An investigation to detect leakage of oil using wear debris analysis in journal bearing of 1 MW hydel power plant

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Abstract:
In the hydel power plant a small leakage of water is comman hence it is difficult to detect the leakage of oil from naked eye. The leakage of oil is experienced by the level indicator of oil tank. Based upon the complain of decreasing oil level in the oil tank frequently, it is decided to monitor the whole oil channel as well as bearing on the periodic basis. In the monitoring process, Wear particle analysis as well as temperature of oil inside bearing and pressure of oil inside the bearing was considered. wear debris was filtered using vacuum pump and filter paper and then it is analyzed based upon their aspect ratio(Major length/ Minor length), its color and the length of particle. It is found in investigation that there are (non metallic wear (irregular and large) that can be co-related with oil seal. It is investigated that the leakage of oil is mainly because of wear and tear of oil seal.

1. Introduction:

It is recommended for doing predictive maintenance of hydel power plant for maximize the profile and minimize the maintenance cost. It is not recommended to take shut down of hydel power plant without proper diagnosis since it may lead to huge economical losses of the company[1]. So it is a general practice to do condition monitoring of hydel power plant equipment to minimize the shutdown of machine. Classification of wear debris plays an important role in the fault finding process[2]. Based upon the shape and size of wear debris it can be easily predicted about types of fault and their location. Some artificial intelligence and expert system e.g. relational grade analysis is used for the classification of wear debris. Relational grade analysis has the potential to describe the distinct properties of wear debris and identify those using numerical parameters[3]. Color of particles also having the potential to detect the location and parts from where it is coming.

2. Experimentation:

Experimentation was carried out in mangle hydel power plant of 1 MW Francis turbine. Focus of the study is to condition and monitor of journal bearing that couples the Francis turbine to 3 phase power generator. There was a continual observation regarding leakage of lubucating oil from the system (entire hydraulic pack includes from oil tank to bearing via pump and pipe line). In the due process of condition monitoring, there are various steps involves e.g. collection of oil samples, filtration of oil samples by means of vacuum pump, washing of filter paper using carbon tetrachloride, microscopic view of filter paper to analyze the fault.

Four oil samples in volume 30 ml have been collected from exit pipe line. The oil samples are passed through filter paper of mesh size 2.5 micron with the help of vacuum pump as shown in figure 01. After filtration of lubricating oil, the filter paper is washed in carbon tetra chloride solution for removing oil and dirt from the filter paper. The filter paper is heated up to 70^{o} Celsius for removing the carbon

tetrachloride from filter paper. Microscopic view of filter paper is taken at various places as shown in figure 02. The magnification power of Lica microscope is 100X.

