Lubricating Oil Analysis - A Review

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Abstract- This paper is a review on lubricating oil analysis for monitoring engine condition. Engine is the most important and crucial operating mechanism In order to protect the engine from breakdown and maintain its performance, the engine needs to be lubricated with the appropriate lubricant. This oil can be analyzed to predict breakdown of engine in advance, so we can properly plan its preventive maintenance to avoid sudden breakdown. Different methods explained by researchers discussed below to understand lubricating oil analysis aspect.

Keywords-*Lubricating oil, Ferrography, Oil analysis, Engine condition monitoring.*

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I. INTRODUCTION

Engine is the most important and critical operating mechanism. Engine needs to be lubricated with the appropriate lubricant in order to protect from breakdown and maintain its performance. The properties of the lubricant needs to be resolute in order to calculate the overall health and performance of the engine. Base oil and additives are two primarily ingredients of lubricating oil. The base oil gives lubrication to the engine's moving parts to protect them against wear and tear caused by friction. The additives prevents deterioration of oil under extreme temperature conditions thus provide additional engine protection.

Now a day's oil analysis is done using a combination of physical and spectrochemical tests to monitor lubricant and component condition. International Organization for Standardization (ISO), the American Society for Testing and Materials (ASTM) and the Society of Automotive Engineers (SAE) has established standard Oil analysis test procedures. Oil analysis is most important part of proactive maintenance. It is an integral part of the maintenance plan for power plants, manufacturing plants, trucking companies, construction equipment, aircraft, refrigeration systems, processing and chemical plants, etc.

Lubricating oil analysis is a maintenance tool used to detect and quantify wear metals and contaminants in used lubricating oil. In oil analysis samples of oil are taken periodically to analyze wear rate. These provides important information about condition of engine components.

II. METHODS TO ANALYZE LARGE WEAR PARTICLES IN USED OILS.

A. Acid Digestion Differential Method

In Acid Digestion Differential Method two measurements are made on each sample. In first measurement sample is introduced to plasma after diluting it with solvent by an appropriate ratio. In second measurement concentration of different metals is calculated. When these two measurements are compared we get difference which is an indication of large particle fraction.

B. Ferrography

To overcome deficiencies of spectrometric oil analysis the ferrography technique was developed in the 1970's. In this method metal particles are separated from the fluid for microscopic examination and further analysis. In analytical ferrography, strong magnetic field gradient is used to separate wear particles from the used oil sample. In this method size and concentration of different metals can be calculated which is helpful in determining rate of wear to predict future failure.

C. Rotating Disk Electrode

Now a days optical emission spectroscopy (OES) is used to measure the ppm (parts per million) levels of wear metal, contaminants and additives in oil sample. In this method oil is burned or sparked between a rotating carbon disc electrode and a carbon rod electrode. The sample is placed in a sample cap, the disc is partially immersed in the oil sample and the disc rotates as the burn proceeds. After burning light of different wavelength comes from plasma. An optical system is used to separate the discreet

wavelengths. These separated wavelength gives information about concentration of different metals in used oil.

III. LUBRICATING OIL ANALYSIS

KIM S.S., Hwang [1] explained that there were so many abnormal wear debris in used lubricating oil that severe abrasive wear, sliding wear, and adhesive wear occurred and resulting in the decrease of anti-wear performance thus the oil has been difficult to play a lubricating role. The existence of a large number of abrasive grains destroyed the lubricating oil film thus the boundary lubrication condition was coming for Friction pairs and the wear degree aggravated.

So, the wear types in the experimental process may be normal sliding wear and mild abrasive wear and reached the lubrication performance of new one.

R.K. Upadhyay [2], proposed that Engine oil is an important and the most essential part of machine system. Oil monitoring is tool determine lubricant useful life. Lubricating oil analysis can be made for performance testing or engine condition monitoring. Knowledge of system's failure modes is helpful for cost-effective analysis. Contamination occurs by mating contact inside the engine chamber. According to the observation, rubbing, cutting, fatigue, corrosion, abrasive and scuffing wear modes were observed.

Researcher uses analytical ferrography technique to analyze the wear particles present in used oil. This technique involves passing a volume of fluid over a slide which is supported over a magnetic field. Permanent magnet arranged to create a varying strength over the length of the substrate. Debris deposited over slide serves as a media for optical analysis.

Researcher concluded that used oil analysis is known to be very effective tool health monitoring and as a proactive maintenance technology.

