# STRATEGIES FOR LUBRICATING

# BIG IR

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Typically, when mine operators are asked what they are doing for their lubrication program, the response is generally along the lines of scheduled preventive maintenance (PM) and used oil analysis provided by the equipment manufacturer. Unfortunately, these activities alone do not constitute an effective program. This article will explore lubrication strategies for "big iron," which includes large earthmovers such as rope shovels, hydraulic shovels, draglines and bucket-wheel excavators.

## FAILING GEARCASES ON ROPE SHOVELS

A pair of rope shovels working the central Appalachian coal region had planetary gearcases on the propel drives (i.e., the tracks). On average, one of four planetary propel gearcases in service would fail every six to eight months. In a matter of two years, it was conceivable that all four gearboxes would be replaced. A single gearcase cost approximately $400,000, and lead times were increasing to six months. To further complicate the situation, most failures were catastrophic, and the gearcases could not be rebuilt.

So what was causing the gearcases to fail? Lube changes were being conducted approximately every six months on regularly scheduled PMs, and oil samples were being taken nearly every three months, but these tasks alone were not detecting failures. Consequently, there was little belief from the maintenance team that used oil analysis was effective.

Part of the problem was the lack of new oil sample analysis with which to compare the used oil. Lubricants for "big iron" typically have high viscosities (approximately 1,000 centistokes) and unique additive packages. The only way to know if you have lost your additive package in your used oil is to have a new oil reference.

Another problem was the test slate being performed on used oil at the laboratory. As with most used oil analysis, labs sell a basic test package that costs $15 to $20 per sample. Typically, this includes a 19-element atomic emission spectroscopy (AES) report, a viscosity test and an indication of moisture content, which is usually determined by a crackle test on a hot plate. With "big iron,"

the amount of wear debris considered normal always flags as exceptionally high at the lab. In addition, the AES test cannot fully account for particles larger than 3 to 8 microns, depending on the instrument used by the lab. "Big iron" machine components are much larger than normal, so the wear debris is larger as well. Simply put, the standard tests didn't see the full picture.

## THE SOLUTION

The solution was to develop machine-specific test slates with custom alarm limits. This required a premium used oil analysis package. For the planetary gearcases, new oil samples for a baseline reference were sent to the lab. A test slate was assembled comprised of 21-element AES, viscosity, acid number, moisture by crackle test, oxidation by infrared (IR) and direct read (DR) ferrography (see the table on the right). The DR test was needed to overcome the particle size limitation with AES. While some labs do not offer the DR test, they can perform a particle quantity (PQ) index, which is a suitable alternative.

Initially, the sample frequency on the four gearcases was weekly so the data density could be increased and what was "normal" could be identified. The maintenance teams thought this was overkill,

| WEAR ELEMENTS | | NEW OIL REFERENCE | TYPICAL USED OIL |
|---|---|---|---|
| Iron | ppm | 13 | 100-300 |
| Chromium | ppm | 0 | 0-1 |
| Molybdenum | ppm | 0 | 0 |
| Aluminum | ppm | 0 | 0-2 |
| Copper | ppm | 0 | 0-2 |
| Lead | ppm | 0 | 0 |
| Tin | ppm | 0 | 0 |
| Silver | ppm | 0 | 0 |
| Nickel | ppm | 0 | 0 |
| Vanadium | ppm | 0 | 0 |
| Titanium | ppm | 0 | 0-1 |
| Manganese | ppm | 0 | 0 |
| Cadmium | ppm | 0 | 0 |
| Contaminant Elements | | | |
| Silicon | ppm | 19 | 0-20 |
| Sodium | ppm | 0 | 0-2 |
| Boron | ppm | 1 | 2 |
| Additive Elements | | | |
| Magnesium | ppm | 7 | 6-8 |
| Calcium | ppm | 5 | 6-8 |
| Barium | ppm | 0 | 0 |
| Phosphorus | ppm | 185 | 185-220 |
| Zinc | ppm | 2 | 2-10 |
| Non-Metallic Content | | | |
| Water | % vol. | Nil | Nil |
| Solids | % vol. | <0.1 | Not tested |
| Lube Data | | | |
| Viscosity at 40°C | cSt | 318.0 | Alarm at ±10% |
| Acid Number | mg KOH/g | 0.85 | 1.2 |
| Infrared | | | |
| Hydroxy | | N/A | 0 |
| Anti-wear Loss | | N/A | 0-1 |
| Oxidation | | N/A | 0-11 |
| Nitration | | N/A | 5 |
| Oxidation/Sulfate | | N/A | 30 |
| Additional Tests | | | |
| PQ Index | | 9 | 30-80 |

A customized test slate for "big iron"

but buy-in and support were obtained from management.

One of the gearcases was new and just put into service. After two weeks of operation, the maintenance crew sampled the gearcase. When the oil analysis report was received, a resample was ordered immediately because the additive levels of the used oil did not appear correct. The resample confirmed that the new oil's additive package had been lost. This is not uncommon for new oil in new machinery. In layman's terms, what happened was that the additives had attached themselves to the machinery's components and were no longer suspended in the oil.

An oil change was ordered on the gearbox, which had been in service only one month. The cost of the oil change was $3,000-$4,000, but the cost of a new gearbox was $400,000. Traditional wisdom for maintaining this machinery was to change the oil approximately every six months. In actuality, it was more like once a year.

As monitoring continued on a bi-monthly basis, the in-service oil was good for three to four months before additives started dropping out and oxidation levels increased. With custom test slates and close monitoring, used oil analysis was able to determine the proper oil change intervals, and the planetary gearbox failures stopped completely.

## COST SAVINGS

Effective maintenance should be viewed in terms of the profits generated. The baseline case for this example involved a gearbox failure every six months, with a cost of $800,000 per year in parts alone. Assuming a gearbox lifespan of five years, the replacement costs amounted to $320,000 annually for the four units in service. The oil change costs included two changes per year per gearcase at a cost of $3,500 per oil change, for a total of $28,000 annually for the fleet. This was increased to three changes per year per gearcase, for a total cost of $42,000. The cost of the used oil analysis was negligible. So for a $14,000 increase in lubrication costs, a profit of $466,000 per year was generated. The savings could be even

greater if the operator only incurred rebuild costs and not replacement costs.

Please note that the oil change interval was dependent upon how much the operator trammed or propelled the shovel. A long-distance tram generally requires an immediate oil change. Effective lubrication programs target and monitor specific failure modes, but there is no standard package applicable to “big iron.”

Many other practices can also be profitable, such as offline oil filtration, using oil sampling ports, adding desiccant breathers and utilizing magnetic filtration for circulating oil systems often found on draglines and shovels. Whether you have “big iron” or normal-sized machinery, knowing the limitations of the technology used to monitor your asset health and tailoring your maintenance activities to overcome these limitations will be paramount in achieving success.

## About the Author

Brian Groff is a senior mining engineer and consultant for Continental Placer, which has been providing services to the mining and industrial minerals community since 1988. Brian has more than 17 years of practical experience in zinc, salt, coal, limestone and aggregates, and has visited more than 100 mines worldwide.

| | BASELINE (BUSINESS AS USUAL) | EFFECTIVE LUBRICATION PROGRAM |
|---|---|---|
| Cost of new gearcases (per year) | $800,000 | $320,000 |
| Cost of oil replacements (per year) | $28,000 | $42,000 |
| Total | $828,000 | $362,000 |

Comparing the costs of business as usual with the costs of an effective lubrication program