The Application of Time Resolved Dielectric Instruments to Air Force Ground Fleet Maintenance

Stephanie Thompson
Computational Systems Incorporated
835 Innovation Drive
Knoxville, TN 37932
(423) 675-2110

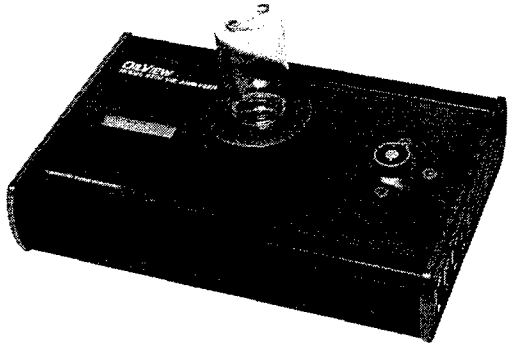
1998

Abstract: In 1993 the Military Equipment Evaluation Program (MEEP) located at Eglin Air Force Base, FL, evaluated a time resolved dielectric instrument for use in air force ground fleet maintenance applications. They identified this instrument as a useful device for what they termed "bumper testing" intended to measure oil quality before changing oil rather than simply changing oil based on calendar months or equipment usage (miles or hours).

Since that time the instrument has been accepted and is in use at many U.S. Air Force installations world wide. Typically an air base will have apploximately 40 ground vehicles for every one flight vehicle. For example, Eglin has approximately 1200 ground vehicles supporting 30 fighting aircraft. The aircraft get oil analysis done very frequently. Until the time resolved dielectric instrument was made available, no oil analysis was performed on the ground fleet.

This paper describes the application, use and results achieved by using a multifunctional oil analyzer in the maintenance shops to determine oil conditions before taking maintenance actions.

Key Words: By-pass filters, condition-based oil change, time-resolved dielectric measurement, ferrous, Management and Equipment Evaluation Program (MEEP), Pacific Air Force Command



Introduction: In 1993, new federal and local legislation effectively increased the cost of changing oil on a timely or mileage-based schedule by tightening regulations related to the disposal of used oil. This prompted the Air Force to research cost-effective ways to analyze vehicle oils. After careful research, the United States Air Force Military Equipment Evaluation Program approved CSI's OilView Analyzer for use in vehicle maintenance.

The research confirmed several things. Often the lubricants being discarded still retained good friction reducing, cooling, cleaning, and corrosion prevention properties. Changing oil based on the condition of the oil is less expensive than changing it based on its age or on the number of miles it has been in the vehicle. And thirdly, the technology is available to perform this analysis easily in the vehicle maintenance facility itself, eliminating the necessity of shipping lubricant samples to a laboratory.

Obviously, costs associated with purchasing new lubricants can be cut when lubricants are purchased less frequently. And costs associated with waste oil disposal are decreased when less waste is produced.

Implementation: The Pacific Air Force Command developed and implemented an oil analysis program based on the capabilities provided to them by the time resolved dielectric testing features of the instrument. "Of the three units tested, [the OilView Analyzer] gives the most comprehensive analysis, with results just short of that obtained from an oil analysis laboratory... Test results were confirmed via lab results of the same oil samples provided by the Department of Defense oil lab at Pensacola NAS."[1] Special oil filters were also recommended, but were not a mandatory part of the program. "The analysis equipment and by-pass filters qualify for Pollution Prevention Program (PPP) funding for their initial purchase."[2]

Information comparing used oil conditions and contamination to new oil is used to determine whether the oil should be changed or filtered. This data is stored, plotted, and analyzed in order to maintain a historical record, plotted and analyzed.[3] When the condition or contamination of the oil deteriorates to a pre-determined point, the oil is changed. Otherwise, it is left alone until the oil is no longer functional.

