A Case Study for the Aluminum Industry

This article discusses the collection and interpretation of data generated by Condition Monitoring that was implemented to analyze the performance of industrial diesel engines and engine oils in an aluminum smelter.

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Introduction:

This project, like so many others, had a very humble beginning. About five years ago, after returning from a routine sales call to the smelter where we were selling synthetic and specialty greases, our lubricant sales representative challenged us to develop a series of lubricants that he could sell to the Aluminum Industry. It seems that in discussion with a group of maintenance people at the smelter, he was told that if ever a company could develop lubricants that would last longer and protect their equipment better than what they were presently using, they would buy from him.

The reality of motors needing oil changes after only 75 hours in service and engine break-downs requiring rebuilds every 1200 hours may seem unrealistic to anyone not familiar with mobile equipment operating in the Aluminum Smelting Industry. Few environments are more demanding on equipment than what is found in aluminum smelters. The high-torque diesel engines that power mobile machines are constantly subjected to wide temperature fluctuations, often operating at abnormally high ambient temperatures; intense magnetic fields; contamination by extremely abrasive, highly reactive, often sub micron un-filterable dust particles; and, to top it off, the machines only do short haul runs. This unique combination of ***oil un-friendly*** conditions has forced the Aluminum Industry to accept premature engine failures and reduced lubricant service life, as a ***normal cost of doing business***. It's been that way for a very, very long time, and we also used to think it was normal.

As lubricant formulators and manufacturers, we accepted the fact that, although the quantities of lubricants consumed by the Aluminum Industry were quite impressive, we didn't really understand why. Enticed by the potential of larger sales, and intrigued by the science, we accepted the challenge that had been presented to us. We decided to use our expertise in condition monitoring using the **COAT**® System to analyze the underlying chemistry behind the problems and see what we could do. We believed that if we could determine why the lubricants were failing, we could then formulate something new to address the problems.

Objectives:

- To develop an engine oil capable of retarding the effects of the catalytic breakdown normally experienced under these harsh smelter conditions and to extend the drain intervals from 75 hours to a minimum of 200 hours
- To develop a Condition Monitoring program that would ultimately insure the effectiveness of the oil so that the current expected engine life of 1200 hours before rebuilds could be extended.

Technology:

- The **COAT**® System uses Fourier Transform Infrared (FTIR) technology for the analysis of lubricants. The **COAT**® System is capable of *detecting, determining,* and *replenishing* precise levels of performance-enhancing additives in their respective lubricants.
- Through fluid monitoring, the service life of a lubricant may be extended by replenishing depleted additives before an irreversible degradation of the oil occurs.

- Reformulating lubricants by incorporating new additives based on data obtained from monitoring oil degradation.

The sequence and interpretation of oil analysis:

Retrieving the data:

- Three industrial lift trucks equipped with CAT-3208 engines were selected for this project.
- Two were filled with Thermal-Lube's POLYON® 10W 40, CG-4 motor oil, and the other was filled with a conventional 15W 40, CG-4 mineral oil.
- All three machines were returned to normal service and oil samples were taken on a regular basis.

Analyzing the oil:

- **COAT®** analysis of the samples revealed a rapid depletion (>85% after only 17 hours of operation) of antioxidant in both oils [Figure 1].
- An experiment simulating the effect of a variety of probable contaminants was set up in our research laboratory. One of the samples of new oil was contaminated with aluminum dust and heated to 150°C. This sample showed a faster decrease in the level of antioxidant when compared with a control sample [Figure 2].

Assumptions:

- The catalytic effect of the contaminant was consuming all the antioxidants in the oil thus allowing the base oil to oxidize.
- Once the base oil itself begins to oxidize, the oil loses its ability form a proper lubricant film, therefore allowing metal-to-metal contact.
- The constraints on mobile equipment of extremely limited space would preclude the installation of a filtration system capable of adequately filtering the sub-micron contaminants from the fluid.
- As there were no mechanical or physical means to eliminate the contaminant, we would have to find a chemical way to neutralize its effect.