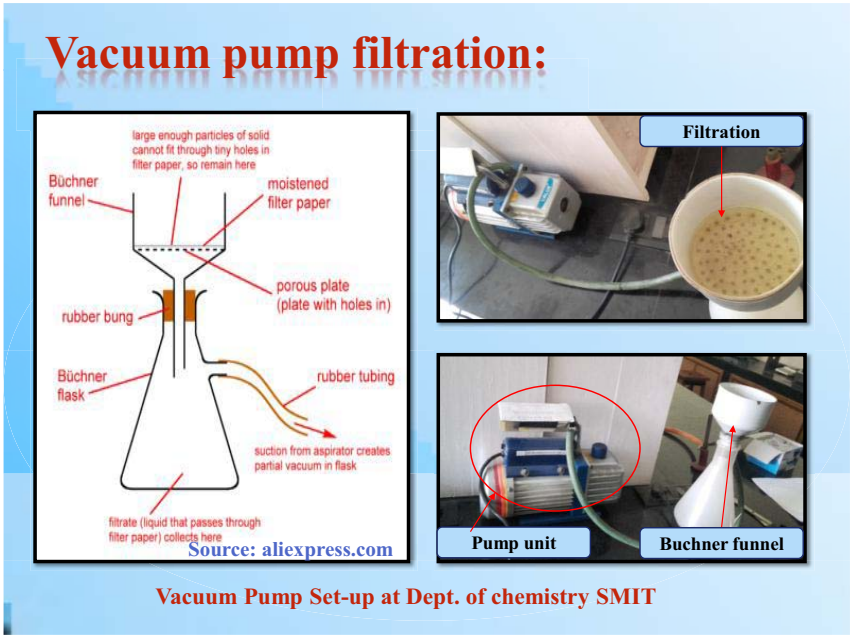

Figure 01: Set-up of vacuum pump filtration

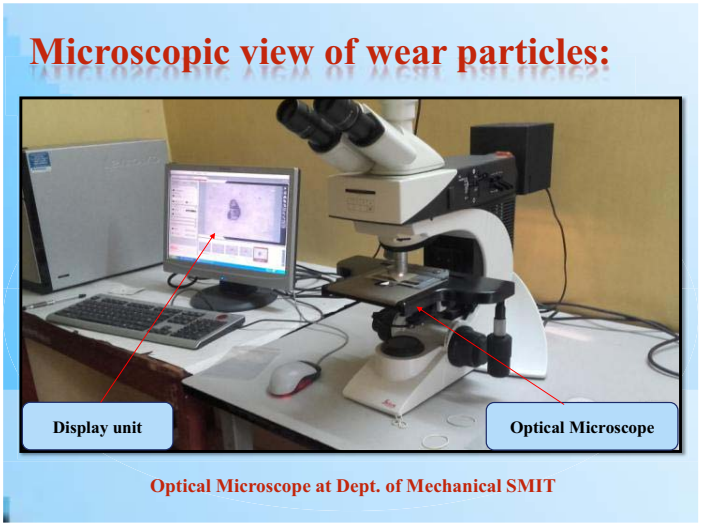

Figure 02: Set-up for acquiring microscopic view by Lica Microscope.

3. Result and discussion:

3.1 Extra long particles

It is observed by experimentation that there are a big difference in between organic particle and inorganic (metallic) particle by its lustre and geometry. Generally ferrous metal have a white bright lustre and sometimes blackish (because of oil deposition). In the journal bearing possible metallic contamination is of babbit and ferrous (both are of white lustre). Here from figure 03(A to F) and figure 04, it is quite clear that longer particle shown in figure 03 do not belong to babbit and ferrous because of its red color and high aspect ratio hence it can be concluded that the red particles visible in oil sample may belong to some organic parts. The only organic parts that attached to the journal bearing are polymer oil seal.

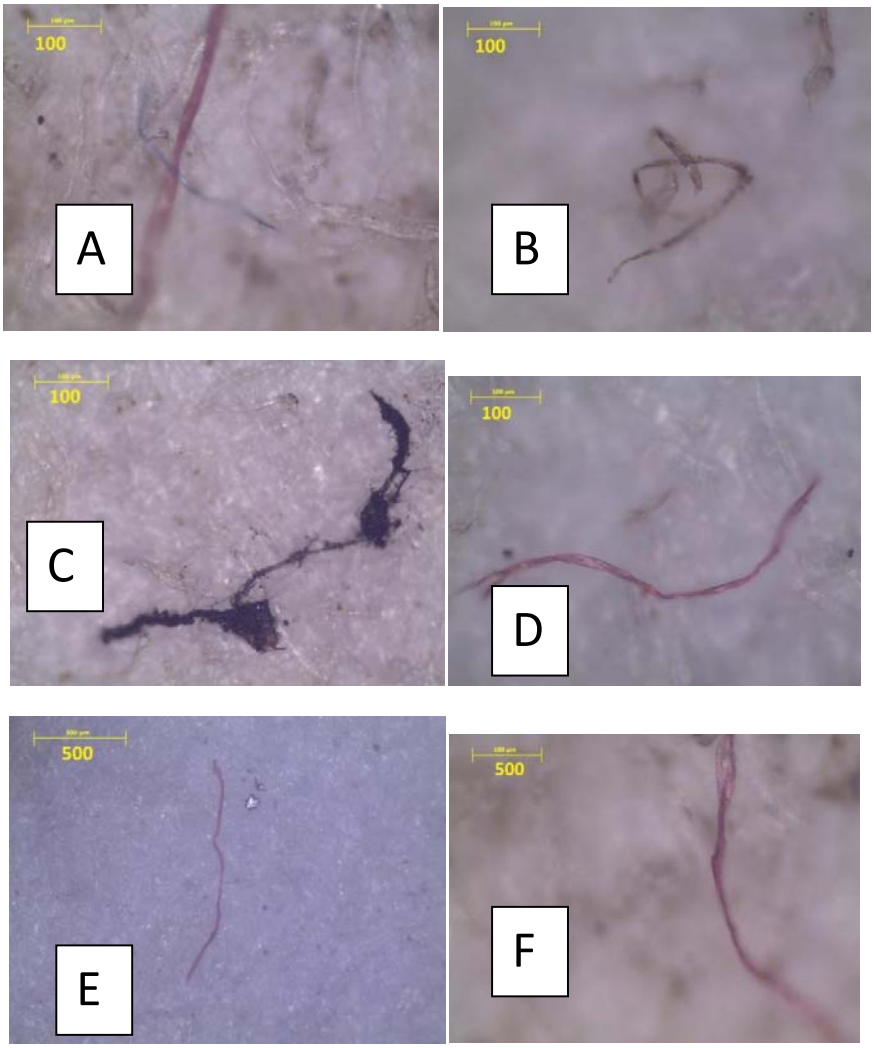

Figure 03: Microscopic View of organic particle

Cause of leakage may correlate with the wear and tear of oil seal and it can be recommended to replace the oil seal to prevent wastage of lubricating oil.

