 turbine flow meter provides an accuracy of $\pm 1\%$ of reading and operating temperatures of $-150^{\circ}\text{F} \dots 350^{\circ}\text{F}$ ($-101^{\circ}\text{C} \dots 177^{\circ}\text{C}$).

The turbine flow meters employ a proven, high-accuracy flow measurement principle. Fluid entering the meter first passes through an inlet flow straightener that reduces its turbulent flow pattern. The fluid then passes through the turbine, causing the blades to rotate at a speed proportional to fluid velocity. As each blade passes through the magnetic field generated by the meter's

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magnetic pick-up, an AC voltage pulse is generated. These pulses provide an output frequency proportional to the volumetric flow rate.

The Blancett meters were particularly well-suited to this application due to their rugged construction. They utilize a 316 stainless steel housing and rotor support, CD4MCU stainless steel rotor, and abrasion-resistant tungsten carbide rotor shaft and journal bearings. These materials help the meters to maintain accuracy and mechanical integrity when measuring corrosive and abrasive fluids.

Best of all, the Blancett turbine meters were easy to install, requiring only minimal modifications for mounting in piping for the gearbox oil coolers (See Fig. 4).



Figure 4. Blancett turbine meters endure harsh conditions in an iron ore mine.

Project Results

BHP Billiton worked closely with GTS Gauges to specify the right flow measurement solution for the oil cooler application. A successful project outcome was achieved by meeting the following criteria:

1. The Blancett turbine meters deliver precise flow measurements to prevent gearbox failure due to a lack of oil. This is essential for ensuring continuous production operations.
2. The monitor head can be changed out without having to remove the turbine meter. As such, time-consuming and potentially costly shutdowns of conveyors can be avoided.
3. The meters have provided extended service without any significant problems, enabling a low total cost of ownership.

Despite being subjected to severe dust and heat, the Blancett turbine flow meters remain accurate and dependable. “We love the sealing of the units. When we open them up, the interior still looks brand new,” commented Jason Watson, BHP Billiton analysis and improvement engineer, fixed plant maintenance.

Conclusion

The success of this application can be attributed to the broad product offering of Badger Meter, coupled with the consultative capabilities and mining industry experience provided by GTS Gauges.

Badger Meter leverages more than a century of flow measurement expertise and advanced, yet proven technology to optimize the most demanding applications. It offers an extensive portfolio of products, services and solutions to measure and control water, air, steam, oil, and other liquids and gases.

GTS Gauges maintains a staff of dedicated application and sales engineers, inside support personnel and factory-trained service technicians to assist customers with their requirements.

BHP Billiton’s gearbox oil coolers now perform as expected and the Badger Meter solution is exceeding the customer’s expectations in a challenging application environment.

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