Interpretation and integration of the data:

- Using the analytical data generated by the **COAT®** System, an "antioxidant cocktail", chemically structured to provide higher resistance to oxidation in the presence of "aluminum dust", was incorporated in the formulation of a ***semi-synthetic*** POLYON® motor oil. (*The decision to formulate a* semi-synthetic *motor oil was based on the assumption that, the level of contaminants in the oil would prove to be the limiting factor of the fluid's effectiveness and the added cost of a fully synthetic fluid would be superfluous.)*
- Subsequent laboratory test results showed that 90% of this new antioxidant was retained after 140 hours under the same simulated test conditions [Figure 2].

Conclusions:

The following graphs [Figure 3] compare additive levels, viscosity, and soot loading for ***semi-synthetic*** POLYON® 10W 40, CG-4 and the conventional petroleum based 15W 40, CG-4 motor oil. These figures illustrate the success of the newly formulated motor oil in resisting the effects of the harsh environment found in the Aluminum Industry; thereby allowing the customer to safely extend the drain intervals of the fluid.

Summary:

Since incorporating the ***semi-synthetic*** POLYON® 10W 40 motor oil in January 1998, the customer is doing routine oil changes at 250-350 hours (3.3-4.6 times the original change intervals) and has not had a single lubricant-related breakdown or engine rebuild (25,000+ hours).

- Based on this performance, the customer has converted all the other fluids (TDH, ATF, AW hydraulics, GL-4 gear oils) in their mobile equipment (as well as some stationary equipment operating in the same environment) to equivalent synthetic fluids. These fluids are also fully formulated and manufactured by Thermal-Lube incorporating the same additive technology prescribed by the **COAT®** System.
- Thermal-Lube continues the condition monitoring of all the fluids and is constantly looking for new chemistry that may enhance their performance.

Graphs and Pictures:

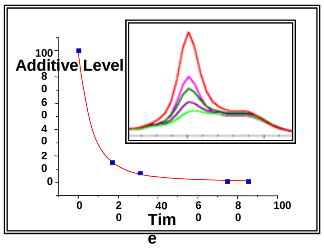

FIGURE 1: *Antioxidant decrease in used lubricants as measured by the* **COAT®** *System from their spectra*

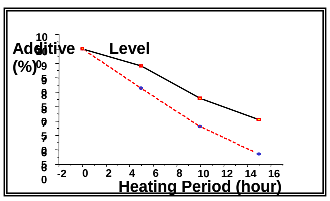

FIGURE 2: *Rate of antioxidant degradation in lab experiment after 16 hours of heating @ 150°C*

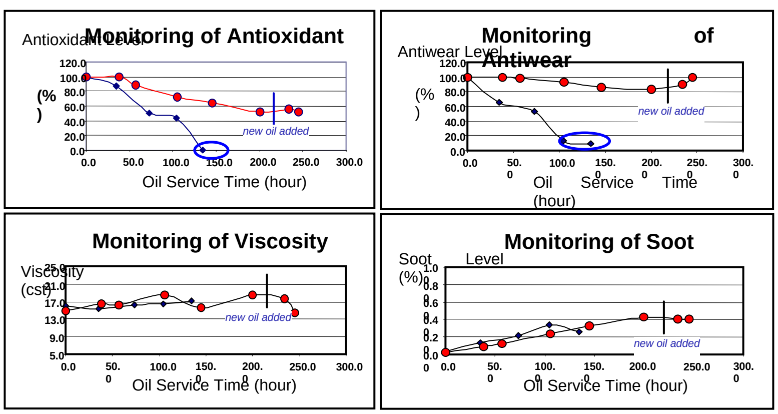

Figure 3: 15W40 mineral oil; Semi-synth. 10W40 POLYON®

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