Keith Day, Magnom

Keeping the Oil Clean

To Reduce Gearbox Downtime

THE DEVELOPERS OF THE MAGNOM™ MAGNETIC FILTRATION TECHNOLOGY EXPLAIN HOW THEIR FILTERS ARE HELPING GEARBOX USERS SAVE MONEY.

This composite image shows how the Magnom filter captures debris without blocking the flow channels.

Richard Ridgeway faced a serious situation at the Rugeley Power Station in Staffordshire, England. The station, which runs on coal, depends very heavily on 14 gearbox-driven coal pulverizing mills.

But the gearboxes that power the mills were failing at the rate of four to six times per year, says Ridgeway, technical support engineer for planning at Rugeley.

The gearboxes had been failing because of contaminants in the lubrication system, which used a filtration system consisting of 2 x 200-micron strainers along with bar magnets. But the system was not capable of removing fine ferrous contamination.

The pulverizing mills use a high-viscosity synthetic oil (BREOX oil—LB460SW) in a recirculating lubrication system. Because of the oil's high viscosity, low-level micron filtration could not be used to remove the contaminants.

One of the options the power station explored was the Magnom™ filtration system. The Magnom is designed to capture submicron-level particles without causing a pressure drop.

Rugeley installed Magnom technology on a recently refurbished gearbox (see Fig. 1), which had been flushed by the rebuilder. All involved expected only very limited contamination, but when Ridgeway removed the core after eight weeks, he was surprised by the amount of debris the Magnom removed from the new fluid (see Fig. 2).

"I was very impressed to see how much debris the Magnom had captured in only a two-month window," Ridgeway says.

The Magnom engineers were less surprised, as this result was very consistent with similar power plant applications in the past.

Rugeley Power Station immediately ordered Magnom process units for every coal pulverizing transmission.

Compared with the costs of gearbox failure—roughly $100,000 each to refurbish—not to mention the cost of downtime, the costs of the Magnom system are small. In fact, in cases like the Rugeley power station, the payback period can be as little as one to two months.

How it Works

Magnom technology was designed for the Formula 1 and NASCAR racing

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Figure 1—Magnom installation at Rugeley Power Station.

Figure 2—The Magnom caputres substantial debris, even after only two months.

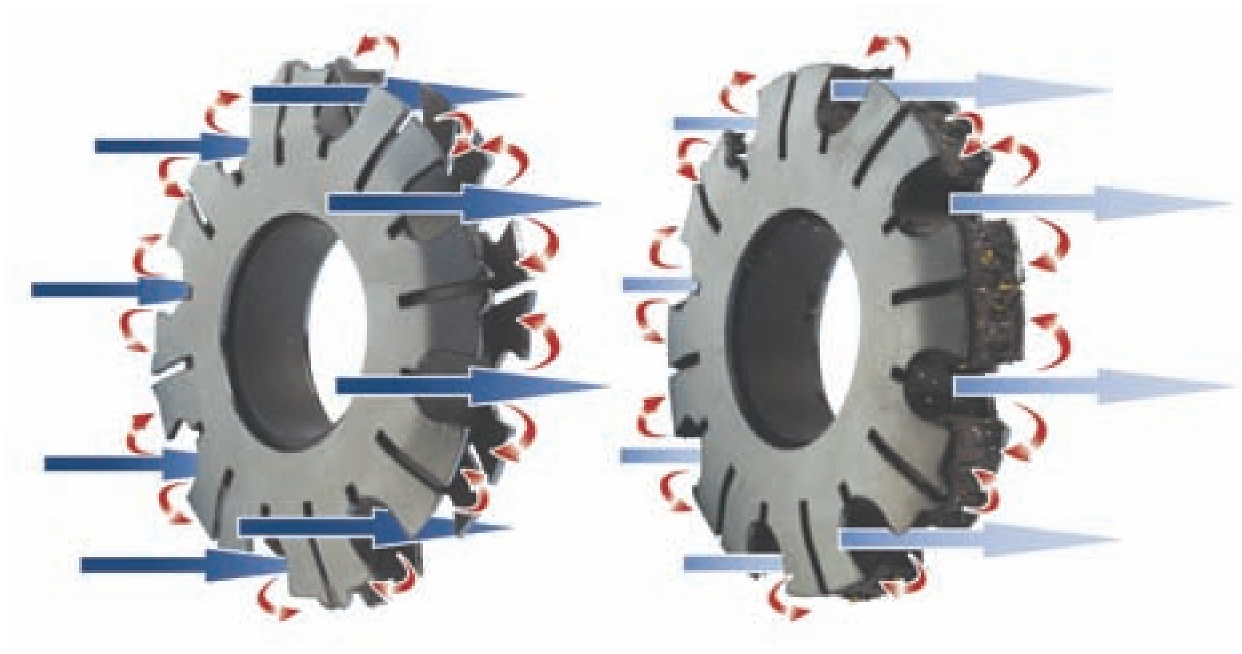

Figure 3—The Magnom focuses magnetic fields between the plates, capturing debris where it doesn't interfere with fluid flow and won't wash off the magnet and back into the lubrication system.

environments as a means to protect engines and transmissions.

