APPLICATION OF MONITORING TECHNIQUES TO SUPPORT WEAR PREDICTION AND TO ESTIMATE COMPONENT LIFE TIME

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1 INTRODUCTION

The application of effective condition monitoring techniques plays an important role in the prediction of failures on mechanical system. Currently, over forty techniques for mechanical system condition monitoring are available. This paper describes condition monitoring procedure for reliable evaluation of machine's condition, diagnosis and residual life prediction. Condition monitoring procedure is based on the results obtained from Used Oil Analysis (UOA), Wear Particles Analysis (WPA) and Vibration Analysis (VA). The combination of all three techniques is used for reliable determination of source, cause, severity and trends of failures on machine elements of mechanical system.

2 CONDITION MONITORING PROCEDURE

Condition Monitoring Procedure for diagnosis failure and residual life prediction of the machine elements of mechanical system is shown in Figure 1. The procedure consists of four main parts: UOA tests, WPA, VA and Maintenance actions.

USED OIL ANALYSIS (UOA)

The main goal of the UOA tests is to measure oil parameters for determination of oil condition and cause of lubricant degradation. Many different tests are available to measure oil parameters and contamination. For reliable estimation of the lubricant conditions viscosity, total acid number, total base number, oxidation, water content and quantity of particles have to be measured. If measurement of these parameters is unsatisfactory, supplementary tests must be carried out to determine whether or not the oil is suitable for further service.

WEAR PARTICLES ANALYSIS (WPA)

Diagnosis of the machine state should be based on shape, size, quantity and chemical composition of wear particles.

Quantitative analysis

For quantitative analysis spectrometric techniques (SP) and/or direct reading ferrography (DRF) can be used.

For determination of the elemental concentration in the oil samples spectrometric method with acid dissolution technique is used. To decide whether elemental concentrations determined in the oil samples taken in successive intervals are significantly different, analysis of variance is applied. The mean squares F value is then calculated and compared with the critical F value which corresponds to a confidence level of 95 percent.

DRF measures the concentration of particles in lubricants. Based on the measured density of large particles, DL, and density of small particles, DS, values for wear particles

concentrations, percentages of large particles or severity index (Is) can be derived. If the calculated severity index ,Is , increases and exceeds the mean value of severity index, Ism, in the range of standard deviation , the result obtained for this sample is different from the previous one and abnormal wear is expected.

Qualitative analysis

When SP or DRF analysis indicate abnormal wear, analytical ferrographic technique to study the wear pattern is used. The ferrogram maker is an instrument in the analytical ferrograph system for preparing ferrograms for analysis. On the ferrogram wear particles arrange along the slide, with the largest particles being deposited first. Ferrous particles line up in strings that follow the magnetic field lines of the instrument. Non-ferrous particles and contaminants travel down in a random distribution pattern not oriented by the magnetic field.

Ferrogram can be analysed using Bichromatic microscope or scanning electron microscope (SEM). Bichromatic microscope utilises both transmitted and reflected light, sources with red, green and polarising filters to distinguish the size, composition, shape, and texture of metallic and non metallic wear particles. A scanning electron microscope with energy dispersive X-ray analyser (EDAX) can be used to asses the shape, size and origin of the wear particles.

VIBRATION ANALYSIS (VA)

Vibration analysis is divided into time domain, frequency domain and statistical analysis. Computer program for acquisition and analysis consists of data acquiring system, data acquisition board with signal conditioning accessories, software and data storage units. Vibration signals are simultaneously sampled from data acquisition units and stored on data storage units.

For comprehensive assessment of the mechanical system condition a combination of UOA, WPA and VA is used.

3 MAINTENANCE ACTION

Maintenance actions are based on the results and a database obtained from the UOA, WPA and VA. The diagnosis of a mechanical elements condition is based on the results obtained from vibration and wear particles analysis. A relatively well-trained person has to identify:

Which element is affected?

What is causing the damage?

How far the damage has progressed?

Recommended maintenance action is the final answer to this questions. For prediction or estimation of the residual life an indetification of the trends and a history of damages on machine elements of the mechanical system is needed.

