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LOW COST DEBRIS ANALYSIS FOR INDUSTRIAL MACHINERY CONDITION EVALUATION

S. RAADNUI

Department of Production Engineering, Faculty of Engineering
King Mongkut's Institute of Technology North Bangkok
1518 Pibulsongkram Road, Bang-Sue, 10800, Bangkok, THAILAND

Abstract

In any mechanical system consisting of gears, shafts and/or bearings, the majority of metallic particles deposited into and carried by the lubrication system originate from the deterioration of oil-wetted working surfaces, even in proper lubrication system, due to failure mechanism (s) such as wear, fatigue and fretting corrosion. Determination of the point at which transition from normal to abnormal or to actual damage occurs has become a focus of attention in research activities for years, because it has been recognized that reliable, economic operation can be achieved through appropriate preventative measures. Known collectively from "all size wear debris analysis" as early failure detection, the methods of testing for damage differ considerably, range from a micron or a sub-micron size debris analysis to Magnetic Chip Detector (MCD) ferrous debris analysis. This paper will be focused on the utilization of the low-cost analysis techniques for evaluation of industrial machinery condition.

Keywords : Debris Analysis, Machinery Condition

1. INTRODUCTION

In condition monitoring of machinery, in general, the "High-Tech" and high cost equipment is normally employed i.e. vibration meter, thermography, used oil analysis apparatus. However, in some places of the world, it is hardly be a good practice to invest for such a thing. On the other hand, a big burden of "breakdown maintenance cost" is also an industrial bust to conquer. Hence, the need for low cost condition monitoring technique is inevitably. Generally, in an oil-lubricated machinery, three basic ways in performing used oil analysis, at low cost, are evidences: Filter Debris Analysis (FDA), Used Lubricant Debris Analysis and Magnetic Chip Detector (MCD) Ferrous Wear Particle Analysis. Majority of tribosystem failure starts from a cheap component primary failure and lead to a more severe failure form i.e. secondary failure of a system or catastrophic failure in a worst case.

2. AN INCLINED PLANAR CHROMATOGRAPHY

This newly developed technique (being in a process to apply for U.S. patent) is a quick and simple test used to estimate the general condition of lubricant. It involves placing one or two drops of used lubricants on an inclined blotter paper (either 240M grade or Whatman No.4 filter paper). The oil drops spread out and dry, the large particles remain within a center corona. Further dispersion leads to oil penetration and filtration through the paper. A sharply defined corona around the oil-wetted area indicates the present of sludge. A good degree of correlation is found between a conventional blotter paper test method and an inclined planar chromatography method as shown in Figures 1 and 2 [1].

Fig. 1(a) Poor dispersancy **Fig. 1(b)** Good dispersancy

Fig. 1 Typical result of an oil spot test (conventional method)

Fig. 2(a) Poor dispersancy **Fig. 2(b)** Good dispersancy

Fig. 2 Typical result of an oil spot test (new method)

3. MAGNETIC CHIP DETECTOR (MCD) FERROUS WEAR PARTICLE ANALYSIS

In power transmission such as gearboxes, crankcases or final drives, failure of one part will cause a chain reaction of secondary failure. If "impending failure" can be identified at an early stage, then suitable preventive measures can be planned in advance. This identification is the objective of the MCD through ferrous wear debris monitoring at strategic positions in the lubrication system. Typical MCD ferrous wear particles from industrial gearboxes are shown in Figures 3 to 5 [2].

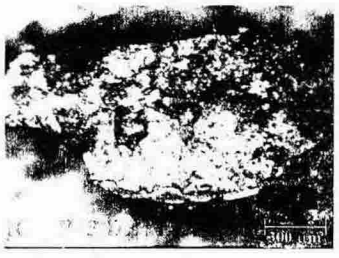

Fig. 3 Free-ferrous fatigue wear particle

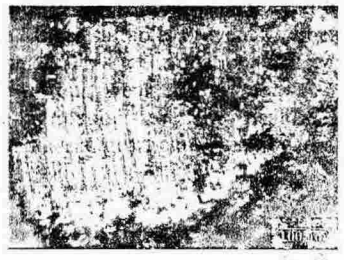

Fig. 4 Free-ferrous severe sliding wear particle

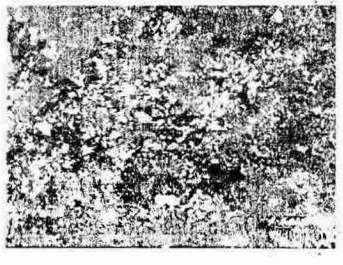

Fig. 5 Free-ferrous rubbing wear particles

4. CONCLUSION

The low cost used oil and wear debris analysis program that has been implemented for industrial application has proven to be useful diagnostic tool for condition monitoring. It is able to distinguish between normal wear of internal components and potentially damaging abnormal wear situations and, in the case of abnormal wear, is able to identify possible wear mechanism (s). The low cost techniques have been found to be correlated with other condition monitoring techniques already in use and, in many instances, have been the determinant of whether a system is to be removed for overhaul [2].

5. ACKNOWLEDGEMENTS

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6. REFERENCES

[1] Raadnui, S., "Low cost machinery health monitoring through used lubricant analysis", to be presented at 2nd International Conference on Research and Development in Mechanical Industry (RaDMI 2002), 02-04 September 2002, Vrnjacka Banjo, Yugoslavia.

[2] Raadnui, S., "Magnetic Chip Detector (MCD) ferrous wear particle analysis", presented at 57th annual meeting of the Society of Tribologists and Lubrication Engineers (STLE), 19-23 May 2002, Houston, Texas, USA.