Evaluation and Effect of a Wear Metal in Used Lubricating Engine Oil of Honda Civic Brand in Our Environment

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Abstract

Used lubricating oil was collected of about 150ml. Determination and Evaluation of designated critical wear metals were analyzed using Atomic Absorption Spectroscopy (AAS), detection and average result for concentration level of wear heavy metals in used lubricating oil of six (6) elements (cadmium, iron, zinc, chromium, copper & lead respectively), are 0.0028, 3.2449, 0.2942, 0.0235, 0.0102 & 0.1824ppm. The result shows that a high concentration of wear heavy metal is likely in iron & zinc obtained in this study which was injurious to a living thing, thus a high concentration of wear metal is a signal of danger to life and our environment where used oil not properly disposed. It's suggested that awareness and enlighten should be given to the people's living in such environment where used lubricating oil is not properly disposed and also intact laws which will ensure that mechanical workshops make use of standard waste treatment for disposing of or discharge of the used lubricating oil.

Keywords: Wear metals, Lubrication oil, Environment's effect, AAS, Zaria

INTRODUCTION

Lubricating oil is derived from petroleum-based and non-petroleum-synthesized chemical compounds. Hydrocarbons, polyalphaolefins (PAO), and poly-internal olefins (PIO) were all employed as base oils in motor oils. The base oils of some high-performance motor oils contain Esters. which can account for up to 20% of the total weight. (*Chattopadhyay, 2011).*

A lubricant is a substance, usually organic, that is used to reduce friction between surfaces in contact, hence lowering the amount of heat generated when the surfaces move. It may also have the ability to transmit forces, move foreign particles, and heat or cool surfaces. Lubricity is the attribute of lowering friction.

Motor oils' main function is to reduce wear on moving mechanical parts; it also cleans moving parts from the sludge, inhibits corrosion, and improves sealing, (*Chattopadhyay, 2011).*

Wear metal is also defined as a process in which dimensional loss of one solid occurs as a result of interaction between two surfaces or boundary faces of solids within the working environment, with or without actual decoupling and material loss. Loads and features such as unidirectional sliding, reciprocating, rolling, impact loads, speed, and temperature are all factors that affect wear. Wear metal is concerned with surface interactions, specifically the loss and distortion of material on a surface as a result of the opposite surface's mechanical action (Williams, 2005).

In materials science, wear material is erosion or sideways displacement of material. The size of the generated particles may vary from millimeter range down to an ion range. (Udonne & Onwuma, 2014).

STATEMENT OF THE PROBLEM

Lubricating oil is an important substance that controlled or gives an engine or machines performance or efficiency to work smoothly and prevents such mechanical parts of a machine from being worn. Disposal of used or waste lubrication oils in our environments becomes rampant, most people in our society are not aware of the harmful substances that are attached to this lubricating oil that has been used. The effect of these harmful substances derived as a result of wear metal associated with used lubricating oil that may affect the human being and our environment directly or indirectly via water from our stream, plants we eat, and physical environment, high volume of this used lubricating oil were improperly disposed of through an industrial plant, mechanical workshops, and other smalls garage of machine repairer. This gives the researchers' a base to investigate on effects and evaluation of the used lubricating oil of the Honda Civic Brand.

AIM AND OBJECTIVES

This study aims to determine the effects and evaluation of wear metals (Analysis of used lubricating engine oil) of Honda Civic Engine, with objectives as;

1. to know the characteristic of lubricating oil
2. to understand the analysis of heavy metals (wear metals)
3. to investigate the effect of heavy (wear) metals in our environment and human health

JUSTIFICATION OF THE STUDY

For more than 30 years, spent oil has been analyzed for concentration trends of heavy wear metals, as well as formulation metals. Copper (Cu) and iron (Fe), both wear metals, may indicate wear in an engine or any oil-wetted compartment. Boron (B), silicon (Si), or sodium (Na) may indicate dirt or antifreeze contamination, resulting in a failure. Because these components have a role in lubricating, they are important. A good maintenance program that monitors metals in the lubricating oils not only saves money by avoiding the expense of disassembling components for visual inspection but can also detect unexpected wear before the component fails. This study will provide relevant information about heavy wear metal, lubricating oil, and the impact of wear metal on readers and society in general.

