Used Lubrication Oil Analysis of Dumper Truck Used In Mining Application

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Abstract

The dumper truck used in open cast mines as well as in different construction sites. This equipment is working under very hazardous condition. Due to the extreme hazardous conditions in open cast mines and in construction sites it has often seen that these equipment brakes down faster than other equipment. In order to predict the failure in advance, used lubrication oil analysis is used to understand the nature of the abnormality present in the equipment. In this work, used lubrication oil analyses of a 120 ton dumper truck used in open cast mines have been selected. Oil sample form the oil sump has been collected at five different ours. All the oil samples have been analyzed by using AES technology. From all the samples the parts per million values of different ferrous particle has been obtained and then a graph for the same has been plotted to understand the result in a better way.

Introduction

Since past few decades the AES technology is used by many researchers to find out the parts per million values of different ferrous particle suspended in used lubricating oil. It has been observed that AES is giving a very reliable as well as quick analysis. Another advantage has been cited by many researchers that this technology needs a very easy and simple sample preparation technique [1]. AES technology is not only used in the mining industries but also being used in marine industry [2] due to its reliable outcome. Oil condition monitoring is helping us to evaluate different parameters of used lubricant, which also include the fluid contamination [3]. With the help of this technique sudden failure of the machine can be prevented [4, 5]. In this work, used lubrication oil analysis has been carried away to understand the contamination level of lubrication oil. From the used lubrication oil the test sample has been prepared and the level of different contaminant has been measured.

So far there are many research article are present which has been stated that the metallic particles are present in the used lubrication oil due to abnormal wear mechanism in the associated machine [6]. Nearly hundreds of year ago it has been stated that the wear particle that are suspended in the used lubrication oil can gives us many information regarding the frictional phenomena between two mating surfaces [7]. Due to this unique property of the suspended wear particle the condition monitoring with the help of AES technology has been gained a remarkable popularity since past few decades [8-12].

Experimental Analysis

In this work used lubrication oil of 120 ton BEML dumper truck has been collected at five different intervals. It has to be mentioned that all the samples have been collected at the end of their life. It has been observed many times that at the end of the life the lubrication oil is having the maximum amount of contamination. This is the reason why always the researchers are using the end of life lubrication oil to analyze the health condition of the equipment. In this work the lubrication oil has been collected at 10700^{th} hour, 11500^{th} hour, 11800^{th} hour, 12500^{th} hour, and 12800^{th} hour. The oil sample collection hour has been mentioned here is in term of total run time of the engine since it is introduces in field. The typical lifetime of the lubricant is ranging between 250 hours to 300 hours. The result for the same has been show in table 1.

Table 1: Part per million value of wear particle

Hours	Fe	Cr	Pb	Cu	Sn	Al	Ni
10700	21.6	0.7	6.8	15.9	0	3.7	0.1
11500	33.5	2.1	6.8	13	0	0.7	0
11800	29.8	1.1	4.9	31	0	0	0
12500	11.7	1.1	17.5	17.8	0	3.1	0
12800	77.5	32.4	16.1	135	0	4.8	6.9
Hours	Ag	Si	B	Na	Mg	Ca	Ba
10700	0	4.1	1.1	4.2	6.3	3120	0
11500	0	5.6	15	7.9	1.5	3230	0
11800	0	4.2	0.7	71	32	2799	0
12500	0	3.1	0.4	6.1	5.7	3891	0
12800	0	7.1	28	6.1	5.2	3019	0
Hours	P	Zn	Mo	Ti	V	Mn	Cd
10700	1189	1419	0.7	0	0	1.2	0
11500	1307	1389	2.3	0	0.1	0	0
11800	1288	1254	7.9	0	0.9	0	0.3
12500	1167	1219	1.8	0	0.5	0	0
12800	1201	1291	0	0	0.9	0.9	0.1

Discussion

All the graph has been plotted against the contamination of wear particle and oil sample collection hour. From the table 1 it has been observed that the parts per million values are ranging between 0 to as high as 3891. For this reason different graphs have been plotted for different materials. Graph 1 has been plotted for the same purpose but only for aluminum, nickel, molybdenum and manganese particles. It has been observed that the molybdenum particle is