4 REFERENCES

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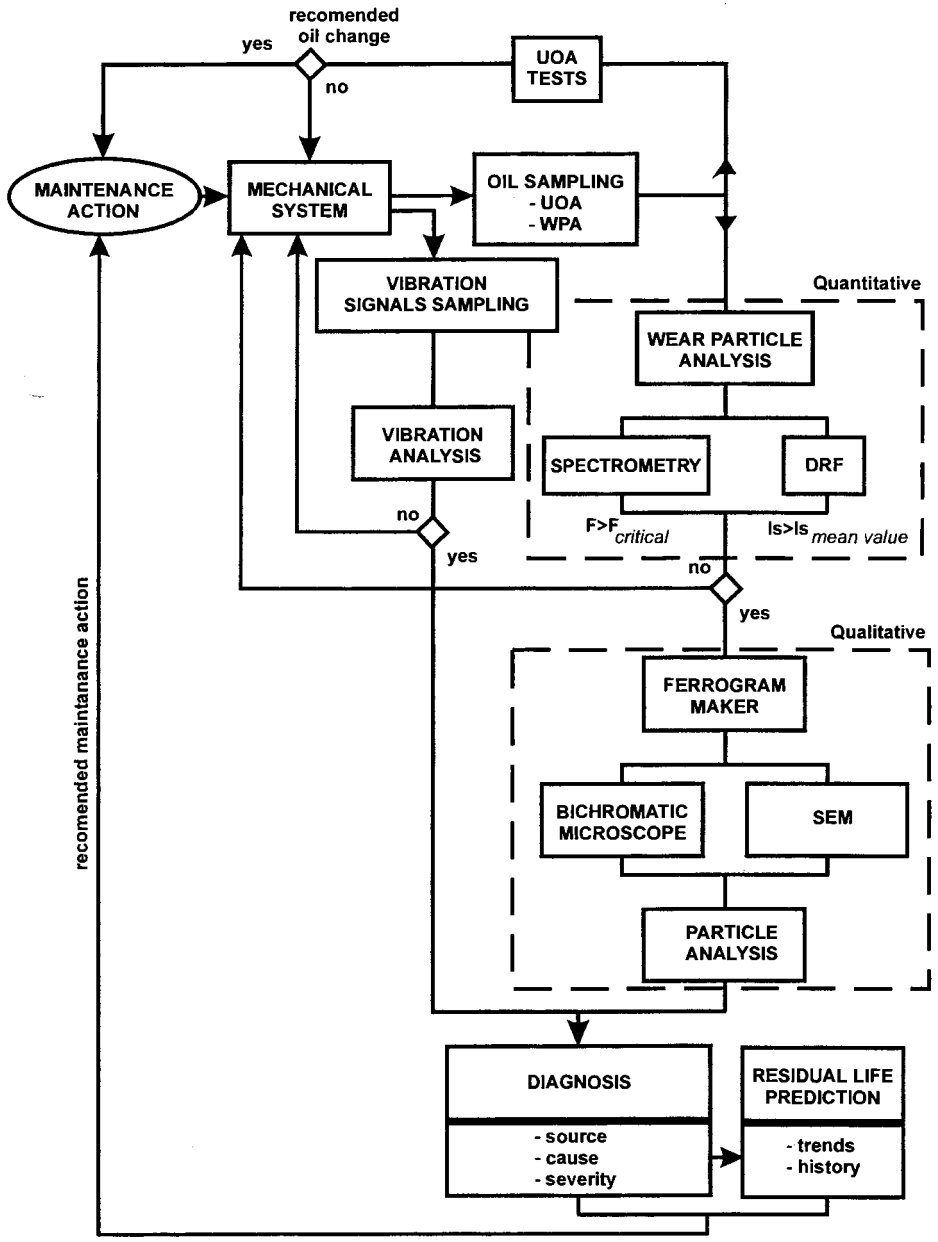

UOA - Used Oil Analysis
WPA - Wear Particles Analysis
SEM - Scanning Electron Microscope with Energy Dispersive x-ray Analyser
DRF - Direct Reading Ferrograph

Fig. 1: Condition monitoring procedure for prediction failures on mechanical system.