

Keeping the Oil Clean

To Reduce Gearbox Downtime

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



This composite image shows how the Magnum 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 Magnum™ filtration system. The Magnum is designed to capture submicron-level particles without causing a pressure drop.



Rugeley installed Magnum 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 Magnum removed from the new fluid (see Fig. 2).

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

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

Rugeley Power Station immediately ordered Magnum 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 Magnum 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

Magnum technology was designed for the Formula 1 and NASCAR racing
continued



Figure 1—Magnum installation at Rugeley Power Station.



Figure 2—The Magnum captures substantial debris, even after only two months.

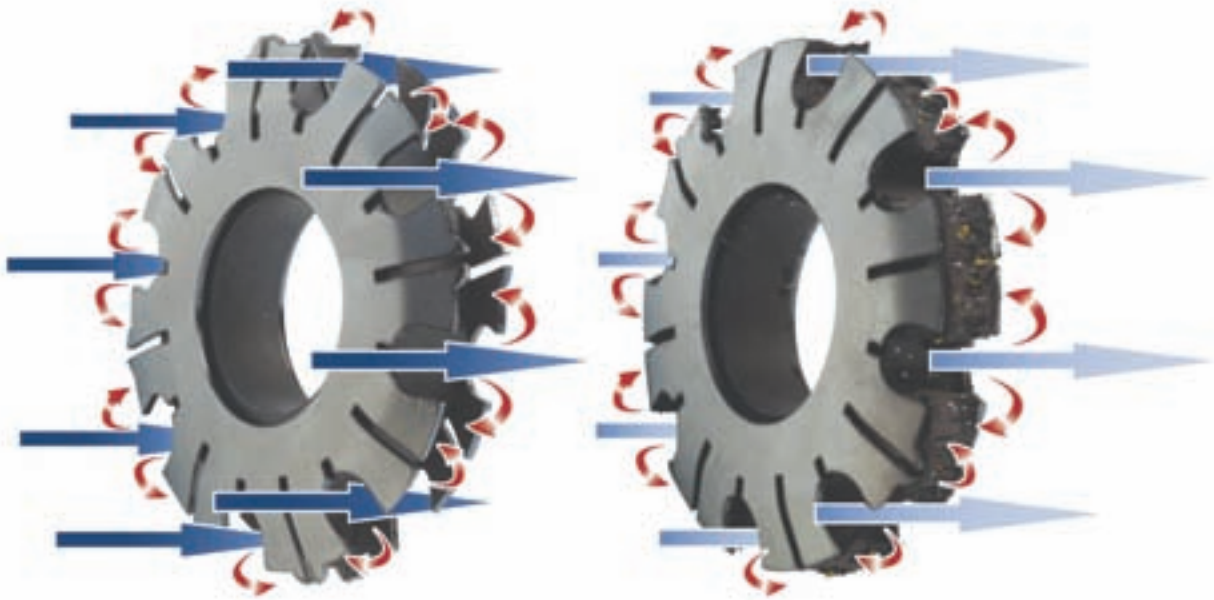


Figure 3—The Magnum focuses magnetic fields between the plates, capturing debris where it doesn't interfere with fluid flow and won't wash off the magnet and back into the lubrication system.

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, Magnum 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 destruc-

tive 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 Magnum core, which is at the heart of all Magnum technology today (see Fig. 3).

The Magnum 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—Magnum installation at the Didcot A Power Station in England.

Generally, the Magnum'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 Magnum starts low and remains low even when it collects large amounts of contamination.

Given this low backpressure design, the Magnum 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 Magnum 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 Magnum in Action

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

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

The Magnum 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 Magnum'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 Magnum process units to each of its 32 coal pulverizing transmissions.