SCOPE AND LIMITATIONS

This study covers the determination, evaluation and effects of heavy wear metals in lubricating oil used with restricted case of Honda Civic Brand.

LITERATURE REVIEW

This study is to provide insight into the sources of heavy metals and their harmful effects on the human, environment and also to soil fertility in the farming system. Heavy metals are generally referred to as those metals which possess a specific density of more than 5 g/cm^3 and adversely affect the environment and living organisms (Järup, 2003).

When present in extremely low quantities, these metals are required for maintaining certain biochemical and physiological activities in living organisms; nevertheless, when concentrations reach certain thresholds, they become toxic. Heavy metal exposure persists and is increasing in many regions of the world, despite the fact that heavy metals have several negative health impacts and last for a long time. Heavy metals are significant environmental contaminants, and their toxicity is becoming a growing concern for ecological, social, and economic reasons. (Jaishankar *et al.*, 2013; Nagajyoti *et al.*, 2010). Arsenic, cadmium, chromium, copper, lead, nickel, and zinc are the most regularly discovered heavy metals in wastewater, and they all pose health and

environmental problems (Lambert *et al*., 2000). Heavy metals enter the environment through natural processes as well as human actions. Soil erosion, natural weathering of the earth's crust, mining, industrial effluents, urban runoff, sewage discharge, insect or disease control chemicals applied to crops, and many more factors are all sources of heavy metals (Morais*et al*., 2012).

In 1866, American John Ellis formed a company to devote his time to developing an all-petroleum, high viscosity lubricant for steam engines, which were previously using inefficient mixtures of petroleum, animal and vegetable fats. When he developed an oil that worked well in high temperatures, he made a breakthrough. There would be no more gummed valves, rusted cylinders, or leaking seals as a result of this (Don, 2009).

To safeguard the sliding and spinning metal elements of early internal combustion engines, early cars used the slippery by-products of crude oil from which their fuel was derived. To prevent seizure, adjacent moving metal parts require an oil coating between them, as well as a medium to transport away heat as speed increases. The Society of Automobile Engineers in the United States was tasked with establishing engine oil standards. They decided to compare and characterize lubricating lubricants based on their viscosity. In layman's terms, viscosity refers to how easily a liquid pours (Miller, 2005).

Although they were originally working in Fahrenheit, the SAE opted to compare the viscosity of oils at 100 degrees centigrade. This is the temperature of oil in a big end bearing, which is the most stressed component of a typical car engine. Mineral oils lose their viscosity as the temperature rises, and at roughly 100°C, they become very thin and consequently weak. As a result, tests at this temperature are a good indicator of oil strength. The amazingly exact approach of pouring oil through a known size hole and measuring how long it takes to come out is used to determine viscosity. Kinematic viscosity is the end effect of this (Thorsten Bartels *et al*, 2005).

Properties of Lubricating Oil

Lubricants are often referred to as the "lifeblood" of machinery, are an important component in a variety of industrial processes. They're used in everything from bearings to motors to hydraulics to keep industries functioning properly:

i. Lessening wear and tear
ii. Reducing friction
iii. Removing heat
iv. Preventing rust and corrosion
v. Removing contaminants

The Properties of Lubricating Oils are;

1. Viscosity

The internal resistance to the flow of a fluid is characterized as its viscosity. The slower the fluid moves, the higher its viscosity. Higher viscosity is required if you want your film to stay put at slower speeds. The most significant attribute of a lubricant is viscosity, which is used to generate a lubricating layer, cool machine components, seal and manage oil consumption. Load, temperature, and speed must all be balanced. The table below shows how each component influences how high or low a viscosity should be.

