Used Lubrication oil analysis of dump truck engine used in mining industry

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Abstract

Dumper truck in the mining industry used to carry away the overburden material and ore material. The primary work of these dump trucks is to receive material from shovel and carry the material away to the dump yard. During this process cycle the dump truck need to work in a very hazardous environment and as a result often this equipment face premature failure. In order to forecast the premature failure AES technology is used to analyze used lubrication oil to see the contamination level. The contaminants found from this analysis are generally metallic particles resulting from abnormal wear and tear of the engine components. In this work AES has been used to count the particles present in the used lubrication oil of a cummins dump truck engine. For this analysis oil sample has been collected from the oil sump of the dumper truck at the end of their life at five different run time of the engine.

Introduction

Dumper truck in the mining industry is used to carry away the overburden material as well as the core, ore and minerals. During this process, the dump truck used to receive the excavated material from shovel bucket. Normally in the open cast mining industry there are four dump trucks are associated with a single shovel. If any dumper truck suffers from the premature failure then the entire work of the unit suffers. In order to prevent this kind of unwanted hindrance it is important to go through the periodic checkups of the instruments. In this regard AES technology has proved its superiority over a decade. AES technology is useful to understand that which component is suffering from abnormal wear and tear [1-5]. It has been observed from the previous open literature that the contaminating suspended metallic particles used to carry a lot of information regarding the health condition of the component [6]. Due to all these reason AES analysis is gaining remarkable popularity among the researchers and in different industry [7-10]. However many research work have mentioned that this technology is one of the cost effective condition monitoring method [11]. Due to its cost effectiveness and reliable outcome and simple sample preparation technique, this technique is considered to be one of the most important condition monitoring method [12-14]. Due to all these advantages, in this work AES technology has been used to analyze used lubrication oil of a 120 ton capacity dumper truck used in open cast mines. In order to see the changes in health condition oil sample have been collected at five different run time hours. All the oil samples have been collected at the end of their life so that the maximum contamination can be analyzed.

Experimental Analysis

In this work oil sample has been collected at five different working hours of the engine. Oil samples have been collected at the end of the life of the lubrication oil. Every time the oil sample collected from the engine just before the fresh oil is refilled into the engine. First the contamination of the engine oil is allowed to stabilize and sediment. After that form the bottom part of the oil sump the oil sample has been collected. In this method the maximum contamination can be collected and analyze. In this work the oil samples have been collected at 7300th hour, 7600th hour, 8100th hour 8400th hour, and finally at 9200th hour of engine run time.

All the oil sample has been used after sample preparation and analyzed. The hour of collection is shown here is the engine run time since it is introduce into the field and not the lubrication life. The typical lifetime of the lubricant is ranging between 250 hours to 300 hours. The obtained data from the analysis has been given in table 1.

Hours	Fe	Cr	Pb	Cu	Sn	Al	Ni
7300	18.8	0.3	4.9	8.1	0	2.3	0.8
7600	36.4	1.3	4.8	20	0	1.3	0
8100	23.8	1.2	10.2	31	0	1.2	0
8400	13.1	1.7	4.1	7	0	1.3	0.2
9200	52.4	19.8	5.9	98	0	2.2	6.6
Hours	Ag	Si	B	Na	Mg	Ca	Ba
7300	0	7.7	3.6	5.1	5.8	2589	0
7600	0	3.1	8.1	6.3	10.2	2876	0
8100	0	4.2	0.2	66	47	2965	0
8400	0	2.3	0.3	2.8	6.6	3531	0
9200	0	8.8	21	62	7.1	3333	0
Hours	P	Zn	Mo	Ti	V	Mn	Cd
7300	1351	1334	1.9	0	0	1.7	0
7600	1241	1367	3.1	0	0.7	0	0
8100	1431	1232	9.6	0	0.3	0	0.6
8400	1371	1179	1.9	0	0.8	0	0.3
9200	1467	1351	0	0	0.7	1.5	0.4

Discussion

Base on the experimental data graphs have been plotted against different contaminating metal particles. The particle has been counted in terms of parts per million values. The parts per million values have been directly obtained through AES technique. From the experimental data it has been observed that the contamination value in ranging between 0 to as high as 3531. Due to this high difference in the particle contamination range all the data cannot be plotted into a single graph else the graph will be completely unreadable. In order to make the graph readable total four different graphs has been plotted.

