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Condition Monitoring of I.C Engines by using Oil Analysis

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Abstract

Engine is the main part of the automobile vehicle. Diesel and petrol engines can be used for the automobile vehicle. Performance of the engine depends upon the good condition of the components like cylinder, cylinder head, piston, piston ring, valves, connecting rod, crank shaft, cam shaft etc. The failures of engine component can be reduced by condition monitoring techniques. There are many types of condition monitoring techniques are available vibration analysis, infrared thermography, engine oil analysis, as non-destructive tests. The aim of this paper is to reduce the failures of engine components by analyzing the used oil. In these paper engine oil analysis techniques is used. Engine oil is the life-blood of machinery. Much like doctors assess our health through urine analysis, engine components must be monitored in much the same manner. Engine oil analysis mean testing a sample of engine oil in unused and used condition. Analysis done for various properties like viscosity, volatile matters, total base number, total acid number, ash content, flash point and wear metals particles like Iron, aluminum, copper, chromium, lead, zinc in order to monitor the wear of the engine components. The properties of the oil will be changed based on the distance travelled. The used oil can be collected from the engine after various running kilometer and analyzed.
Keywords: Condition monitoring, Diesel engine, Oil analysis, Wear, Automobile vehicle

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I. INTRODUCTION

Oil observance could be a predictive technique for condition observing programs. It will be used as a prophetical tool to spot the wear and tear modes of rubbing elements and diagnose the faults in automobile vehicle. It means a technique of anticipating the soundness of instrument in a very non-intrusive way, by the study of wear and tear particles. The continual trending of wear and tear rate monitors the performance of engine and its elements and provides early warning and designation will be consequently. Oil condition observance will sense the danger prior to vibration technique. This system holds sensible for each oil and grease samples. By analyzing the oil sample, the residual lifetime of used oil is set and a fault within the machine will be diagnosed before the engine break down.

Sliding adhesive wear particles area unit found in most lubricating oils. They are a sign of traditional wear. The objective is to differentiate of these particulars in keeping with their morphological attribute of size, shape, edge details thickness magnitude relation, color texture and by exploitation this classification we are able to predict wear failure modes within the engine, utilization of this info to forestall the engine from potential future hassle. So in this way it is clear that the aim of this work is to reduce maintenance work which in term also reduce all the expenditure which are used for maintain a Vehicle's engine in a working able condition. Metals in grease will return from numerous sources, like wear, contamination and additives [1]. Whereas operation metal wears ensuing from friction or corrosion of the parts like pistons, bushes, bearings, etc., Contamination will return from dirt, leaks or residual metal items. Additives used as detergents, anti-oxidants and anti-wear agents, square measure additional so as to cut back engine wear. Wear of a particular part is publicized by a rise within the concentration of a specific metal, or the abrupt look of a metal [2]. Since totally different engine parts square measure composed of various alloys, the rise of a specific metal will be wont to determine close failure of a particular part [3]. Associate analysis of trace metals in engine oil has allowable the identification of sporting parts before severe failure, while not dismantlement of the engine. The determination of Al, Cd, Cr, Cu, Fe, Mg, Ni, Pb, atomic number 50 and atomic number 30 victimization atomic absorption spectrum analysis [3-4].

II. TESTING METHOD

The engine oil is collected at three total different kilometers and collected a similar kind of recent oil. The oil analysis is performed while not the any purification of oil, if the purification method carried suggests that the properties are going to be modification. A photometer is a device to light candlepower at totally different wave lengths. It produces a light-weight supply, and when the sunlight passes through a matter, the light is diffracted into a spectrum which is detected by a detector and observed the results we will use. The output is represent by graph of light intensity versus wavelength. It’s a tool which is employed to find the condition of the oil lubricated systems (Examples: Motors, Engines, Gear boxes, Hydraulic systems). The systems are often unbroken underneath police investigation while not activity them. Usually broken compounds are localized and replaced repeatedly before a failure happens. The amount and sort of wear and tear metals in sample of oil is set. The amount will indicate one thing concerning the magnitude of the damage and also the kind of wear metals will reveal that element is sporting out.