Company engineers were charged with investigating why previously healthy engines and transmissions would suffer bearing failure almost without warning. Detailed analysis on piston thrust faces, bearing journals and shells from failed engines revealed high carbon steel fragments buried in inclusions in the softer sacrificial metal surfaces of the bearings, typically emanating from the oil feed holes. The fragments produced tracks of circumferential wear in the steel journals. Further analysis showed that 5- to 20-micron carbon steel or iron contamination was causing most of the wear and damage to these critical bearings and components.

The engineers realized that improved oil filtering would remove the damaging wear debris before it had the opportunity to cause a chain reaction of wear and eventually catastrophic failure.

They believed that a finer porosity filter, for example between 5 and 20 micron nominal, might restrict the flow to such a degree that oil starvation would be more problematic than the contamination itself. Size and cost constraints prevented the fitting of a fine filter of a size that would not incur too much of a pressure drop.

With this knowledge, Magnom considered magnetic sump plugs, but investigation and basic lateral thinking demonstrated some fundamental flaws with them.

Namely, magnetic field strength falls by the inverse of the cube when moving away from the magnet. If a magnetic plug is to attract contaminant, that contaminant must pass very close to the magnet. Particles don't have to be too far removed from the magnet to negate any attraction, greatly limiting magnet efficiency.

Also, magnets suffer from particle wash-off, particularly in high-vibration environments (which cover most fluid systems) and high-velocity oil flows (which is why they are generally located in the center of a large sump). Despite these inherent problems, magnetic sump plugs are common to most vehicles and fluid systems.

The company initially thought there might be a way to create an in-line magnetic solution that would handle the full flow of the fluid. The real question was how to eliminate the destructive wash-off problem. The engineers discovered that a number of designs had been tried by companies, but they all had limitations, usually because designs relied on placing a magnetic surface area into the fluid. This surface area, like the sump plugs, was not close enough to most of the fluid and allowed contaminant to be washed off. These flaws were particularly evident at high flow rates and high viscosities.

To overcome these issues, the engineers realized the device would have to focus strong magnetic flux gradients (fields) into the fluid at full flow. These would pull particles directly from the fluid flow instantly, without suffering contaminant wash-off. The target solution was to efficiently remove large volumes of magnetic debris from a fast-flowing fluid without incurring a pressure drop.

The result of this research was the Magnom core, which is at the heart of all Magnom technology today (see Fig. 3).

The Magnom is entirely scaleable in that the diameter can be sized to accommodate different pipe and flow requirements, and cores can simply be stacked together to increase the capacity for contaminant as required.

Figure 4—Magnom installation at the Didcot A Power Station in England.

Generally, the Magnom's flow channels tend to combine to a flow area equal to more than 110 percent of the feed pipe flow area. In this way, the pressure drop across the Magnom starts low and remains low even when it collects large amounts of contamination.

Given this low backpressure design, the Magnom can be fitted on the suction side of a pump without fear of creating cavitations due to a pressure drop. In many full-flow systems, the pump is often the most expensive component and is devoid of effective filtration protection.

The Magnom has demonstrated removal of contaminant that is less than one micron in size (0.07 microns to be exact).

The technology has been scaled to a number of different applications, including large scale transmissions.

The Magnom in Action

In addition to Rugeley, the Magnom has been used at a number of other power stations in England.

The first Magnom power plant installation was at the Didcot A Power Station in Oxfordshire, England. Conventional filtration could not be used because it caused too much of a pressure drop, placing a huge strain on the pump.

The Magnom was used by Didcot to clean the open gear lubricant on a coal pulverizing gearbox after it had seen significant gear wear.

The Magnom process unit was used, as it could be installed into a 2" line without increasing the pressure drop. The unit was also appropriate because it is capable of removing up to 4 kg of contaminant before it is cleaned.

As the lubrication system was not recirculatory in nature, the filter was skid-mounted with a small pump, as shown in Figure 4.

