

Condition Monitoring of Used Lubricant of Dozer

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Abstract

Heavy mining equipment like dumpers dozers shovels are considered to be the backbone of the industries. Majority of the production is completely relying upon this heavy equipment. So for obvious reason the periodic maintenance is considered to be one of the most important concerns for the industries. In this work the Atomic Emission Spectroscopic (AES) analysis has been done for 15W30 Engine oil used in a BEML Dozer. From the analysis the wear particle suspended in the lubricant has been analyzed and counted in terms of ppm. From these wear particle analysis the part which is under abnormal wear condition has been figured out. For the test purpose used lubrication oil has been collected at five different hours of operation and the results of all these five different hours has been compared.

Introduction

Wear particle analysis is a very useful method to analyze machines reliability [1]. Atomic Emission Spectroscopy has proved its capability as one of the most important predictive maintenance tool for wear particle analysis since past few decades as this process does not need any complex sample preparation method [2]. This method has already been opted by many heavy equipment industries including mining and marine industries [3]. Oil condition monitoring are generally performed to understand three basic details of lubricant, they are the fluid property, fluid contamination and amount of suspended wear particle [4]. Atomic emission spectroscopy is used to analyze and count the suspended wear particles. Wear debris analysis for these heavy machines are very crucial as this can prevent the failure of the machines [5] otherwise failure of such machine is unavoidable [6].

Since many decades ago it was very well established facts that wear particles produced due to different wear mechanism [7]. Almost a century ago it was stated that the wear particles can specify the condition of friction of two mating surfaces [8]. Because of these properties of wear particle the analysis has gained interest among the researchers since mid of the previous century [9]. For all these reasons Atomic Emission Spectroscopy has been used in many industries for wear prediction as well as machine health forecasting [10-13]. It has also proved its superiority than any kind of predictive maintenance to identify wear mechanism and wear modes present in a machine [14-18].

Experimental Analysis

In this work the engine oil of a BEML Dozer has been collected at five different operating hours i.e. at 12500th hour, 12700th hours, 12900th hours, 13100th hours, and 13300th 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 results obtained from the AES analysis are tabulated in table 1

Table 1: Wear particle count in ppm

Hours	Fe	Cr	Pb	Cu	Sn	Al	Ni
12500	15	0.5	8	3	0.1	7	0
12700	28	0.9	9	12.6	0	2	0
12900	13	1.7	13	38	0	1.5	1
13100	10	0.6	4	5	0	3.2	1
13300	50	17	7	30	0	2.1	6
Hours	Ag	Si	B	Na	Mg	Ca	Ba
12500	0	7	1	3	5	3784	0
12700	0	7	11	6	3.2	3482	0
12900	0	4.2	2	72	4.8	2638	0
13100	0	3.1	1	5	31.2	3127	0
13300	0	6	21	9	11.2	2773	0
Hours	P	Zn	Mo	Ti	V	Mn	Cd
12500	1254	1734	5	0.1	0	2	0
12700	1254	1658	3	0	0.1	2	0
12900	1145	1638	9	0	1	1	0.1
13100	1169	1745	3	0	1.1	0.9	0
13300	1427	1534	2	0.2	1.8	0.2	0.1

Discussion

It has been seen from the Table 1 that the wear particle concentration at different hours are having many different and diversified value. It ranges between 0ppm to 3784 ppm. So it is not possible to plot all the data in a same graph, otherwise many data will not be visible. For the proper understanding of the wear particle count, the data of Fe, Cu, Na, Mg has been plotted in Figure 1. Figure 2 has been for Cr, Pb, Si, and Figure 3 has been plotted against the wear particle count of Al, Ni, Mo and Mn. Figure 4 Consists of the data of Ca, P and Zn

