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Wear Particle Analysis Using Ferrography

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ABSTRACT

The Ferrographic analysis of wear particles contained in used lubricant oil samples that collected from the engines and gearboxes of a Hero Honda Splendor bike. Ferrography analysis and elemental analysis have been employed to selection the material information about the physical point of used oil and the wear condition of the parts from gearbox and main engine. The application of wear particle analysis and ferrography in particular is an effective means to identify and respond to maintenance needs of bike engine.

Keywords: Lubricant oil, ferrographic analysis, wears particles, elemental analysis.

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I. Introduction

Ferrography is a wear particle analysis utilizing diagnostic and predictive techniques to evaluate the on-line condition of interacting lubricated or fluid powered parts or components. The use of Ferrography to assess a system’s condition is to avoid time consuming and potentially damaging hardware teardown and other destructive or interfering inspections. Ferrography can analyze a system’s fluid to determine the type of wear it is experiencing and hence, predict the type of system failure and when the failure may occur. Ferrography can provide an established and easily performed inspection method for determining the health of a system and providing an early failure detection method. Ferrographic analysis encompasses wear (metallic and non-metallic), contaminant (crystals, water, and organic and inorganic compounds), and lubricant (friction polymers) monitoring.

1.1 Ferrograph analysis apparatus

The particles are separated on a serve object glass where due to its displacement in a special magnetic field (with a very high field gradiation) causes the particle should be sorted according to size. The largest particles are unload first while smaller ones travel farther with the flowing oil. The density i.e. the attentiveness of particles at a single location on the ferrogram is measured with a optical densitometer by allowing light to pass through it. The wear index SA = AL2-AS2 is obtained by the comparison of the density AL of the large particles and the density AS of the small particles.

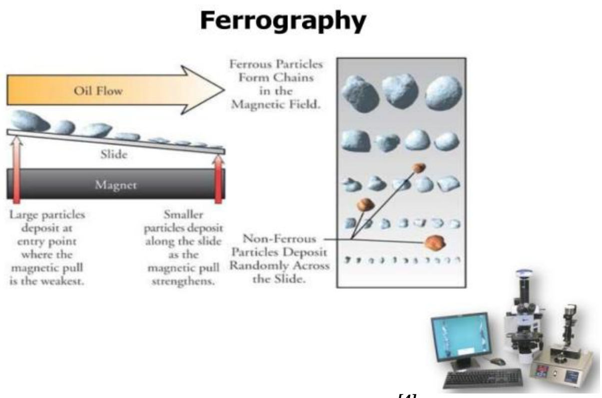

Fig1.1. Ferrograpy [4]

1.2 Types of ferrograph instruments

Two basic types of ferrograph instruments are used to assess the wear particles.

- Direct reading ferrograph System
- Analytical Ferrograph system

1.2.1 Direct reading ferrograph System

The direct reading ferrograph, shown in Fig1.2.1.1, measures the concentration of wear particles in a lubrication oil or hydraulic fluid. The particles are subjected to a powerful, magnetic gradient field and are separated by order of decreasing size.

Fig 1.2.1.1 Direct Reading Ferrography System [1]

Particles 5 µm and larger are confined to the entry end of the deposition field, as shown in Fig. 1.2.1.2. The particle sizes become progressively smaller along the deposition path.

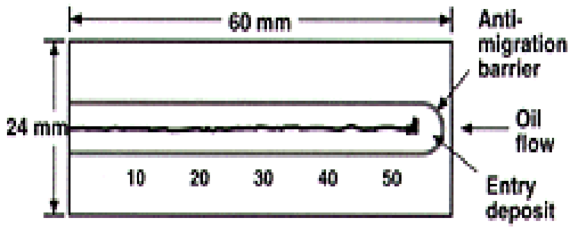

Figure 1.2.1.2 In A Direct Reading Ferrograph, Wear Particles In An Oil Or Fluid Are Deposited Subject To A Magnetic Gradient And Are Separated By Decreasing Size. [1]

Particle attentiveness are sensed at two locations—at the entry deposit and at a point approximately 4 mm further down the tube. Based on the calculation of the density of large particles, DL, and the density of small particles, DS, we can derive values for wear particle concentrations and the percentages of large particles. With these measurements, machine wear baselines can be established, and trends in wear condition can be monitored. This system direct ferrograph readings serve to alert maintenance personnel to an abnormal trend in wear.