Om Prakash Sondhiya, Amit Kumar Gupta [3] stated that Ferrography is a technique for analyzing the particles present in fluids that indicate mechanical wear. Ferrography provides Microscopic Examination and Analysis of Debris (particles) found in lubricating oils. Analytical Ferrography is among the most powerful diagnostic tools in oil analysis in tribology. When implemented correctly it provides tremendous information on machine under operation. Performance may be improved through proper filtration of oil. Clean oil lubrication is always more effective. Adopting approach of oil replacement is expensive. Ferrography also helps improving filtration efficiency and frequency for oil cleaning systems.

M.C. Isaa, and N.H.N. Yusoff [4] stated that the application of wear particle analysis and Ferrography in particular is an effective means to identify and respond to maintenance needs of marine ships machineries. Ferrographic analysis of wear particles contained in used lubricant oil samples that collected from the engines, generators and gearboxes of a commercial marine ship. Flash point, viscosity measurement, Ferrography analysis and energy dispersive X-ray analysis (EDX) have been employed to extract the relevant information about the physical aspects of used oil and the wear condition of the parts from generator, gearbox and main engine.

M. Lukas and R. J. Yurko [5] stated that Oil analysis spectrometers have been in use for the analysis of wear metals, contaminants and additives in lubricating oils for almost 50 years. They have become the mainstay and primary analytical tool of most machine condition monitoring programs based on oil analysis. Spectrometers have evolved from large instruments that take up the better part of a laboratory, to smaller table top instruments. Analysis times have decreased from hours to seconds and no longer have to be operated by experts to obtain excellent analytical results.

X. L Wanga and G. N. Zhang [6] stated to investigate the behavior of failure and recycling of lubricating oils, three sorts of typical 10w-40 lubricating oils used in heavy-load vehicle including the new oil, waste oil and regeneration oil regenerated by self-researched green regeneration technology were selected. The tribology properties were tested by four-ball friction wear tester as well. The results indicated that the performance of anti-extreme pressure of regeneration oil increase by 34.1% compared with the waste one and its load-carrying ability is close to the new oil; the feature of wear spot are better than those of the waste oil and frictional coefficient almost reach the level of the new oil's. As a result, the performance of anti-wear and friction reducing are getting better obviously.

Syazuan Abdul Latipa, Salmiah Kasolanga and others [7] proposed that Traces of wear metals in used operating lubricant by principal vary in origin and its concentration value. These wear metals concentration obtained from the used lube provide vital information regarding the cause and level of the deterioration existed and progressed in operating mechanical component. It has been affirmed that the occurrence of severe wear metals appeared to act as a catalyst that could speed up the degradation of a particular lubricant used during operation. It has been well recognized that, spectrometric analysis is exceedingly practical for the reason of quantitatively and qualitatively evaluate the elements of additives, contaminants and wear metallic particles presence in lubricating oil.

From this study researcher concluded that, the occurrence of wear by product of these elements presence in the mechanism can be classified as benign wear and the presence of wear particles on both mission profiles considered as normal wear particle mode and within the accepted wear severity limitation.

Sreten Perić1, Bogdan Nedić, Dragan Trifković, Mladen Vuruna.[8] Investigated that, tribological tests that are part of the oil analysis and are used to access the condition of the system. Furthermore, the results of experimental research on the tribological characteristics of the oil sampled from engines and gear transmissions of the vehicles All of these road vehicle were in regular use by the Serbian armed forces. The performed research has revealed some significant changes in the tribological characteristics of oil for engine and gear transmission lubrication. These changes directly depend on the condition of the entire engine and transmission elements, i.e. depend on their functional characteristics. The method of oil analysis should contribute to an early detection of failures due to friction and wear processes in vehicle engines and reduce the need for preventive maintenance.

Final conclusion on lubricating oil analysis from researchers work as below

1. Used lubricating oil contains so many abnormal wear debris which results in the decrease of anti-wear performance of lubricating oil.[1]
2. Oil monitoring is tool determine lubricant useful life.[2]
3. Analytical Ferrography is among the most powerful diagnostic tools in oil analysis in tribology.[3]
4. Wear particle analysis is an effective means to identify and respond to maintenance needs of marine ships machineries.[4]
5. Oil analysis spectrometers are used for the analysis of wear metals, contaminants and additives in lubricating oils.[5]
6. Use of regeneration oil is more beneficial than use of new oil.[6]
7. Wear metals concentration obtained from the used lube provide vital information regarding the cause and level of the deterioration existed and progressed in operating mechanical component.[7]
8. The method of oil analysis reduce the need for preventive maintenance.[8]

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