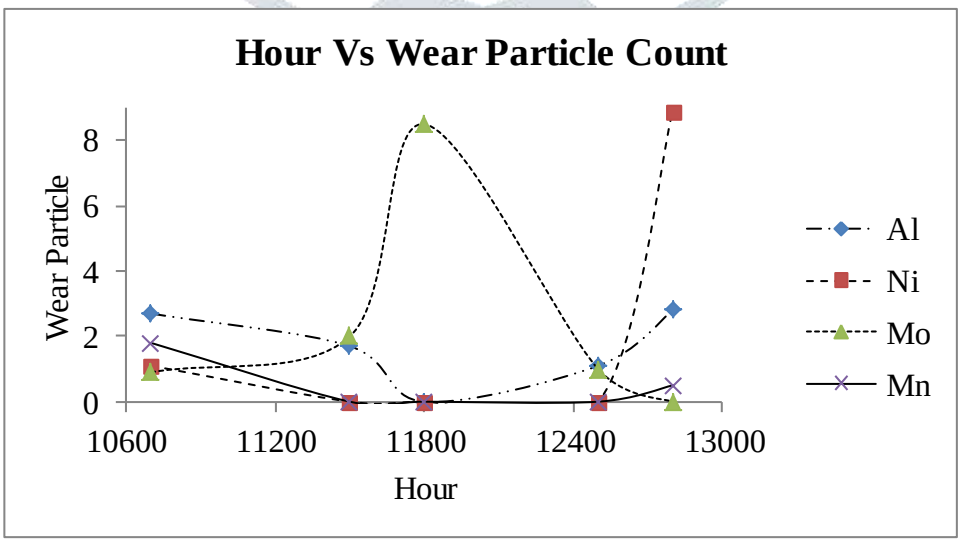

Figure 1: Wear Particle data of Al, Ni, Mo, Mn

showing a higher value at third oil collection hour and nickel is showing an abnormal value at last collection hour. Apart from these two values the rest of the values are within the limit and is not showing any alarming scenario. The data of Iron, Copper, Sodium and Magnesium has been plotted in graph 2. From the graph it has been seen that the sodium is showing an abnormal value at third collection hour, Nickel is showing an alarming increment at last oil sample collection hours and Iron is also having the maximum value at last oil sample collection hour. Apart from this none other value is falling into the abnormal zone.

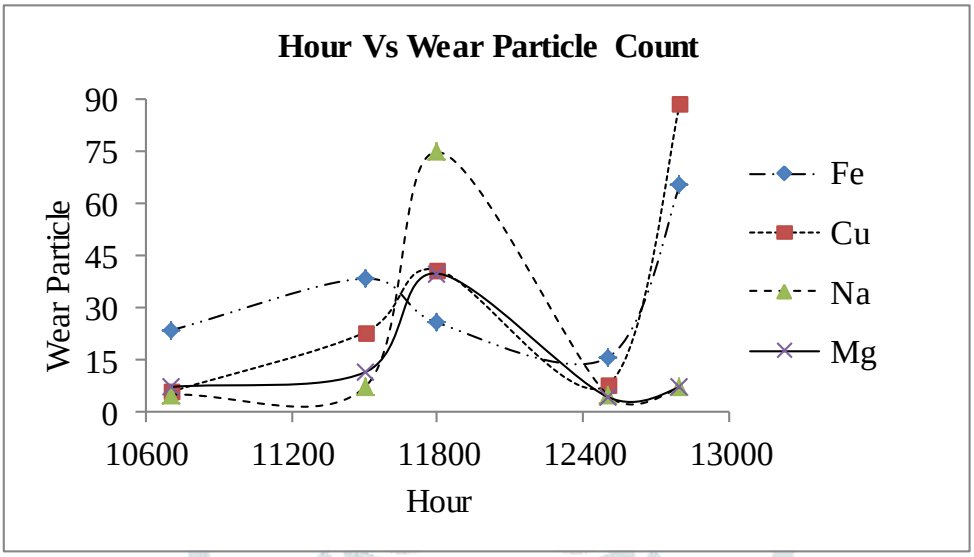

Figure 2: Wear Particle concentration of Fe, Cu, Na, Mg

Graph 3 has been plotted against the wear particle data of calcium, phosphorus and zinc. It has been seen that all the particles are showing an abnormal values in every sampling hour.