1.2.2 Analytical ferrography system

When direct ferrograph readings indicate abnormal wear, analytical ferrographic techniques can be used to study the wear pattern. The purpose is to pinpoint the difficulty and identify the nature of potential machine problems. Analytical ferrograph system includes:

1. A ferroscope for measurement and analysis
2. The FM Ferrograph, which accurately prepares ferrograms, or slides on which wear particles have been deposited
3. The PASSPORT SOFTWARE system for data management and reporting.

1. Ferroscope

The ferroscope is a three-power bi-chromatic microscope with a CCPC camera for recording digital images. Under magnifications of 100X, 500X, and 1000X, the ferroscope utilizes both transmitted and reflected light sources with red, green, and polarizing filters to distinguish the size, composition, shape, and surface of both metallic and non metallic wear particles.

2. Ferrogram maker

The FM ferrogram maker, shown in Fig. 1.2.2.1, is designed with two independent stations to permit two samples to be prepared at the same time. Each station includes a holder that accurately positions a slide at a slight incline over the machine assembly.

Fig 1.2.2.1 The FM-Ill Ferrograph, An Instrument In The Analytical Ferrograph System, Prepares Ferrograms For Analysis [1]

Ferrograms, as depicted in Fig 1.2.2.1 can be prepared automatically, semi-automatically, or manually at the operator's option. In the automatic mode, the oil sample is deposited on the glass slide at a carefully controlled rate. At the end of the sample discharge cycle, the wash cycle is automatically initiated, and an audio and visual signal indicates when the ferrogram is complete. A sample of used fluid, which can be a lubricant pre preparation, a hydraulic fluid, or an aqueous solution, is prepared by diluting with tetrachloroethylene (actisol) as a fixer to improve particle precipitation and adhesion.

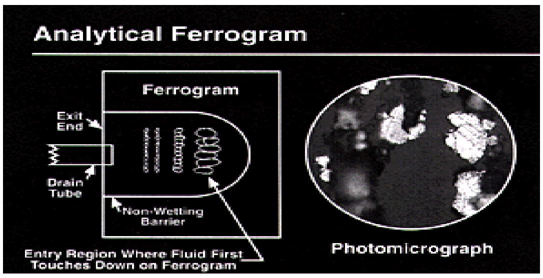

Figure.1.2.2.2 Ferrograms are prepared by depositing an oil sample on a glass slide. Showing particles lined up in strings, the sample on the left was taken at close to the entry deposit, at 50 mm

PASSPORT SOFTWARE SYSTEM

The Passport Software features the Passport system for enhanced data management, comparative analysis, and reporting. As shown in **Fig. 1.2.2.3,** the system features a video camera that projects the image through a personal computer to a high resolution video monitor.

Fig 1.2.2.3 The PASSPORT Analytical System [1]

II. LITERATURE REVIEW

The aim of the literature review was to get the detail about the approach of methodology adopted in carrying out wear particle analysis using Ferrography.

Raymond .J.Dalley (1990) [1] stated that a ferrographics analysis of wear particles starts with the magnetic separation of machine wear debris from the lubricating, grease, or hydraulic media in which it becomes suspended.

R. Gligorijevic, J. Jevtic and D. J. Borak (2006) [2] stated that the reduction of harmful pollutant emissions as well as CO2 emissions emanating from motor vehicles will beof considerable interest in the coming decades. Emissions legislation will be the guiding principle in the developmentof new technologies and vehicles.

N.Govindarajan& R. Gnanamoorthy (2008) [3] states that failure analysis of the rolling sliding contact fatique specimens tested at the different contact stress and slide roll ratio are carried out .Severe running in wear particles are ferrogram prepared in the sintered materials while the concentration of the wear particles is less in the wrought steels

O. Levi Æ N. Eliaz (2009) [4]A sensitive, reliable procedure was developed for condition monitoring of an open-loop oil system, based mainly on Analytical Ferrographythis is the first demonstration in the literature of the use of Analytical Ferrography for health monitoring of an open-loop oil system. The method is already used on adaily basis.