Though the analyzer also provides information about the wear condition of an engine, it is not used for engine analysis by PacAF. It is not cost effective to do work on most ground vehicle engines unless it has obvious operational problems. Even if the ferrous content of the oil is high, the engine will simply be changed out when a problem develops. On the larger equipment, like snow plows, engine analysis might be useful and cost effective, but research must be done to verify this before a program can be implemented.[4]

Because improper sampling techniques will skew the analysis results, all personnel upon which the program depends must be dedicated to its success. The Vehicle Maintenance Manager designates one person to be trained as the oil analyst, but the base members that fall into the role of customer must also be educated about the new program. To accomplish this during the startup phase of the program, the VMM may establish a cross-functional Process Action Team made up of maintenance supervisors, workers, and outside organizations that represent the various groups of vehicle maintenance customers.[5]

"Operator servicing of the engine oil presents the greatest potential for crankcase contamination," so the oil is changed and the majority samples are taken only in the vehicle maintenance facility by the analyst.[6] This change from the old way of doing things must occur at the same time that the interval between oil services is changed. These changes require, "the cooperation of all vehicle users in addition to 100 percent support from the vehicle maintenance team if it is to be creditable and successful."[7]

Sampling and Testing: Once all parties have agreed to the changes that must take place for the program to begin, the sampling interval must be established. "Analysis works best when intervals are based on the following three criteria: fuel consumption, established scheduled maintenance interval, and/or every six months."[8] Programs that are phased in

rather than implemented all at once will probably use all three criteria at some time or another.

Once all vehicles have been phased into the oil analysis program, "fuel consumption is the most effective means in determining when to analyze engine oil. This criteria tracks engine use regardless of vehicle use. Data from our test program indicates oil analysis must be accomplished every 300 gallons of fuel used for diesel and gasoline engines."[9]

The Pacific Air Force Command uses a computer program to track the fuel consumption of each vehicle by its identification number and the amount of fuel pumped into the tank. "When, according to the Materiel Transaction Listing, the vehicle's fuel consumption exceeds 300 gallons since the last oil analysis, an oil sample must be obtained and analyzed to determine its condition." [10] The operator brings the vehicle into the CSC where an oil sample is taken. If moving the vehicle is inconvenient, the oil analyst will go into the field and collect the sample just after the operator shuts off the vehicle, so that a representative sample is retrieved.

The data from the test run on the sample is compared to the data of the clean reference oil. The state of deterioration or contamination of the oil is rated according to levels preset by the Pacific Air Force Command. Each type of oil tested is given its own alarm levels or limits beyond which the oil is considered "good," "fair," "marginal," "bad" or "extreme." A lube condition of "good" or "fair" requires no further action in servicing the engine oil... A "bad" or "extreme" lube condition requires replacement of engine oil, all OEM oil filters, and replacement of any by-pass filter elements."[11] A "marginal" alarm requires the replacement of one of the by-pass filter elements if by-pass filters have been installed.

When water is found in the oil, another sample is drawn and tested to eliminate human error. If the second oil analysis also indicates water in the oil, than maintenance will conduit additional troubleshooting by other techniques to verify coolant is not leaking into the oil.[12]

Results: Currently there are five Pacific Air Force Command bases using the condition-based oil change program rather than a timely or mileage-based program. These bases are: Hickam AFB, HI; Elmendorf AFB, AK; Eielson AFB, AK; Anderson AFB, Guam and Kadina AFB, Japan. Soon, Ukoda AFB, Japan, will be moving to condition based oil changes as well.[13] Specific information on four of the five programs follows.

Hickam AFB, HI: Hickam Air Force Base has the largest of the four programs. Fifty to sixty samples are drawn and tested daily from 5000 ground vehicles. This represents half of the fleet of ground vehicles. The range of vehicles in the program includes: construction equipment, sedans, and snow equipment. Before the oil analysis program, each vehicle used, on average, 4.2 gal of oil per year. The quantity dropped to 1.8 gal/year After starting the program the quantity used dropped to 1.8 gal/year.[14]

Hickam Air Force Base has owned the testing equipment since 1995 and was the first to implement the oil analysis program as a part of the testing phase. The rest of the bases use the manual that was produced by officials involved in this phase of implementation as a blue print for their own programs.[15]