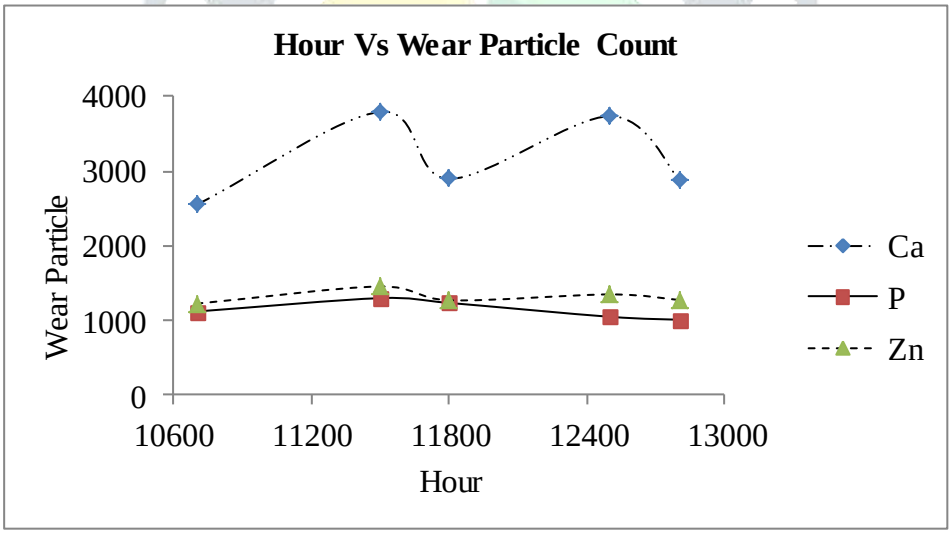

Figure 3: Wear Particle concentration of Ca, P, Zn

It is a very common fact that these particles always show an abnormal value at the end of the lubricant life. All these particles are in reality is the inherent component of oil additives. So when the life of the lubrication oil finishes up, these particle concentration increases abnormally. So none of this values are forecasting any abnormality of the engine condition.

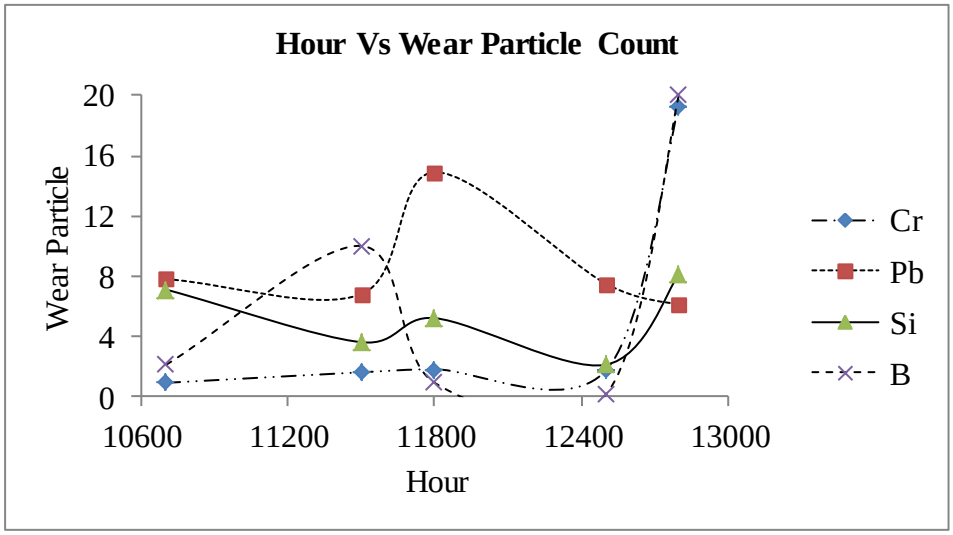

Figure 4: Wear Particle concentration of Cr, Pb, Si, B

The last graphs have been plotted against the suspended wear particle data of Chromium, Lead, Silicon, and Boron. From this graph it has been observed that all the particle are showing an abnormal increase in the last sampling hour except lead. The abnormal value is reflecting at the third sampling hour. Apart from this value all the other values are falling in the normal range and do not fall in the analysis part. It has been observed for all the data that at the very first sampling hour there is no abnormality but as the time goes on the abnormal data for different particles are coming up. The abnormal value of iron along with Chromium and Nickel signifies the wear in the bearing material, whereas the abnormal value of aluminium shows the wear due to mis alignment between piston and cylinder liners.

Conclusion

In this work oil sample has been collected form a 120 Ton capacity dumper truck of BEML. The oil sample has been collected at five different hours of operation. All the engine oil has been collected from the oil sump just before changing the engine oil. The end of life engine oil has been analyzed in order to get the maximum suspended wear particle concentration. In this work AES technology has been used to get the wear particle contamination data in ppm. All the value of suspended wear particle has been plotted in four different graphs. It has been seen that the maximum contamination has been found in the last or the fifth sampling hour followed by third sampling hour. In rest of the sampling hour the data is not showing any abnormality. Although from this analysis the nature of wear cannot be obtained, but this method is very useful to determine that in which of the components the wear is taking place.

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