A. Method Description:

Spectrophotometer oil analysis is probably one amongst the additional ordinarily used techniques for the determination of bound components by either atomic emission or atomic absorption chemical analysis. Whereas the techniques is instantly machine-driven to attain a quick output of sample and has morphology of the damage dust and is sensitive to particles sizes 10 ~m13 [5].

III. RESULTS & DISCUSSION

The oil analysis is done by the use of spectrophotometer and the results are tabulated. It shows a possible of wear in the engine components.

Table – 1
Description of Collected Samples

SL. No	Properties	Fresh oil	Used oil @ 3450km	Used oil @ 6090km	Used oil @ 8487km
1	Viscosity cSt @ 40˚C	105.1	148.2	179.8	232.8
2	Viscosity cSt @ 100˚C	13.65	15.4	18.9	24.9
3	Volatile matters %	0	0.8	1.3	2.2
4	TBN mg KOH/g	13.65	9.2	8.8	6.5
5	TAN	0	1.4	2.9	5.3
6	Flash point ˚C	226	231	245.7	251
7	Ash content % by mass	0	0.21	0.37	0.52
8	Wear metal analysis (ppm)				
	Iron	0	102	224	314
	Aluminum	0	132	294	350
	Copper	0	29.5	45.9	67.1
	Chromium	0	11.4	20.1	26.3
	Lead	0	14	31.2	45.7
	Zinc	0	255	540	787.1

IV. TESTING RESULTS

A. Viscosity:

Viscosity is one of the main parameter of lubricating oil, with the help of the viscometer apparatus viscosity will be find out. The known volume of lubricant is allowed to flow in a viscometer, from a given height, through standard capillary tube under its own weight and the time of flow in second is recorded. The time is proportional to the viscosity [6]. The viscosity have been found out for two different temperature and the values were tabulated. And the respected graph are plotted in Fig-I. The viscosity of the engine oil will increase that respected to oil film thickness reduction. The oil film thickness is to prevent contact between two metal contact surfaces.

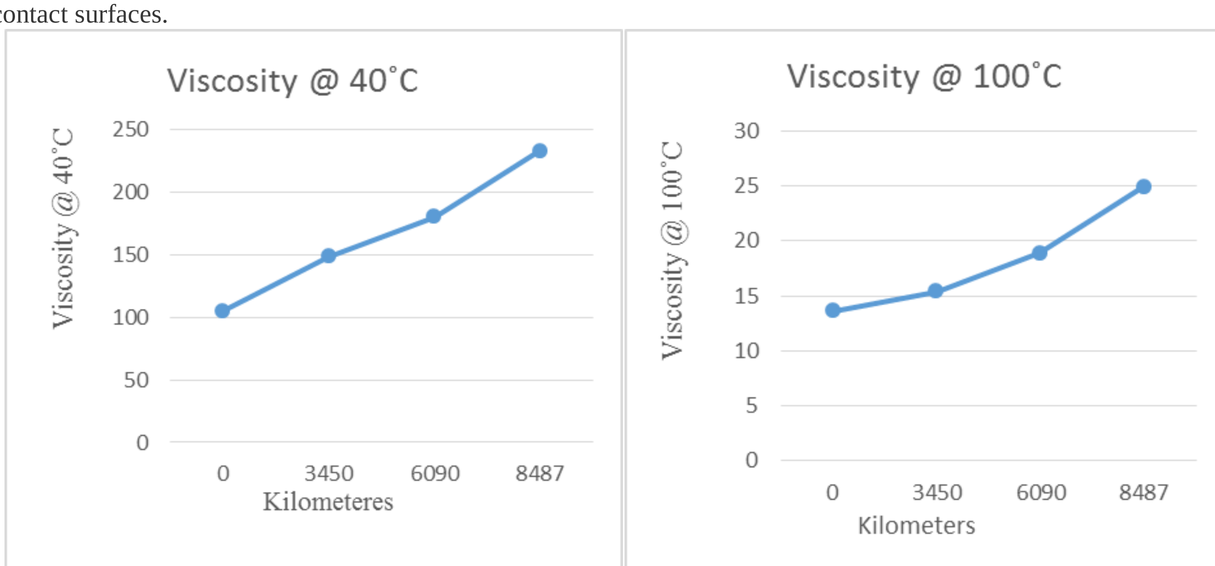


Fig. 1:

B. Total Base Number (TBN)

The total base number is the amount of alkaline additives present in the lubricant that are capable of neutralizing the acid products of combustion. The TBN values are shown in table no 1. If the TBN value is decrease then the oil loses its neutralizing capability. The result shows that there TBN value decrease with resected to the running kilometer.