Eielson AFB, AK: Eielson Air Force Base has been performing condition-based oil changes for 2.5 years. There are 860 vehicles in the oil analysis program, including: fork lifts, graders, bulldozers, snow plows, regular pick-up trucks, and police cars. Testing intervals, based on fuel consumption, dictate a sampling rate of around 80 vehicles per month.[16]

As a result of condition-based oil changes at Eielson Air Force Base, between 340 and 400 quarts of oil is saved each month. This oil savings represents an even greater dollar amount than it would at other bases because of the expensive synthetic oil necessitated by the harsh north Alaskan climate. *Note of interest:* It has been found that there are cases in which oil in an engine remains usable for up to two years. Previous to condition based oil changes, this oil would have been discarded four times in two years.[17]

Elmendorf AFB, AK: There are 1200 vehicles in the oil analysis program at Elmendorf Air Force Base. The range of vehicles tested includes pick-up trucks, heavy equipment, forklifts, dump trucks, refuelers, graders, and cars. 10W30 and 15W40 are the two types of oil used and tested. Due to a recent personnel change in the Elmendorf role of oil analyst, no further information is available on the program there; however, the program is run in accordance with the guidelines established during the initial test at Hickam.[18]

Kadina AFB, Japan: Oil analysis equipment has been in use at Kadina Air Force Base in Japan since June of 1995. Fifteen to eighteen samples are taken daily from the fleet of 2000 cars, light and medium trucks, and heavy construction equipment. The only oil used in the is 15W40. As a result of the condition based oil change program, there has been a reduction in the amount of oil purchased, as well as a reduction of the base's hazardous waste.[19]

Conclusion: Implementing and applying the time-resolved dielectric measurement by the Pacific Air Force Commands Vehicle Maintenance Manager has brought benefits other than simple oil savings. "In addition to reducing waste oil generation, collateral benefits include: reduced acquisition of petroleum based lubricants, reduced labor hours in the management of waste oil, a reduction in risk assessment incurred during storage, pumping, and shipping waste oil, and an extension of engine life through improved, in use, lubricant . . . ." [20]

The oil analysis equipment purchased is flexible enough to allow expansion of the analysis program to include other applications. In fact, the Pacific Air Force Command is now planning to use the equipment to test oils in hydraulic systems.[21]

References

[1] *Oil Quality Analyzer Evaluation Report.* Project No. EV92-11, Management and Equipment Evaluation Program (MEEP). Start Date: July 1992. Completion Date: August 1993.

[2] Pacific Air Force Command Manual. Vol. 24-301, Sec. 2.2.4. Certified by Colonel David M. Wang. March 1997.

[3] Ibid, Sec. 1.3.

[4] SMSgt. William Klayman. Hickam AFB, HI. January 1998 interview.

[5] Pacific Air Force Command Manual. Vol. 24-301, Sec. 2.1. Certified by Colonel David M. Wang. March 1997.

[6] Ibid, Sec. 1.9.

[7] Ibid, Sec. 1.7.

[8] Ibid, Sec. 1.6.

[9] Ibid.

[10] Ibid, Sec. 2.4.1.1.

[11] Ibid, Sec. 2.4.1.4.1.

[12] Ibid, Sec. 2.4.1.4.1.2.

[13] SMSgt. William Klayman. Hickam AFB, HI. January 1998 interview.

[14] Ibid.

[15] Ibid.

[16] Master Sgt. John Edmonson. Eielson AFB, AK. January 1998 interview.

[17] Ibid.

[18] Michael Davis. Elmendorf AFB, AK. January 1998 interview.

[19] TSgt. Jamie Huffman. Kadina AFB, Okinawa, Japan. January 1998 interview.

[20] (Pacific Air Force Command Manual. Vol. 24-301, Sec. 1.1. Certified by Colonel David M. Wang. March 1997.

[21] SMSgt. William Klayman. Hickam AFB, HI. January 1998 interview.