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Experimental Investigation on Effect of Vegetable Oil based Lubricant for Diesel Engine

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Abstract

Objective: Vegetable oils are being investigated as a potential source of environmentally favorable lubricants, due to their unique combination of biodegradability, renewability and excellent lubrication performance. **Methods/Statistical Analysis:** In this testing, the thermocouple was mounted in the crankcase drain plus, gas outlet to exhaust and coolant outlet to conduct the experiments. Lubricants like SAE 40, palm oil and palm oil-castor oil blend were used in a conventional diesel engine. In this experiment, maintaining temperature plays a vital role, the temperature of crankcase oil, the coolant temperature and the exhaust gas temperature were compared at various conditions with different load conditions. And the crankcase oil temperature, coolant temperature, exhaust gas temperature was analyzed. **Findings:** The crank case oil temperature, coolant temperature and exhaust gas temperature was found at no load, 2.5 kg, 5 kg, 7.5 kg load conditions. The crankcase oil temperature, coolant temperature and exhaust gas temperature for palm oil and palm oil castor oil blend were found to be lower than SAE 40. Compared to the mineral-based commercial oils, palm oil-based lubricants exhibits superior tri-biological properties but offers no clear advantage on engine and emission performance.

Keywords: Biodegradable Lubricant, Diesel Engine, Palm Oil, SAE 40

1. Introduction

Early this century, serious environmental concerns have stimulated an increased interest in biodegradable lubricants. When compared to lubricants made from petroleum, vegetable-based lubricants are much more biodegradable. The unique properties of vegetable oils such as their high viscosity index, low frictional co-efficient, high flash point and low volatility makes them much more suited for vehicular lubrication than mineral oils[1].

To meet the ever-increasing demand for petroleum fuels and lubricants, India is forced to import crude oil and its products since indigenous production falls short of demand. Also, there is increasing pressure on the vehicle lubrication industries to increase the eco-friendliness of their products[2]. So, a legitimate question appears: What can be substituted for mineral lubricants in the future? We consider that vegetable oils, synthetic oils and their mixtures might represent such a possibility[3]. Vegetable oils are biodegradable; they can be produced in large amounts as they are renewable and they are environmentally friendly. There was a wide range of advantages that vegetable oils act as lubricants such as high biodegradability, low levels of pollution, compatibility with additives, low making cost, wide production potential, low toxicity, high flash and fire points, low volatility and high viscosity index[4]. As drawbacks for their use as lubricants, we have to consider relatively high freezing points and their low oxidative stability[5].

The purpose of this learn was to create alternative lubricant, other than the usual petroleum-based lubricant oil and to make natural, biodegradable, ecologically friendly lubricant oil without affecting emission or reduce emission to eliminate solid additives. In this experiment SAE 40, palm oil and palm oil castor oil blend was tested in a four stroke diesel engine and the results were compared.

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2. Experimental Details

A four stroke diesel engine was tested to use 100 percentage SAE 40, palm oil and palm oil (14%) + castor oil (86%) blend as its crankcase lubricant. A thermocouple was used to measure the crankcase oil temperature, engine coolant outlet temperature and exhaust gas temperature at every 5-minute interval. The engine was operated for an hour under each of these conditions: No load, 2.5 kg, 5 kg and 7.5 kg load. First, SAE 40 was used as crank case lubricant, after that, palm oil was used as the lubricant and the temperature values were noted. Then some graphs were plotted and compared.

The engine specification is as follows: Four-strokes single cylinder direct injection diesel engine, 8 HP (5.9 kw) Power, 1800 rpm speed, Bore Diameter 87.5 mm, stroke 110 mm.

3. Results and Discussion

The difference in crank case oil temperature shows in Figure 1 with time for different loads. It was found that as the load condition was increased, the temperature of the lubricant also increased. For no load condition, the temperature was found to increase up to 40 minutes after which it remained constant.

As the temperature was increased due to combustion of fuel, heat and high load conditions, the friction power was found to be higher than no load condition; more amount fuel admitted. With an increase in load condition, the oil temperature was fond of increasing up to 40 minutes, after which it did not vary. When the temperature increased, the viscosity of the lubricating oil also digressed. The palm oil temperature was found to be lower as compared to SAE 40 oil at no load to all load condition. The castor oil-palm oil blend temperature was also found to be low as compared to SAE 40 oil. There was a reduction in the temperature of vegetable oil-based lubricant due to lower friction force acting between piston and cylinder wall due to the hydrodynamic lubrication that takes place between the piston and the cylinder wall. The oil temperature and viscosity can't affect hydrodynamic lubrication.

Figure 2 shows that coolant temperature was found to increase under high load conditions. Initially, under the no load condition, the engine fuel admission was lower. The heat generated was lower and the engine coolant temperature was also found to be lower. While the engine operated at 7.5 kg load, the temperature of coolant increased due to friction and the coolant temperature was also found to increase under this high load. Due to friction, some power losses created this power loss were converted in to heat only. Load increased means friction between moving part of the engine is increased.