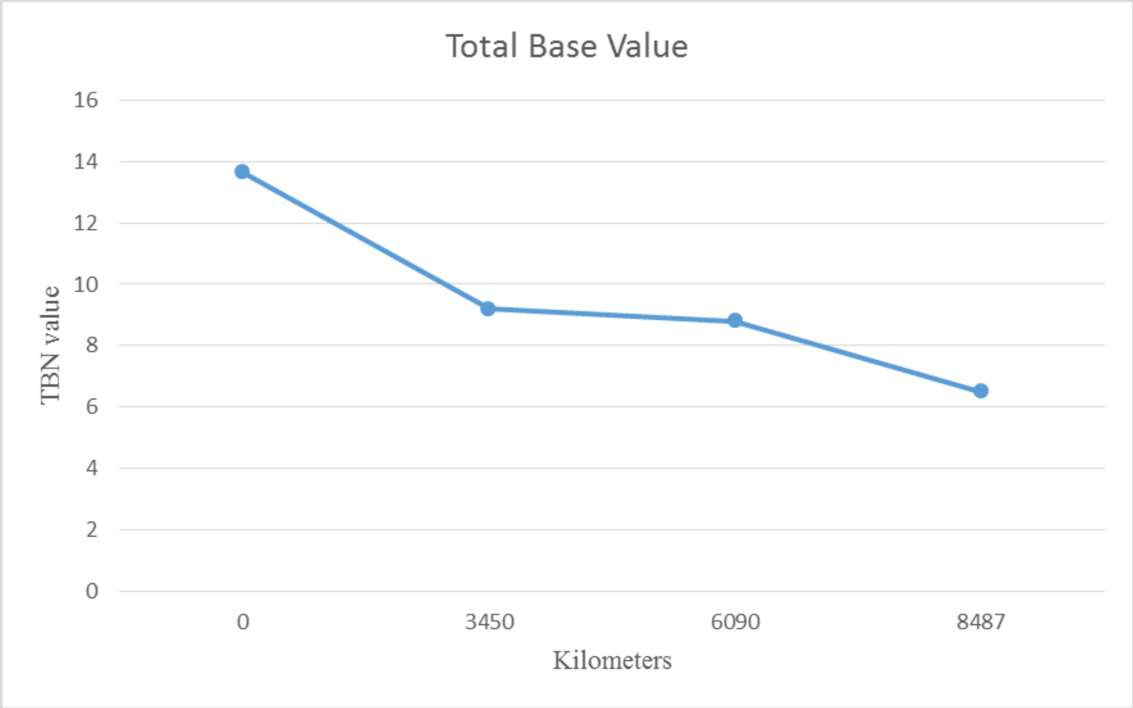


Fig. 2:

C. Total Acid Number (TAN):

Total acid number is the total quantity of acid or acid-like constituents in the lubricant. High TAN value indicates that the lubricator oil involved in chemical reaction or react with metal. TAN indicates the usefulness of the oil. Results shows that increase in the TAN value and there is oxidation and contamination.