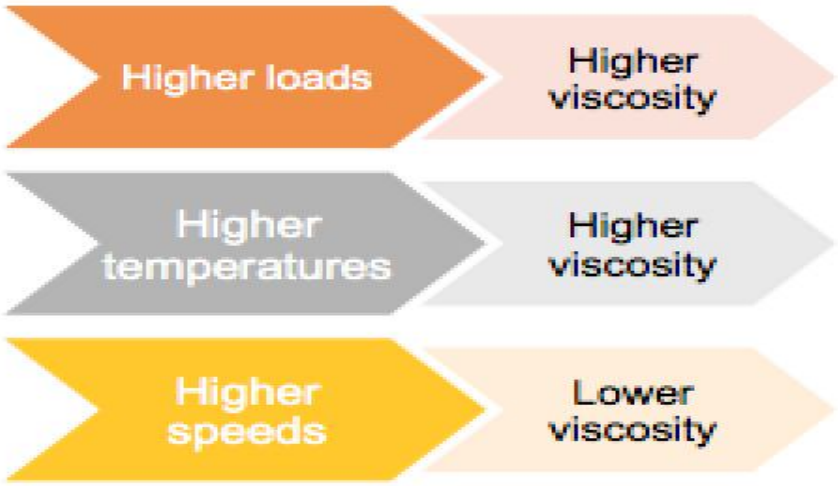


Figure 1: Viscosity Chart

2. Thermal Stability

The capacity of lubricants to withstand disintegration at high temperatures is referred to as thermal stability. Sludge, deposits, and increased viscosity can all be caused by poor thermal stability.

3. Oxidation Stability

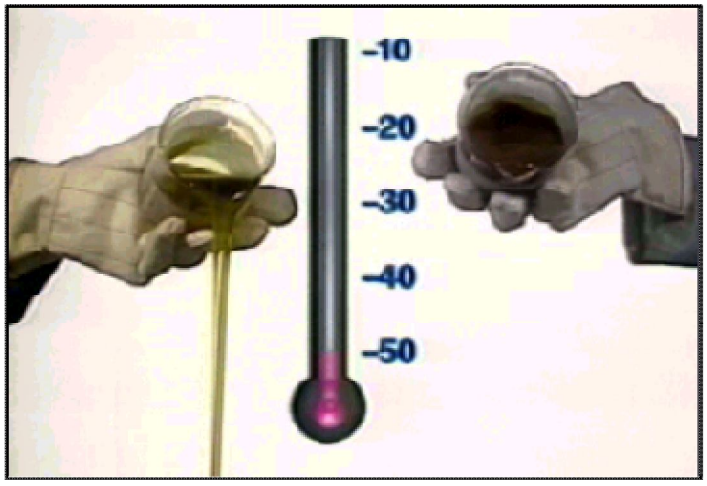
The capacity of a lubricant to resist the chemical reaction with oxygen is referred to as oxidation stability. It can lead to the formation of sludge and an increase in viscosity.

Heat, light, metal catalysts, acids generated by water contamination, and other pollutants all accelerate oxidation stability.

4. Pour Point

The lowest temperature at which an oil will flow under specified test conditions is known as the pour point. The amount of wax particles removed during crude processing has an impact on it.

The higher the pour point, the more wax particles there are. The lower the pour point, the fewer wax particles there are.



5. Demulsibility

Another significant feature of lubricating oils is demulsibility. It refers to an oil's capacity to separate from water.

6. Flash Point

The flash point of an oil is determined by heating it until vapours develop, then passing a flame over it. The flash point of an oil is the temperature at which it flashes but does not sustain a flame. Lubricating oils have a flash point of 204°C (400°F) or higher.

7. Fire Point

The fire point is calculated in a similar way to the flash point. A flame is carried over the oil after it has been heated until vapours have formed. The temperature at which the oil sparks and maintains a flame is known as the fire point. Lubricating oils have a fire point of 371°C (700°F) or above.