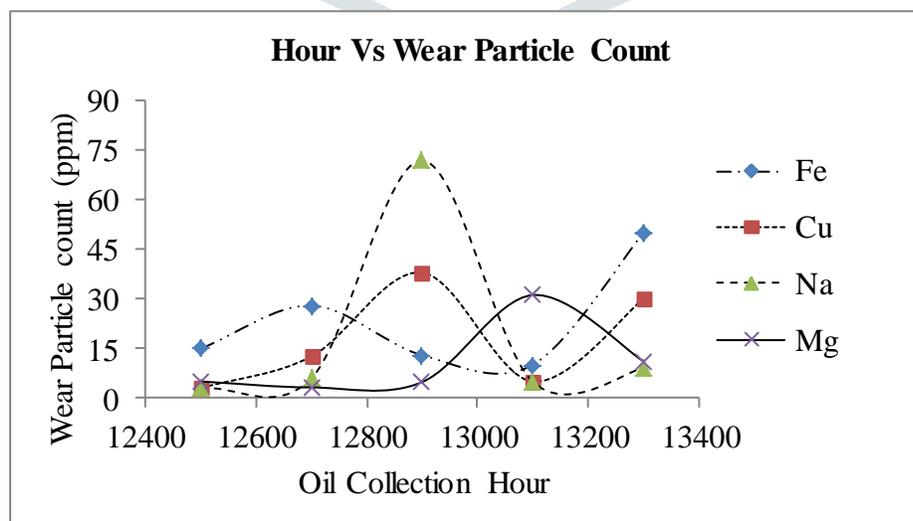


Figure 1: Wear Particle concentration of Fe, Cu, Na, Mg

From Figure 1 it has been observed that the wear particle count of copper and sodium has been increased abnormally at sixth sampling time. As the copper and sodium amount both has been increased together, we can assume that this may not a component failure but lubricant failure because both of them is conventionally use as oil additive. Simultaneously it can also be observed form Figure 4 that the quantity of Ca, P and Zn was also considerably high at the same sampling time then it can easily be predicted that the oil was degraded completely at the time of sixth sampling.