M.C. Isaa, N.H.N. Yusoffa, HasrilNaina, MohdSubhi DinYatia, M.M. Muhammada,IrwanMohd Nora (2013) [5] The observed morphology of wear particles using ferrographic analysis, particularly in the iron-containing debris, indicate the involvement of two types of wear mechanisms, namely normal rubbing wear which generates very small iron particles in the range of 1–15 µm or less, and abrasive wear, which is caused by particles with size of 15–50 µm. Thepresence of abnormal wear particles will cause the lubrication system to not work efficiently and at the same timedestroy parts of the metallic components.

ZbigniewStepien, Wieslawa Urzedowska, Jan Czerwinski (2014) [6] the results obtained in these investigations indicate the kind of lubricating oil base stock and its improvement way, as well as type of engine and its service conditions as very important factors affecting the engine oil performance depreciation.

Yuesen Wang, Xingyu Liang, GequnShu, LihuiDong (2015) [7]Lubricating oil contributes to both small and large size particles. However, conclusion that large particles mainly from the unburned organic and metallic additive fraction should be further verified in future works. The combustion ratio of oil determines its influence. Low combustion ratio donate to lose aggregate structure, while high ratio contributes to compact one. Oil-related particles have larger collection size than neat diesel particles, which may be caused by the unburned organic and metallic ash fraction in particles.

Chandan Kumar, Dr. Manoj Kumar (2016) [8] stated that Ferrography is a method for analyzing the particles present in fluids that indicate mechanical wear. Ferrography supply Microscopic Examination and Analysis of Debris (particles) found in lubricating oils. These particles contain of metallic andnon metallic matter. The metallic particle in a wear condition that separates different size and shapes of metallic dust from components like all type of bearings, gears or coupling (if lubricated in path). Non - metallic particle contains of dirt, sand or corroded metallic particle. Analytical ferrography is among the most powerful determination tools in oil analysis in tribology. When execute correctly it provides tremendous information on machine under operation. Yet, it is frequently excluded from oil analysis programs because of its comparatively high cost and a general misunderstanding of its value. Performance may be upgrade through proper filtration of oil. Clean oil lubrication is always more effective. Adopting approach of oil replacement is expensive. A rapid centrifuged and/ or magnetic separator cleaning structure helps cost cutting and disposal of used oil, as well. Ferrography also helps upgrade filtration efficiency and frequency for oil cleaning systems. The objective of their work was to present the ferrographic analysis of wear particles contained in used lubricant oil samples that collected from the engine of dumper, A heavy vehicle that normally used in coal mines. The supplication of wear particle analysis and ferrography in particular is an effective means to identify and respond to maintenance needs of Engines and machineries.

PRABIR KUMAR BANDYOPADHYAY,RAM BALAK CHOUDHARY ,RAVIRANJAN PRASAD (2017) [9] States that Wear particle analysis provides that earliest warming of component failure in the lubricant path .The analysis can pinpoint the specific failing elements ,saving on both the cost of repairs and downtime associated with equipment maintenance. Continuous monitoring through diagnostic techniques is helpful for prevention of failure of machine.

A.K. SINHA, V.N. KONDA, M.D. SOMAN PILLAI &V.S. SRINIVASAN [10] studied the Ferrography as a diagnostic predictive maintenance tool that is available to alert problems early in rotatory and reciprocating machinery. The particle of abnormal and accelerated wear generated by each of the mechanism can easily be recognized by their shape, size and texture appearance. Thus, wear particle analysis can avoid failures and can also pinpoint the root cause of problem. It was capable of indicating the rate of wear, severity of wear, type of wear and location of wear for the equipment well in advance. Their work will provide an overall view on the application of ferrography for identifying primary modes of failure in critical equipments of Indian Nuclear Power Plants. The trending of particle quantification (PQ) index was found suitable for trend analysis of the wear process. The normal, alarming and severe levels of wear in terms of PQ index were being established. Their aim was realized on the strength of extensive experimental work on oil samples drawn periodically/regularly from machine.

III. CONCLUSION

The study about Ferrography today has advanced as one of the premier predictive maintenance tools. Ferrography can be valuable in helping to determine the maintenance needs for machinery by identifying the specific conditions of machine wear.

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