Total base number (TBN) is a measurement of oil's reserve alkalinity, or its ability to neutralize acids, and is another modifiable feature of lubricating oil. The resulting quantity is calculated as follows: mg KOH/ (gram of lubricant). Similarly, the total acid number (TAN) is a measure of the acidity of a lubricant. Zinc, phosphorus, or sulfur levels, as well as excessive foaming testing, are some of the other tests available (Udonne JD., 2014).

Lubricating Oil Grade

Two viscosity grades are included in the SAE classification for multi-grade oils; for example, 10W-30 specifies typical multi-grade oil. The viscosity of the oil at cold temperature is 10W, and the viscosity at 100 °C (212 °F) is the second number. SAE J300 defines the two numbers used for single-grade oils separately. As a result, a 10W-30 oil must meet the SAE J300 viscosity grade standards for both 10W and 30, as well as all other viscosity grade restrictions (for example, a 10W-30 oil must fail the J300 requirements at 5W). Oil can also be labeled with one of the two SAE viscosity grades if it does not include any VIIs and can pass as a multi-grade (Woydt, 2007).

Application of Metals

When compared to four-stroke engines, two-stroke engines are less expensive to construct, lighter and have a higher power-to-weight ratio. Two-stroke engines are good for chainsaws, weed trimmers, outboard motors, off-road motorcycles, and racing applications for these reasons. Snowmobiles benefit from two-stroke engines since they are easier to start in freezing climates. Four-stroke engines, on the other hand, create more torque at lower rpm, resulting in increased equipment durability compared to high-revving two-stroke engines, as well as improved fuel efficiency and lower emissions. Four-stroke engines are ideal in applications such as motorcycles, ATVs, and personal watercraft for these reasons (James, 2005).

Four-Stroke Lubrication

Oil stored in an oil sump lubricates four-stroke engines. Splash lubrication or a pressurized lubrication pump system are used to distribute oil throughout the engine; these systems can be employed separately or combined (James, 2005).

The crankshaft is partially submerged in the oil sump to achieve splash lubrication. The revolving crankshaft spills oil all over the engine, including the cam lobes, wrist pins, and cylinder walls (James, 2005).
Using an oil pump, pressured lubrication creates a pressurized film of lubricant between moving parts including main bearings, rod bearings, and cam bearings. It also supplies oil to the valve guides and rocker arms of the engine.

Two-Stroke Lubrication

Two-stroke engines collect some oil beneath the crankshaft, but they use a total-loss lubrication system that blends oil and fuel to generate both energy and lubrication for the engine. In the cylinder's

intake tract, oil and fuel are mixed together to lubricate essential components such as the crankshaft, connecting rods, and cylinder walls.

Pre-mix two-stroke engines require a fuel-oil combination to be blended before being inserted in the fuel tank, whereas oil-injected two-stroke engines pump the oil straight into the engine, where it mixes with the fuel. Because they lack a specialized lubricant source, two-stroke engines are known to wear more quickly than four-stroke engines; nonetheless, high-quality two-stroke oil greatly lowers engine wear (James, 2005).

Wear of Metal

Wear is also defined as a process in which dimensional loss of one solid occurs as a result of interaction between two surfaces or boundary faces of solids within the working environment, with or without actual decoupling and material loss. Loads and features such as unidirectional sliding, reciprocating, rolling, and impact loads, speed, and temperature, as well as different types of counter-bodies such as solid, liquid, or gas, and different types of contact ranging from single phase to multiphase, in which the last multiphase may combine the liquid with solid particles and gas bubbles, all affect wear (Williams, J. A., 2005).

Causes of Engine Wear

Dirt is the leading cause of engine wear, according to automotive specialists. In fact, according to Federal-Mogul Corporation, dirt is the cause of 43.4 percent of all engine bearing problems.