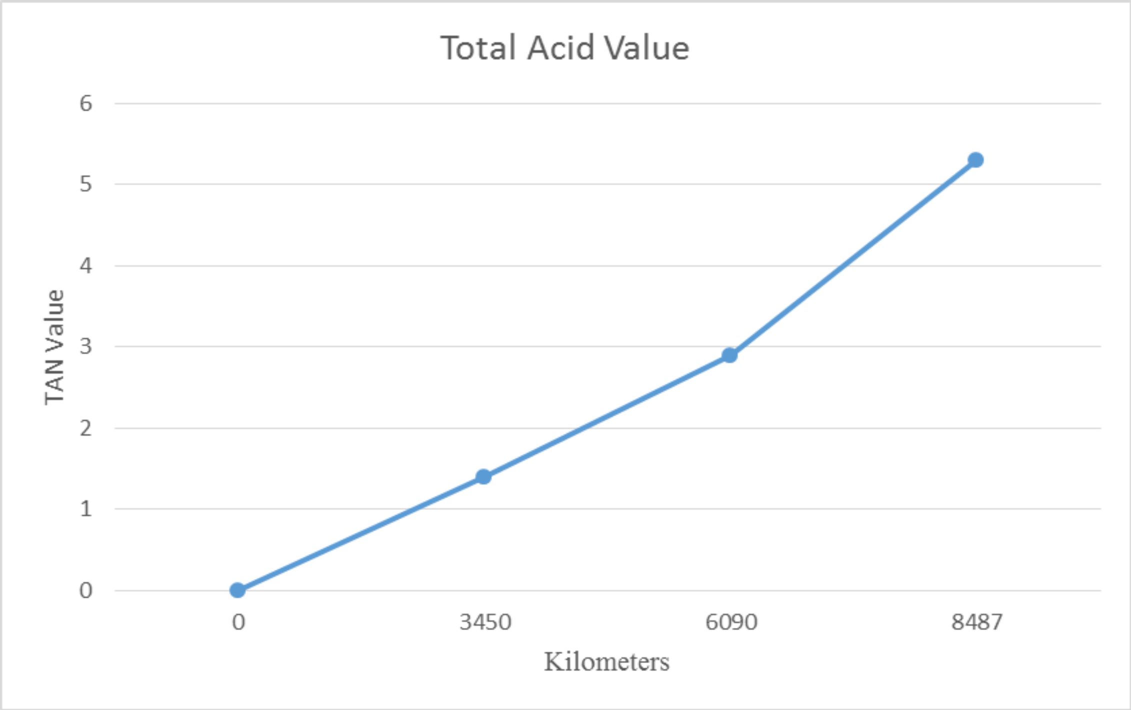


Fig. 3:

D. Flash Point

Flash point is the lowest point of temperature at which the oil gives off whereas enough vapour that ignite for a moment when a small flame brought near it, fire point is the lowest temperature at which a vapour of the oil burns continuously for at least five seconds. A good lubricant should have flash point at least above the working temperature at which it is to be used. Results shows increase in flash point with respected to running kilometer.

