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Oil Condition Monitoring of HEMM Gear Oil Using Atomic Emission Spectroscopy

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Abstract

Oil condition monitoring is considered to be one of the most important predictive maintenance tools. Since past few decades researchers have been doing oil condition monitoring for predicting the condition of lubricant as well as lubrication envelop. So far many of them have performed Atomic Emission Spectroscopy analysis for predicting the engine condition. But unfortunately till date only a few have been attempted the same for predicting the condition of gears by analyzing gear oil. In this work, gear oil analysis of heavy earth moving machines has been done with the help of Atomic Emission Spectroscopy analysis. Used gear oil has been collected at five different hours for analysis. From the analysis it has been seen that the gear oil analysis have predicted the health of gear oil as well as health of the gear properly.

Introduction

Since past few decades wear particle analysis have considered to be the most important tool to forecast the health of any machinery component [1]. Many researchers and industries [2, 3] are selecting Atomic Emission Spectroscopy method for wear particle analysis as this method involves very simple sample preparation method [4]. Oil condition monitoring technique basically opted to analyze three basic properties of lubricant, namely; the fluid property, fluid contamination and amount of suspended wear particle [5]. The wear particles that are generated and suspended in the lubricating oil due to various wear mechanism [6] are carrying several information [7]. Atomic Emission Spectroscopy tells us the number of these wear particle suspended in lubricating oil in terms of parts per million (ppm). In order to prevent the sudden failure of gear, condition monitoring of gear oil is an essential factor [8] but unfortunately only a few have tried the same with particle counting and shape analysis [9]. In this work particle counting method has been opted for forecasting the health of gear oil and gears in the gear box. In this work Atomic Emission Spectroscopy has been opted for the analysis of gear oil due to its well accepted superior outcome [10-14]

Experimental Analysis

In this work thegear oil of a Komatsu 100 Ton capacity dumperhas been collected at five different operating hours i.e. at 2069th hour, 2569th hours, 3069th hours, 3569th hours, and 4069th

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hours. The operating hours mentioned in this article are the total run time of the engine till the collection of the lubricating oil and certainly do not indicate the total run time of the lubricating oil. The data obtained for Atomic Emission Spectroscopy are shown in Table 1.

Table 1: Atomic Emission Spectroscopy data for gear oil

Hours	Fe	Cr	Pb	Cu	Sn	Al	Ni
2069	43	0.7	0.5	0.3	0	0	0
2569	69.4	7.8	0	0.9	0	0	7
3069	23.7	0.4	0.7	0.3	0	0	0
3569	62.8	0.9	0	0.3	0	0	0
4069	20.2	0.5	0	0.2	0	0	0
Hours	Ag	Si	B	Na	Mg	Ca	Ba
2069	0	1.7	0.1	1	0	1.9	0
2569	0	3.9	0.3	0.7	0	5	0
3069	0	0.3	0	0.7	0	9.6	0
3569	0	0.9	0.2	0.3	0	6.9	0
4069	0	3.4	0	0.8	0	5.8	0
Hours	P	Zn	Mo	Ti	V	Mn	Cd
2069	99.1	5	0.1	0	0.9	0	0
2569	138	1.6	0	0	0	0	0
3069	109	5.1	0	0	0.4	0	0
3569	99.7	3.9	0	0	0.4	0	0
4069	116	6.3	0	0	0.7	0	0.9

Result Discussion

From the Table 1 we can observe that few of the particles are either not found in the analysis or present in a very insignificant amount**.** Especially the amount of Pb, Sn, Al, Ag, Mg, Ba, Mo, Ti, Mn, Cd is zero or very less. So in this work the analysis for these materials will not be performed. Rather,the possible source of other materials will be discussed here. Iron debris is found inside the used oil when there is deterioration in cylinder liners, crankshaft, gears, and anti-friction bearing and so on. Chromium debris is answerable for ring, anti-friction bearing, cylinder liners, coating degradation. Nickel debris is generated because of the degradation of anti-friction bearing, turbine additives and so on. Vanadium particle are produce due to valve and gas contaminant. Higher amount of copper is answerable for wear in simple bearing. Calcium, zinc, phosphorus, sulphur, and boron indicates the degradation of oil additive. If the quantity of those metals is found in higher quantity in oil then it taken into consideration that the lubricating oil has been degraded. Sodium and silicon are majorly present due to see water and dart access respectively.

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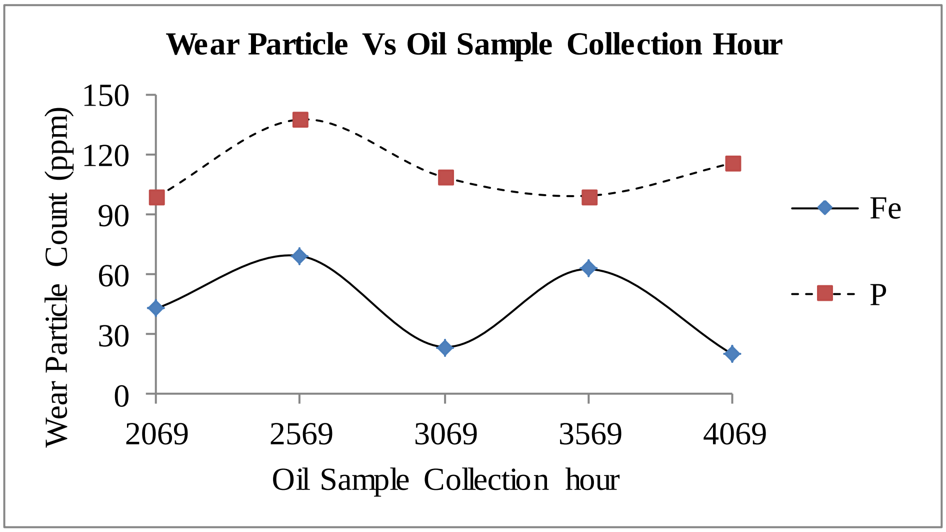

Figure 1: Wear Particle concentration of Fe, and P

From Figure 1 it has been seen that the amount of Fe and P was abnormally high at every sampling hours. The possible source for Fe and P wear particle in the gear box are gears and bronze component. This statement signifies that there is some amount wear particle are generating form the gear surface due to in appropriate loading in the gears.