Dirt particles, which are razor-like flakes of road dust and airborne grit sucked into the engine through the intake manifold, are particularly abrasive. These pollutants are carried by the oil into the precision clearances between bearings and other moving parts, where they grind and gouge surfaces, modify clearances, and generate more abrasive debris, along with leftover manufacturing dust and wear-metal particles generated inside the engine. Precision components become sloppy and weary as the wear cycle continues, eventually failing.

Filtration is the key to avoiding costly engine repairs caused by dirt, trapping and keeping contaminants outside the oil circulation system. Filters that are truly effective must be able to capture contaminants of all shapes and sizes. AMSOIL provides a comprehensive range of products (James, 2005).

Environmental Effect of Used Lubricating Oil

The chemical makeup of used lubricating oil, as well as its effects on the environment, make used motor oil a severe environmental issue around the world. Motor oil lubricants are petroleum-based materials that are hazardous to the environment and difficult to dispose of. Used motor oil is responsible for about 40% of the contamination in America's waterways. At 385 million gallons per year, used oil is the most common source of oil pollution in US harbours and waterways, owing to improper disposal. Drains and urban street runoff, much of which is due to poor engine oil disposal, are by far the most significant sources of motor oil pollution in our oceans. A single gallon of wasted oil can form an eight-acre slick on the top of the water, posing a threat to fish, waterfowl, and other aquatic life. According to the US EPA, oil coatings on the water's surface prevent dissolved oxygen from being replenished (Boughton B, 2004).

Effects of Cadmium on the environment

Cadmium's toxicological effects are derived from its chemical resemblance to zinc, an important micronutrient for plants, animals, and humans. Cadmium is bio-persistent, meaning that once absorbed, it

stays in the body for a long time (decades in humans), even if it is finally eliminated.

Long-term exposure has been linked to kidney failure in humans. High levels of exposure have been related to obstructive pulmonary illness and lung cancer, though research on the latter is difficult to interpret due to complicating variables. Cadmium can cause bone problems in humans and animals (osteomalacia and osteoporosis). Furthermore, the metal has been related to elevated blood pressure and myocardial damage in animals, while most human research contradicts these findings (Bernard A, 2008).

The average daily intake for humans is estimated as 0.15µg from the air and 1µg from water. Smoking a packet of 20 cigarettes can lead to the inhalation of around 2-4µg of cadmium, but levels may vary widely.

Effects of Copper on the environment

Copper is necessary for human survival, but excessive amounts can cause anaemia, liver and kidney damage, as well as stomach and intestinal distress. Overexposure to copper puts people with Wilson's disease at a higher risk of developing health problems.

Effects of Lead on the environment

Lead can cause a variety of biological consequences in people, depending on the concentration and length of exposure. At greater doses, various consequences occur, with the developing fetus and newborn being more sensitive than adults. High amounts of exposure can induce toxic biochemical effects in humans, which can lead to issues with haemoglobin production, as well as damage to the kidneys, gastrointestinal tract, joints, and reproductive system, as well as acute or chronic nervous system damage (James R, 1996).

Lead poisoning that is severe enough to induce symptoms is now extremely rare. However, there is compelling evidence that lead can have minor, subtle, subclinical effects at intermediate doses, notably on cognitive development in children. Some studies suggest that there may be a loss of up to 2 IQ points for a rise in blood lead levels from 10 to 20µg/dl in young children (James R, 1996).

Effects of Chromium on the environment

Metal alloys and pigments for paints, cement, paper, rubber, and other materials contain chromium. Low-level exposure can cause skin irritation and ulceration. Long-term exposure can harm the kidneys and liver, as well as the circulatory and nervous systems. Also in aquatic life, increasing the risk of eating fish that have been exposed to high chromium levels.