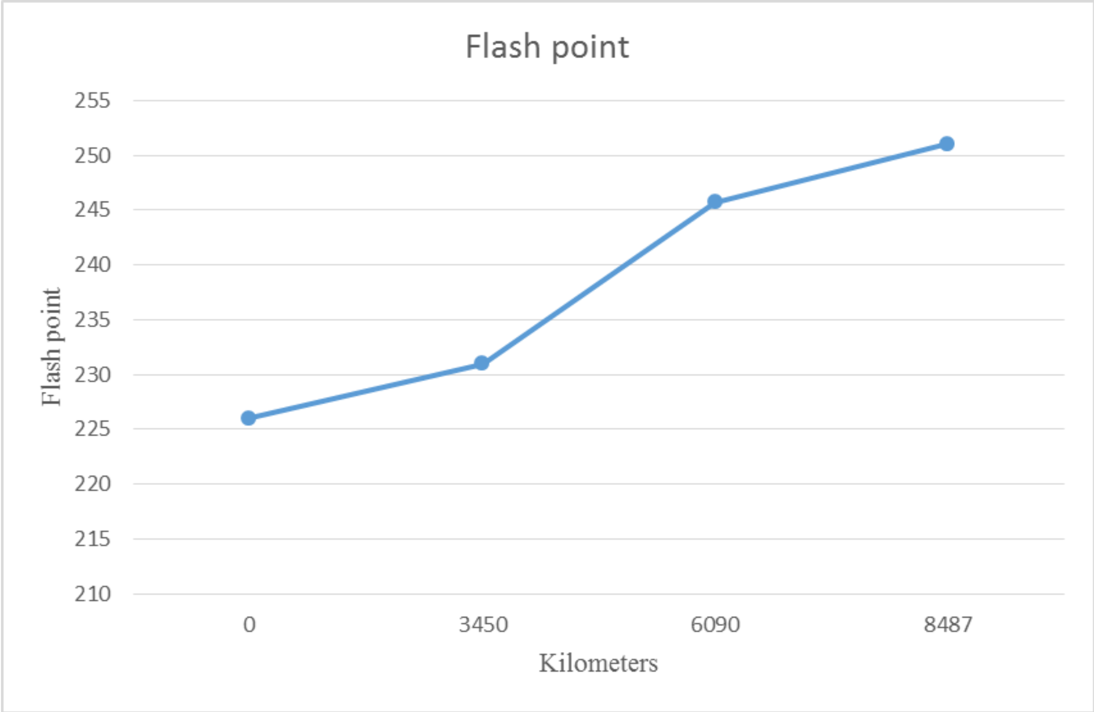
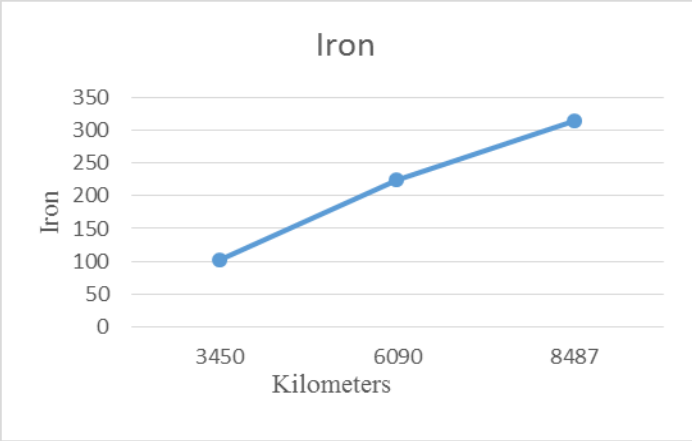
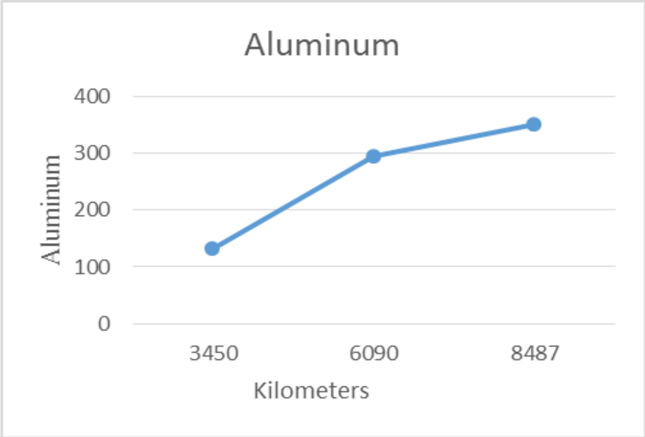


Fig. 4:

E. Wear Metal

Fluid cleanliness is critical in hydraulic systems where pressure and velocity are involved. Excessive fluid particle contamination is a main cause for components failure. Wear metal analysis allows to monitor the engine components, contamination levels on a scheduled basis. In this method many wear materials can found like Iron, aluminum, copper, chromium, lead, zinc. The values are listed in table no 1 and respected graphs are plotted. The result shows the wear element present in the oil.