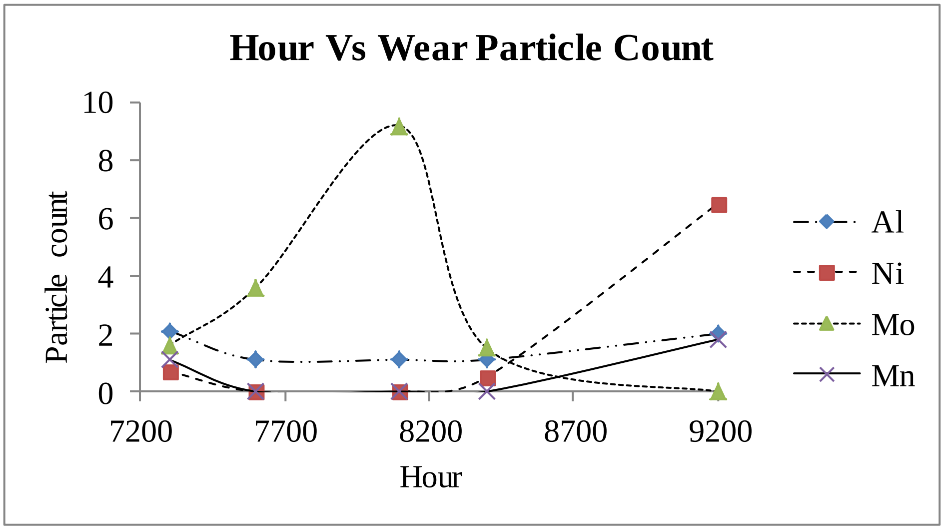

Figure 1: Wear Particle data of Al, Ni, Mo, Mn

In Figure 1, data of Aluminum, Molybdenum, Nickel and Manganese has been plotted. From this figure it has been seen that Molybdenum is showing an abnormal value at third sampling hour and Nickel showing an abnormal value at final sampling hour. Apart from these none other value are showing any abnormality.

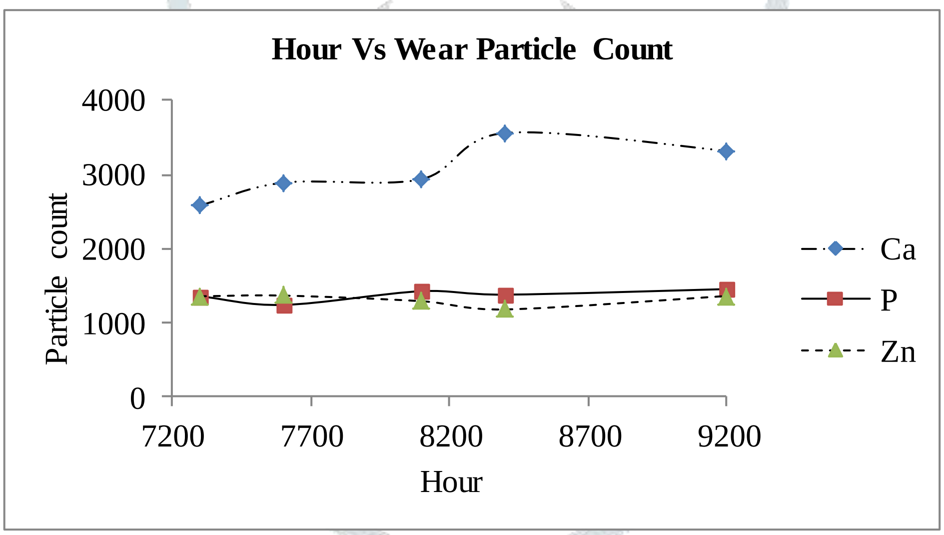

Figure 2: Wear Particle data of Ca, P, Zn

From figure 2 it has been observed that all the values are extremely high. The main reason behind it is the oil additive. All these material are the inherent component of oil additive and at the end of the life cycle these additives degrade. As it is already mentioned in this article that the oil samples has been collected at the end of the life cycle so usually these metal particle concentration shows a very high value in this regard. However this value is not carrying any significant information about any engine component degradation.