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

Since adopting the Magnum 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

continued



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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GLEASON BEVEL EQUIPMENT

Spiral Generators #40, 106, 116 Rougher, 116 Finisher, 118, 606 Auto, 607 Auto, 607 Manual, 615, 616, 641, 645, 650, 950 — to 1980
Straight Generators #104, 114, 24, 24A, 725 — to 1975
Cutter Sharpeners #12, 13A, 496, 532, 538, 545, 563 — to 1981
Testers #4, 6, 13, 14, 17M, 61, 512 — to 1970
Lappers #15, 503, 504, 514, 516 — to 1991
Cutter Inspection/Setting, #15, 527, 528, 563 — to 1981
Quenching Presses #529 Automatic (250mm),
529 Manual (400mm), 537 (711 mm), full die — to 1992
Thousands of Gleason Straight & Spiral Cutter Bodies & Holders,
Change Gears for most models, Index Plates, Genevas, Lift & Drop
Cams, Gages, Work Spindle Adaptors, Stock Dividers, Re-built Cutter
Spindles, Dresser Arms -- check our website for our inventory,
we want to buy your surplus
See Complete List of individual tools at www.cadillacmachinery.com

GEAR HOBBERERS

Barber Colman 6-10, Plain & Multicycle, Triple & 6-Thread, Single &
Triple Precision, Power Downfeed, as late as 1975
Barber Colman A, 16-16 Manual, Autocycle, Multicycle, Differential, 1-, 2- & 4-Thread,
as late as 1980
Barber Colman 16-36, 2-Thread, as late as 1979
Gleason 775, 6" Capacity, 8.5" Face, 4 DP, Auto-Load for Cylindrical Gear -
Last job produced 3/minute with load/unload, as late as 1986
Lees Bradner 12HD 1972
Lees Bradner HH 16" x 144", 1966
Liebherr L650, L652, LC752, as late as 1987
Liebherr LC1502, 1993
Mikron A 2 1/2
Pfauter PA300, P403, 500mm Capacity, 2-Cut,
with Speed & Feed Change in 2nd Cut, (choice) 1978

HOB SHARPENERS

Barber Coleman 6-5, 10-12, Auto Dress, as late as 1982
Kapp AS203, AS305, AS305B, AST305 & AS410,
as late as 1974

GEAR TESTERS

Lead—Gould 3H 1973
Involute—Fellows 24M, ITW 3412B, 3424B, as late as 1981
Combination Lead/Involute—Maag SP60, PH100, SP160,
as late as 1981

TESTERS MISCELLANEOUS

Gleason 412 - 60" Curvic Coupling Checker
Maag IMT
Maag MT30
Maag MT11
Maag TMA, Maag TMC, Maag TMI

TESTERS ROLLING

Beaver 2203 3"
Hofler UP630, 1987
Hofler ZW400, 1990
Hofler HS-1000 w/ EVTM & SRA, 1972
ITW 2203 3"
Parkson 15N 15"
Parkson 24"/30"
Quaker 2-1/2"

SPLINE HOBBERERS

Barber Colman 16-16, 1966
Lees Bradner HH 16" x 144", 1966

SPLINE MILLERS

Hurth KF32a, Auto-Loader, AMT 4 - 150 Heads,
AMT 4 - 240 Heads, with & without extension,
as late as 1980
Hurth LKF33, 40" Travel, 97" CC, 1970

SPLINE ROLLERS

EX-CELL-O 3251 2-40HP, 1973
Michigan 3237, Auto-Loader, 1966

GEAR GRINDERS

Gleason 29, 105
Kapp VAS 385, 1983
Maag HSP-80, 1967
Reishauer AZA, ZB, DS, 1982

GEAR SHAPERS

Barber Colman 10-4, with Tilt, as late as 1973
Fellows No. 7, 1973
Fellows 48-8, 1978
Fellows 615A
Sykes 1600H Herringbone
Fellows 10-2, 10-4 with Tailstock
Liebherr WSC-401, 1985

WORM HOBBERERS

Gould & Eberhardt #20 TWG
Index plates, change gears, hob arbors, sharpening
arbors, cutter adaptors, etc.
For Barber Colman, Fellows, Liebherr, Pfauter,
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