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New Solid State Oil Condition Sensor for Real Time Engine Oil Condition Monitoring

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ABSTRACT

Engine lubrication oil degrades at varying rates depending on the lubricant, engine type and application. Traditional maintenance programs are designed to change oil on predetermined intervals (such as run time/mileage), with more advanced algorithms taking into account load and operating temperature of the engine, or lab analysis. Conservative interval based maintenance programs spend too many resources changing oil and longer intervals may result in engine damage. Lab based oil condition approaches also have significant time lag and other logistical difficulties.

Real time engine oil condition analysis offers a balance between oil life and maintenance cost. Real time oil analysis also allows for the implementation of active reliability-centered maintenance. When a fleet manager knows the actual maintenance condition of each vehicle in a fleet, it is possible to accurately prioritize and schedule appropriate maintenance. Real-time oil condition monitoring can help insure that a fleet utilizes the maximum useful life of the lubricants while protecting the performance of the engine

Researchers at Symyx Technologies have developed a miniature, solid state oil condition sensor based on a crystal tuning fork. The sensor provides direct measurement of the critical physical properties of viscosity, density, dielectric permittivity, and AC conductance of lubricants [1, 2]. Simultaneous measurements of multiple parameters of lubricating oil in an engine can provide improved sensitivity for detection of changes, which may be the result of degradation or contamination. This paper investigates the response of the Symyx sensor to various diesel engine oil base stocks, additive packages, common oil contamination and real time engine oil monitoring. Results of the Symyx sensor output are compared to conventional lab oil analysis techniques. The suitability of the Symyx sensor as means of determining diesel engine oil condition and predicting remaining useful oil life is discussed.

INTRODUCTION

Many approaches are available to reduce maintenance costs of industrial equipment and commercial fleets. Traditional preventative maintenance programs based on scheduled intervals can improve fleet reliability. Such programs however often “over maintain” the fleet and burden the maintenance programs with higher costs and logistics. Reliability Centered Maintenance is another approach to maintain a fleet. This approach may reduce the maintenance burden but will likely require a different burden in developing maintenance schedule models and maintenance record keeping of the fleet. A better situation is a fleet equipped with appropriate engine sensor technology that can effectively determine the need for oil maintenance and communicate the need to the maintenance facility. Recent advances in oil condition sensor technology have demonstrated that real-time, in-situ monitoring of diesel engines may achieve the broad goal of service on demand rather than a best-fit rule.

Extensive field test data indicates Thermo King diesel powered refrigeration equipment operated in harsh conditions can achieve a 3,000 hour oil change interval. However, some lightly loaded engine applications using synthetic oils show acceptable oil quality at 8000 hours of use. Since the standard fill capacity of a typical refrigeration unit is 13 quarts, it is obviously an advantage to extend the oil drain interval and reduce the associated maintenance costs. This of course must be done without risking an expensive engine or increasing other maintenance practices. Since Thermo King equipment is used under diverse conditions, and various oil types / grades are possible, rigid oil change rules are not optimal for a maintenance program Extended oil drain intervals are only warranted if the practice does not increase the frequency of rebuilds or replacements, or add other costs that offset the savings. Added benefits of extended oil drain intervals include lessened environmental concerns including the cost of waste oil disposal or reclamation.