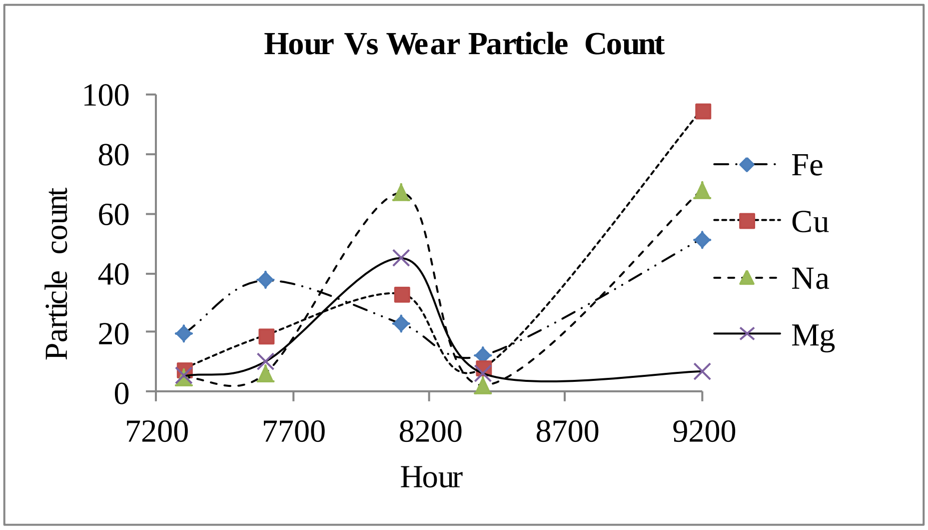

Figure 3: Wear Particle data of Fe, Cu, Na, Mg

From figure 3 it has been seen that Iron copper and sodium is showing a relative higher value at last sampling hour. At third sampling hour the again the value of Sodium, Copper and Magnesium is showing the alarming value and at second sampling hour only Iron is showing a high value.

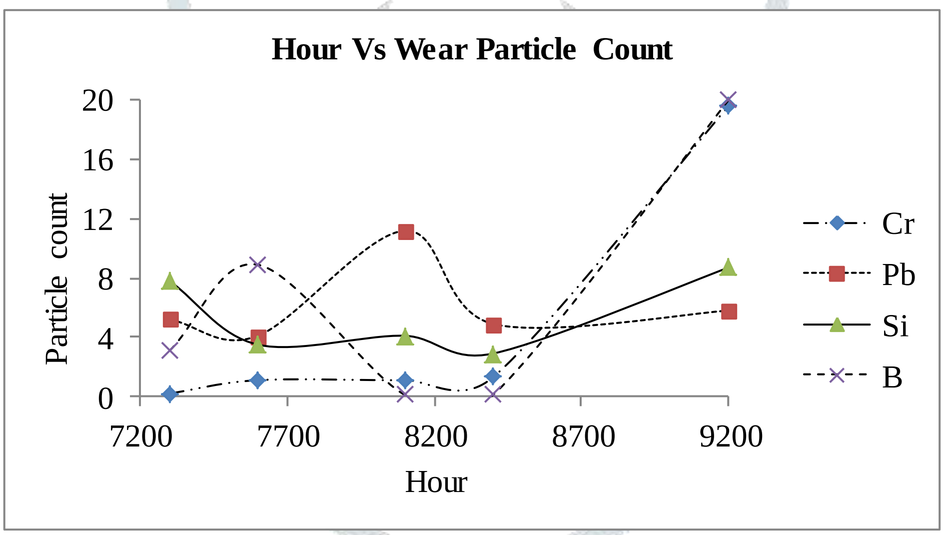

Figure 4: Wear Particle data of Cr, Pb, Si, B

Apart from these all other values are in normal range and we should not draw any conclusion from these. Figure 4 has been plotted against the parts per million values of Chromium, Lead, Silicon and Boron particles. At third sampling hour Lead is showing a higher value as compared to other, but at fifth sampling hour Boron and Chromium is showing a very alarming value.

From the above result it has been observed that many time chromium and nickel is showing a higher value along with Iron. It has been reported that higher value of all these metallic particle can be an identification of bearing material wear. Simultaneously the higher particle concentration of Aluminum along with Iron is signifies the wear between piston and piston liners.

Conclusion

In this work used lubrication oil has been analyzed through AES technology. Lubrication oil has been collected form the oil sump of the engine at the end of their life cycle. Before collecting the oil sample it has been ensured that the contaminating particles sediments properly. After that oil has been collected from the higher sediment area. In this method the maximum contamination has been analyzed. From the analysis contamination particle has been counted in terms of parts per million values. It has been observed that at third and fifth sampling hour the values of the contamination are higher. It has also been concluded that the higher value of these particle is the reason of wear between bearing material or piston liner assembly. Although the type of wear mechanism cannot be concluded form this analysis. The same can be analyzed from analytical ferrogrphic analysis.

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