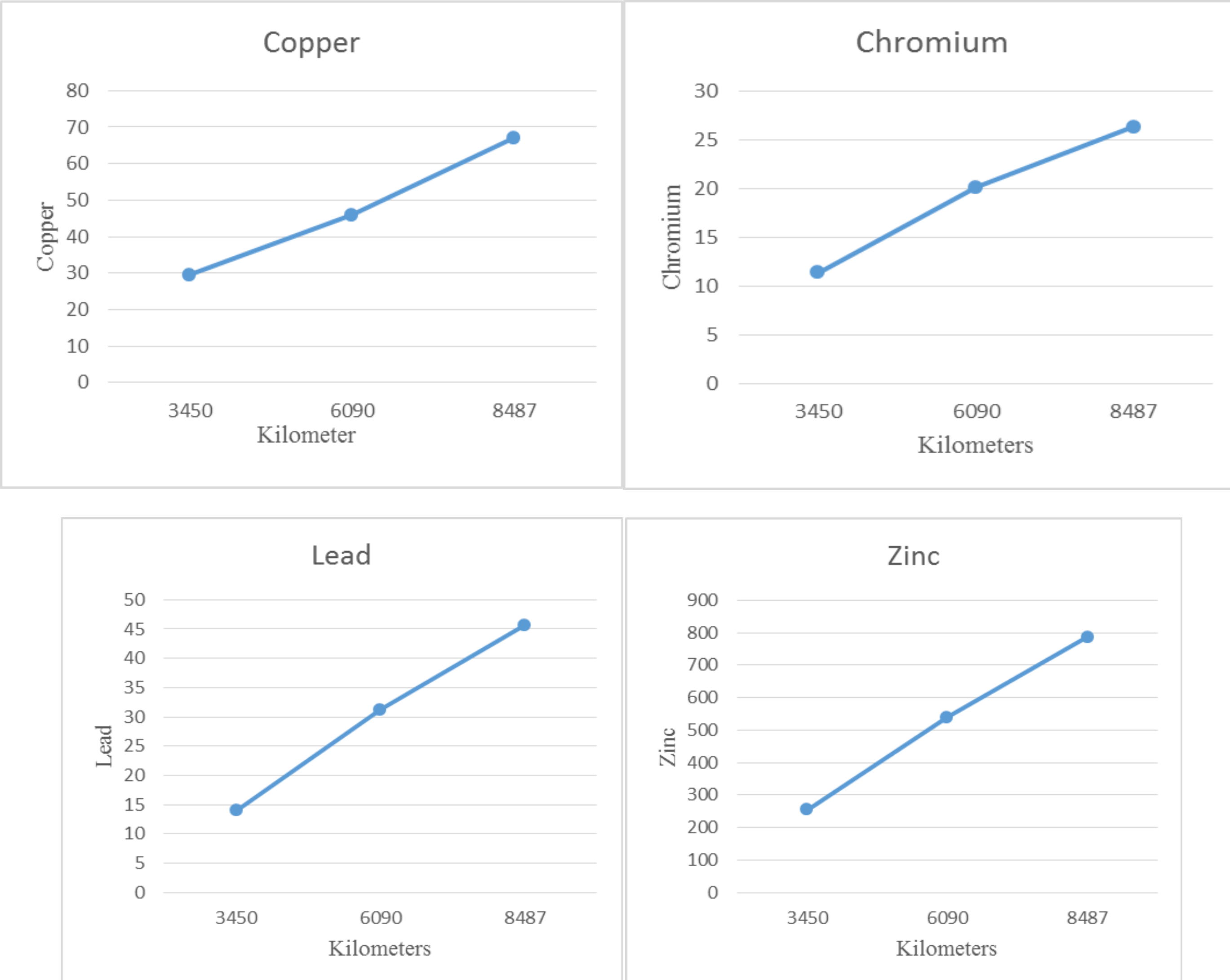


Fig. 6:

V. Conclusion

From the obtained results concluded that the work done by the engine is inversely proportional to the engine oil properties. If the viscosity of the oil increases means engine overheated engine, restricted oil flow, accelerated wear will occur. The TBN value increased, and it leads to corrosion of metal parts. If TAN value increased it leads to oil degradation and corrosion of components. Presence of wear elements in the engine oil has got an adverse effect on the engine components. As the concentration of wear elements on engine leads to the complete failure of the components. Iron and chromium content increased means it is the chance to failure of piston rings and cylinder walls, Aluminum content in the oil means it lead to failure of Pistons, Copper content in oil means its lead to failure of Bearings.

VI. Future work

The condition monitoring technique can be done in other medium like vibration analysis or acoustic emission analysis for various conditions of speed and load and the results can be compared for the better understanding of the conditions of independent components of the engine. Furthermore an analytical algorithm can be developed to find the relationship between the wear and the properties of oil analysis.

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