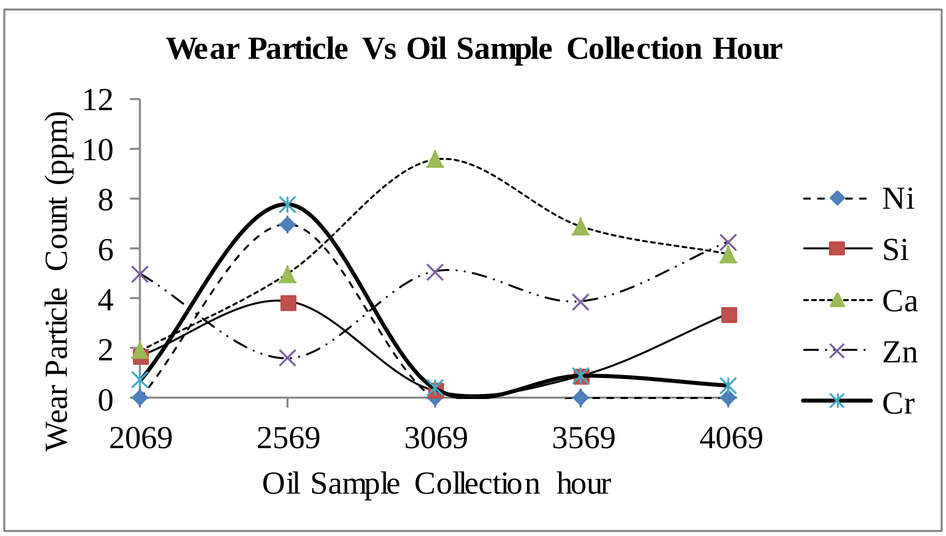

Figure 2: Wear Particle concentration of Ni, Si, Ca, Zn, and Cr

From Figure 2 it has been observed that at the second sampling hour the amount of Ni, Si, Cr, and Ca particle concentration is a bit higher as compared to the other sampling hour. Although this value is not considered as the abnormally high, but as this is a comparatively new gear box, then this reason needs to be analyzed. The possible source for these particles is the grease and the gear surface.

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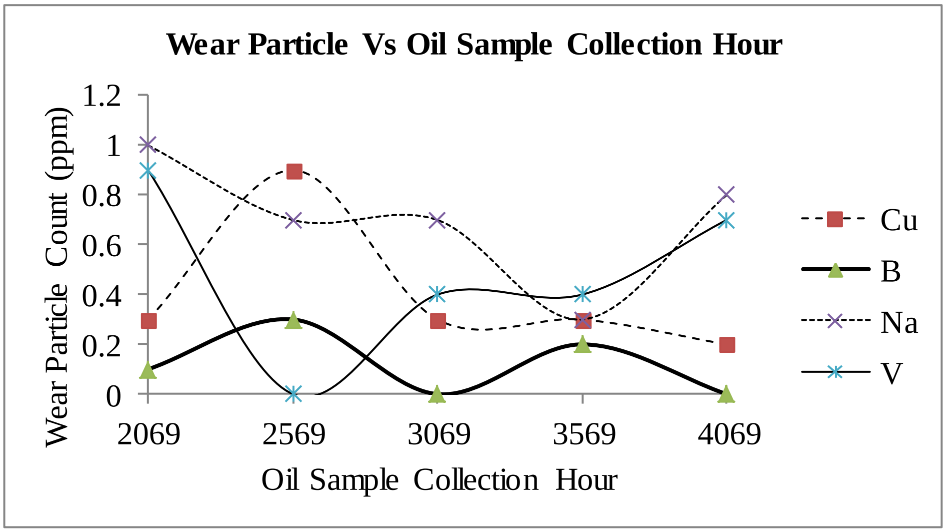

Figure 3: Wear Particle concentration of Cu, B, Na and V

In Figure 3 it has been seen that all the particle count are less than 1ppm. So this value is considered as the normal value. In other ward Figure 3 can be analyzed as the non-threatening data. In the second sampling hour the amount of Cu, Na and B was higher as compared to rest of the sampling hours. From Figure no 1 to figure 3 it can be seen that the wear particle concentration was always greater in second sampling hours. But later the particle concentration has been decreased.

Conclusion

In this work wear particle concentration in the gear oil has been analyzed by Atomic Emission Spectroscopy method. For the analysis purpose five times oil sample has been collected from the same gear box. It has been observed that the gear oil condition monitoring has produced a significant data which can analyze the current health condition of the gear oil as well as the wear scenario inside the gear box. It has been seen that even after 500 hours of run the gear oil did not degrade much, but at the second sampling hour the wear particle concentration was significantly higher as compared to the other sampling hour. It has also been observed that at the third fourth and fifth sampling hour the wear particle concentration has been decreased.

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