3.2 Aspect ratio analysis

Aspect ratio of particles have been plotted in figure 04 where it is evident that percentage of particles having aspect ratio more than 5 micron is continuously increasing from sample 1 to sample 4. Increasing aspect ratio determines that there is a sliding contact between journal and bearing because of drop in hydrodynamic pressure inside the journal bearing. Drop in hydrodynamic pressure may because of leakage of lubricating oil.

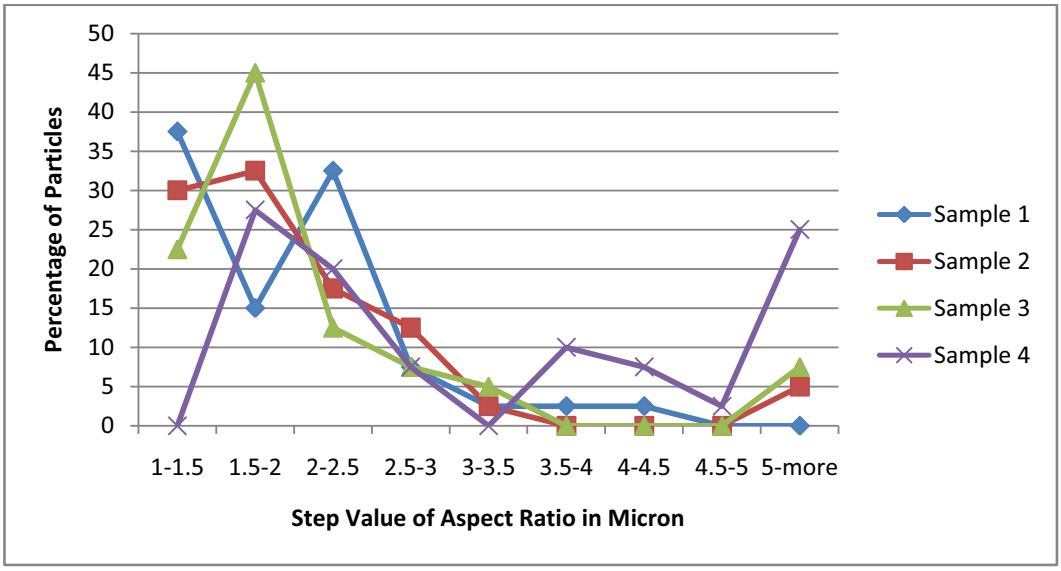

Figure 04: Percentage distribution of aspect ratio of particles

3.3 Temperature Analysis

The temperature of journal bearing is recorded as shown in figure 05 and it is found that the temperature of journal bearing has suddenly increased from sample 3 to sample 4. It may because of increase in frictional force due to decrease in hydrodynamic film thickness. Hydrodynamic film thickness is decreasing because of leakage in lubricating oil .

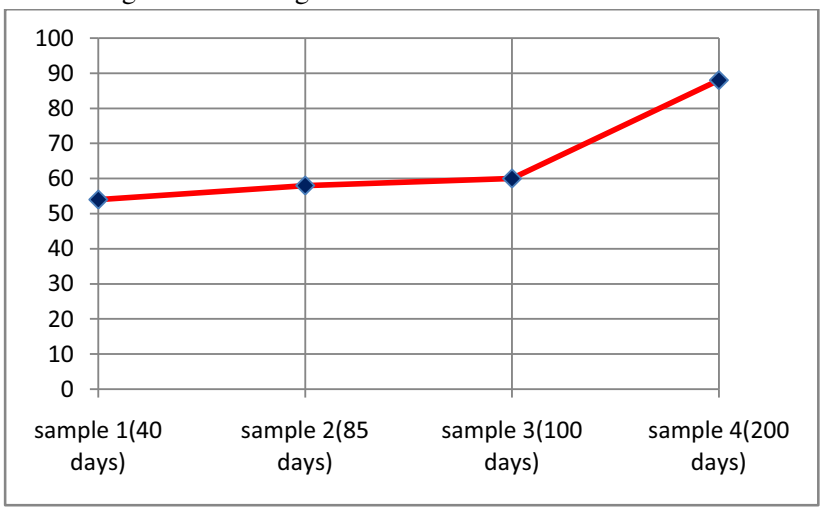

Figure05: Temperature rise of journal bearing

4. Conclusion:

The study is having enough potential for conditioning and monitoring of journal bearing in hydel power plant.

I. Extra high value of aspect ratio indicates the wear and tear of oil seal that is generally made up of organic compound.

II. Continuous increase in aspect ratio is potent enough to predict sliding contact in between the journal and bearing that may because of drop in film thickness because of oil leakage.

III. It can be concluded from the rise in temperature that frictional force is increasing because of drop in hydrodynamic film thickness that is because of pressure drop that can be further concluded in terms of leakage of lubricating oil.

A recommendation can be given to prevent the leakage of oil by the replacement of oil seal. Wear debris analysis have the potential to detect the leakage of the oil in journal bearing.

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