METHODOLOGY AND MATERIALS

Materials

Used lubricating oil, Container, Atomic Absorption Spectrophotometer (A.A.S)

Procedure

The method of metal analysis was adopted (McKenzie, 1981), A known weight of the weight lubricating oil sample was separately mixed with concentrated H_2SO_4 acid in a 1:1 ratio w/v and heated gently on a hot plate to dryness in an evaporating dish. It was then carefully transferred into a Gelenkamp furnace and ashes at 550^0C for 1 hour. Samples (ashes) were then diluted in a little quantity of 2M HNO_3 acid and made up to the 50ml mark in a standard volumetric flask. The samples prepared was then subjected to analysis for alkali and alkaline using flame photometry. The designated heavy metals, additives and wear metals were analyzed using atomic absorption spectroscopy, Buck 205 model with the aid of fuel-rich air acetylene flame at their individual

λmax wavelength. A blank study was also carried out.

RESULTS AND DISCUSSION

RESULTS

Table 1: Concentration of Heavy Wear Metals (Elements) in Used Lubricating oil

Elements	Concentration (ppm)
Iron (Fe)	3.2449
Zinc (Zn)	0.2942
Chromium (Cr)	0.0235
Lead (Pb)	0.1824
Cadmium (Cd)	0.0028
Cupper (Cu)	0.0102

Table 2: Heavy Wear Metal Content in Used compared with Quality Guidelines and Standards by International Organization or country

Heavy metals	WHO (guidelines)	USA (standards)	Present study
Cupper (cu)	2.0	1.3	0.0102
Cadmium (Cd)	0.003	0.003	0.0028
Iron (Fe)	-	0.3	3.2449
Lead (Pb)	0.01	0.01	0.1824
chromium (Cr)	0.05	0.1	0.0235
Zinc (Zn)	3.0	5.0	0.2942

DISCUSSION

With the above results, the research indicated that with exception of iron (Fe) and lead (Pb) which are higher than the remaining that were found to be 3.2449ppm and 0.1824ppm while the others with less level of concentration are; Cadmium, Zinc, Chromium, Copper, with the concentration levels as 0.0028ppm, 0.2942ppm, 0.0235ppm, Cupper 0.0102ppm respectively. This is similarly compared with the standard value of WHO/FAO and USA Standard guidelines for heavy metal.

The result shows that, with six (6) heavy metals (wear metals) found in used lubricating oil of Honda civic only two out of the six samples were found to have exceeded a tolerance limit or international standard of WHO/FAO and USA Standard.

Iron

According to WHO and USA, the acceptable limit of iron is 0.3 mg/L. The occurrence of iron in used lubricating oil is 3.2449ppm. Iron concentration was maximum in the present study.

Lead

Bureau of Indian Standard (10500, 2012) has recommended an acceptable limit of 0.01 mg/L for lead in drinking water. The occurrence of Lead concentration in used lubricating oil was found to be 0.1824ppm.

CONCLUSION AND RECOMMENDATIONS

CONCLUSION

Only appropriate used oil management can guarantee minimal environmental contamination and prevent its irreversible degradation. The analyzed data revealed that iron and lead metals were found to be the most abundant heavy metals in the used lubricating oil. The high concentration of heavy metals like iron (Fe) and lead (Pb) reveals that the used lubricating oil disposed of usually contaminated our environment, especially water lock, soil and animals which are injurious to living things and humans are contained in the used oils as specified in the review of literature the effects of those metals thus, the high concentration of heavy metals is a signal of danger to life in areas where the used oil is not properly disposed of. The study has also been able to predict which components parts of the cars needed attention for physical maintenance and repair of the engine and replacement of the damaged engine parts.

Also, the kind of lubricating oil to be used for different engines depends on the grade and the additives contained in the lubricating oil.

RECOMMENDATIONS

i. The government should intact laws which will ensure that mechanical workshops make use of standard waste treatment for disposing of the used lubricating oil.
ii. Monitoring programs should also be launched from time to time in order to prevent improper disposal in our entire environment to ensure the welfare of society and to protect the natural environment.
iii. Further studies are suggested particularly on the wear metals of used engine oils of various products in order to check their comparatives for quality assurance.

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