Increasing Engine Life

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In June and July of 2005, Rio Tinto Minerals - Boron Operations' haul fleet suffered four catastrophic engine failures. These resulted from main and crankshaft bearing failures on the MT 4400 Terex Unit Rig haul trucks. While the causes and subsequent tactics developed to mitigate these failures are not the focus of this case study, they did prompt an investigation into extending the life of the Detroit Diesel (MTU) 16V4000 engines that power the MT 4400 fleet by 25 percent. This increase would take the engines from the OEM recommended total fuel burn of 750,000 gallons between engine overhauls, to 1,000,000 gallons.

Developing Tactics

As the project team discussed how to use the knowledge gained from diminishing the potential for bearing failures, there was still a lack of understanding regarding the primary system that influences wear metal concentrations detected through used oil sample analysis. The re-burn unit used on the fleet is the Reserve System CLC-2000M. After talking with Mike and Richard Nelson of Reserve Systems and visiting their facilities, the team was confident in their understanding of the CLC-2000M. This discussion - combined with the knowledge gained through the team's work with used oil and filter analysis (in collaboration with Lane Crandall and his team at Oil Analysis, Inc.) - allowed the team to develop a deployment and management strategy for the CLC-2000M. Predictive maintenance tactics were also developed to monitor the health of the engines as they were extended beyond 750,000 gallons burned.

Project Engines On-condition Change-outs			
Unit	Date	Gallons	Hours
8830	November 2006	990,151	26,506
8840	March 2007	995,768	27,067
8841	May 2007	1,003,208	28,001
8831	July 2007	957,476	27,009

Table 1

Executing Strategic Development

The deployment strategy for the CLC was to ensure the units were calibrated to provide an

oil bleed-off metering rate that would allow for the soot load within the engine oil to be maintained at a predetermined level. This level was used to maximize the benefits associated with re-burn (the ability to maintain a reliable clean oil quality) while allowing wear metals contained in the used oil to reach consistent levels. The ability to maintain a relatively constant soot load in the engine oil aided in normalizing the wear metal levels. The management strategy for the CLC included developing training material in cooperation with Reserve Systems to train the mechanics, which allowed them to troubleshoot and repair the CLC units prior to the faults affecting the data provided by the used oil analysis results.

To support the used oil analysis program, the mechanics were given refresher training in hydrocarbon management fundamentals, including proper

oil sampling techniques. The training was reinforced by explaining project context and goals along with regular progress updates. These methods helped develop a sense of ownership among the mechanics.

Creation

After reviewing CLC calibration and gauging buy-in, the team believed the data from used oil analysis results was consistent enough to create custom alarms for trending the engines' health. Generating the used oil analysis alarms proved to be a key factor in extending the engines past 750,000 gallons. In addition to installing custom alarms, used oil filters were analyzed for wear metal content as engines exceeded 700,000 gallons. These two methods elevated the process of analyzing and providing component health recommendations based on engine oil sample data from an intuitive process to one based on tangible values.

Gaining Accuracy

There was quite a bit of skepticism in the beginning of this project with the stated goal of extending the 16V4000s to a million -gallon burn total between overhauls. These doubts faded as the team made engine change-out recommendations based on the engines' health. These recommendations were derived from the data within the used oil and filter analysis results, then verified during engine teardowns. As the team became more confident, they began to correlate the data from sample results to the component wear observed during the engine teardowns. Afterward, they were able to pinpoint the beginnings of a failure to the specific component within the engine. An example of this was the ability to differentiate between a cylinder liner O-ring, cooler and engine oil-driven dampener impending failure based on the copper, iron and potassium levels present in a sample. Their accuracy was less than a 10 ppm difference in element levels between failure modes.

Branching Out

Although this project is ongoing, many of the tactics and methodologies developed have been transferred to other equipment groups with Rio Tinto Minerals' heavy mining equipment (HME) and support equipment fleets. The results of this project illustrate the value that can be added when these units are deployed and managed properly. The value of this project was realized not only in tangible cost savings, but also in the intangible value of aiding in the paradigm shift required of all maintenance personnel from a time-based to an on-condition maintenance-based program.

About the Company
Rio Tinto Minerals produces borates, talc, salt and gypsum. The organization encompasses 3,300 people working at 50 facilities on five continents to serve more than 2,500 direct customers worldwide.

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