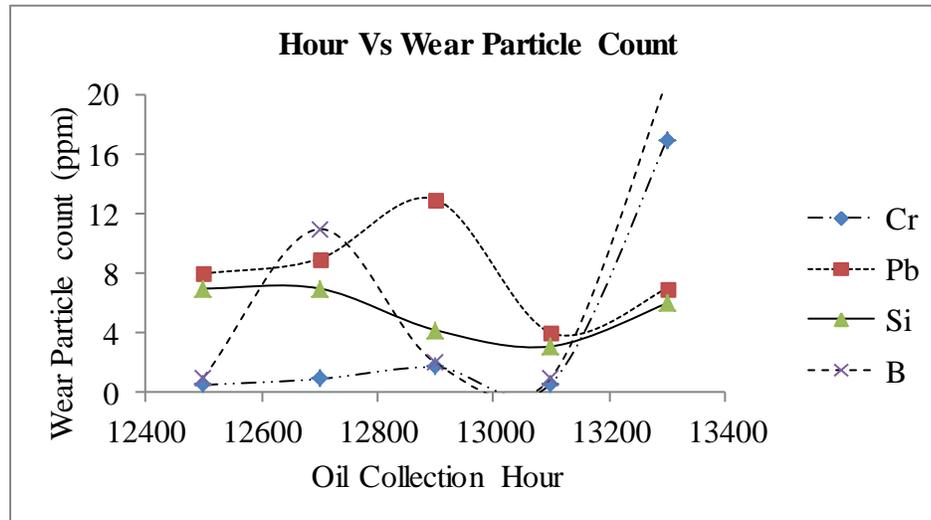


Figure 2: Wear Particle concentration of Cr, Pb, Si, B

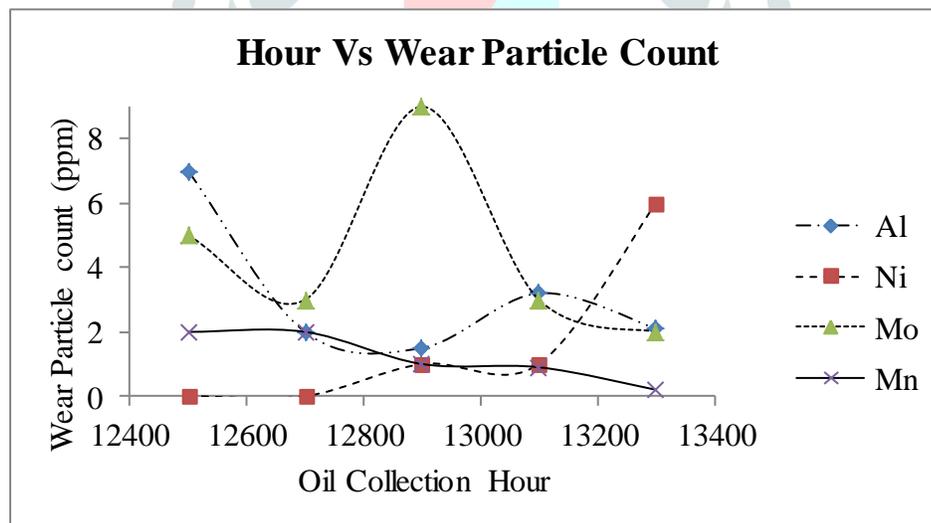


Figure 3: Wear Particle concentration of Al, Ni, Mo, Mn

From Figure 1 to Figure 3 it has been observed that at the fifth sampling time the amount of Ni, Cr and Fe particle has been increased abnormally. Aluminum particle count has also reached a considerable amount where the analysis for the same has also been required. At the same sampling time high concentration of boron particle has been found. From the above data it can be predicted that there was a failure in piston liner and bearing. High boron particle concentration on the other hand is an indication of internal coolant leak.

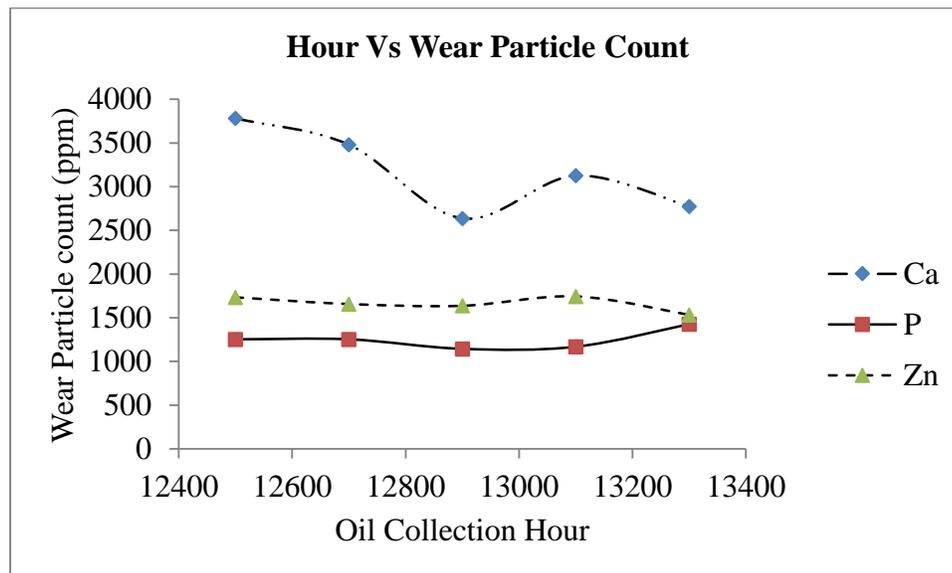


Figure 4: Wear Particle concentration of Ca, P, Zn

In every sampling hour it has been seen that the amount of Zn, Ca and P particle is always high. The higher amount of these particles is the indication of oil additives degradation. In this work all the oil samples has been collected at the end of their life. So, high concentration of these particles is expected.

Conclusion

In this work used lubricating oil has been collected from a BEML Dozer engine. The oil has been collected at five different hours. The samples have been collected after the end of their life. Atomic emission spectroscopic analysis has been done to analyze and count the metallic particle present in the oil. From the Atomic Emission Spectroscopic data, graph has been plotted and analyzed. It has been seen that the amount of Ca, Zn and P is always very high in these samples as they have been collected after the end of their life. It has also been found that at the fifth sampling hour there is an abnormal wear particle generation from piston ring, cylinder liners and bearing. The nature wear cannot be determined from this analysis and another supporting analysis like ferrographic analysis is required for the same.

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