The Magnom's design allows simple inspection. The unit was therefore examined after only two weeks. Large amounts of magnetic and non-magnetic debris had been captured.

An oil analysis showed that once the process unit was installed, contamination levels were reduced to acceptable levels.

Contaminants removed by the filter at Didcot have included iron, soot, aluminum and copper contaminants. The advantages of running much cleaner lubricant include increased gearbox life, increased fluid life and improved gearbox efficiency.

The Didcot A Power Station has since retrofitted Magnom process units to each of its 32 coal pulverizing transmissions.

After the initial clean-up of the system with the Magnom, the core has to be cleaned only every four years as part of planned outages. Figure 5 shows a Magnom core only ¼ full. This core was photographed 12 months after the initial lubricant clean-up had been completed.

Since adopting the Magnom technology across the entire Didcot A plant, gearbox failure rates dropped from an average of four per year down to zero per year, and the payback period has been less than three months.

Another example of the filter's use in power generation is at the Drax Coal Fired Power Station in North Yorkshire, England. Drax uses recirculating lubricant on its coal pulverizing transmissions.

Engineers at Drax quickly found the contamination removal to be successful

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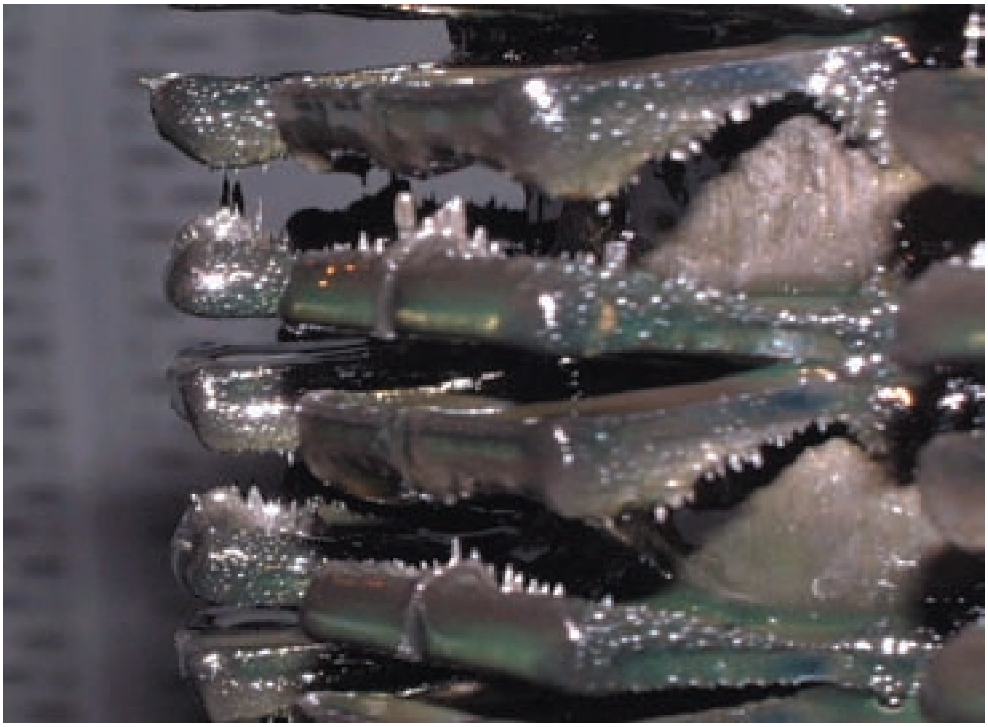

Figure 5—Close-up of a Magnom filter, approximately 1/4 full.

and have initiated a program of retrofitting process units to all 64 of the coal pulverizing gearboxes there.

When installed full-flow in gearboxes (rather than in dialysis mode) the filter can yield significant reductions in lube temperatures, which can lead to further extensions in fluid life.

Aside from power stations, the Magnom is used in a wide range of gearboxes, including in:

- Formula 1 racing cars;
- NASCAR racing cars;
- Indy racing cars;
- Sugar mills on pulp press, diffuser tower and other transmissions;
- Off-highway vehicles on external gearbox lines;
- Cement plants on kiln transmissions, coal crushing transmissions and cement pulverizing transmissions;
- Aluminum plants on roller transmissions;
- Rubber manufacturing plants on mixing and drying kiln transmissions;
- Pharmaceutical manufacturers on mixing and drying kiln transmissions;
- Steel plants on rolling transmissions;
- Paper, pulp and plasterboard plants on roller and mixer transmissions; and
- Mining and mineral extraction operations in large-scale transmissions (crushing, grinding, milling…).

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