From the graph, it can be observed that the coolant temperature of palm oil-castor oil blend is lower than SAE 40 oil under no load to all load condition. The (SAE 40 oil used lubricant) coolant temperature was slightly increased as compared to palm oil-castor oil blend. Due to the low friction force acting between piston and cylinder

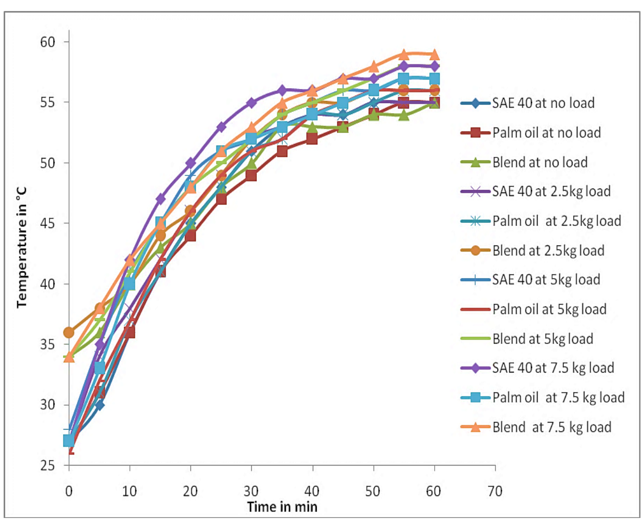

Figure 1. Crankcase oil temperature vs. time.

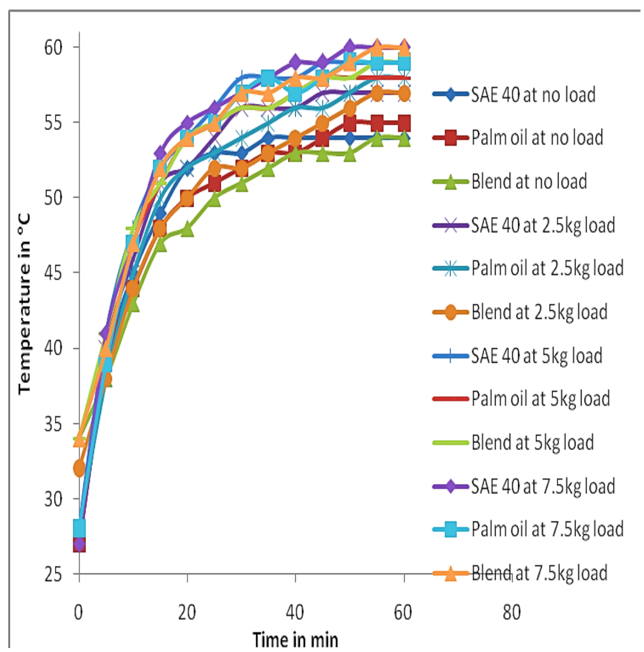

Figure 2. Coolant temperature vs. time.

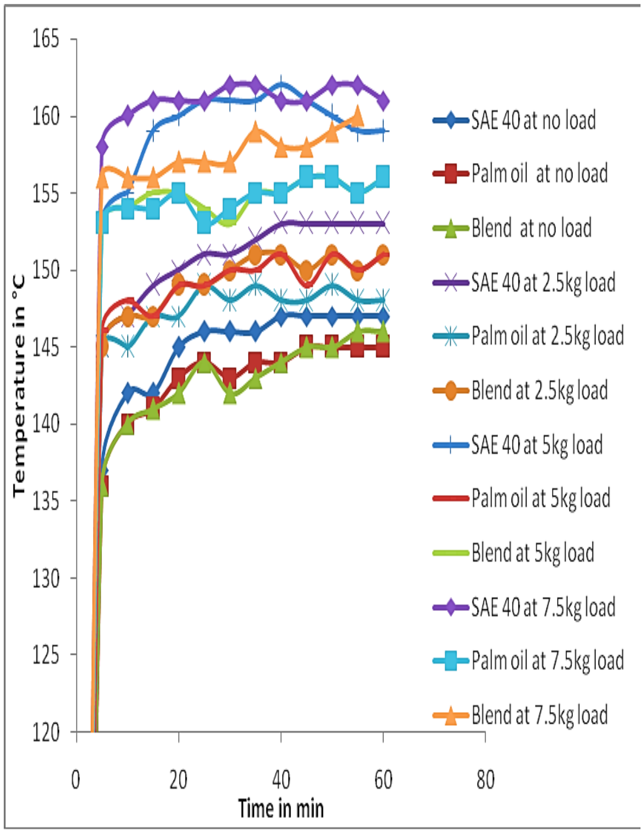

Figure 3. Exhaust gas temperature vs. time.

wall, there is a reduction in friction which causes friction losses and friction heat generation is reduced. As a result, coolant temperature was lower when vegetable oil was used as the lubricant.

The Figure 3 shows that the variation in exhaust gas temperatures with respect to time and varying load conditions. At no load condition, initially, the exhaust temperature was found to increase and after 35 minutes, the temperature remained as constant. When the load was increased, the exhaust gas also temperature increased. The increase in temperature of the exhaust gas is due to complete combustion.

From the graph, it can be inferred that exhaust gas temperature is lower for vegetable oil-based lubricants compared to SAE 40 as the lubricant. The lower exhaust temperature of the vegetable oil is due to a reduction in coolant temperature.

4. Conclusion

The experiments were conducted with SAE 40 and palm oil as the lubricant in a conventional diesel engine. It was found that with the use of vegetable oil (palm oil, palm oil, and castor oil blend) as a lubricant, there was a reduction in temperature of the crank case oil, coolant and the exhaust gas temperature at various load conditions than when SAE 40 was used as a lubricant.

Vegetable oils have a high oil film thickness at a temperature of 20°C to 100°C as compared to SAE 40. Frictional force acting on the piston is low for vegetable oil-based lubricants. When a bio-degradable additive like castor oil was added, it further improved the wear resistance and oxidation stability of blend.

The engine performance and emissions for both lubricants showed no significant difference either. The advantages of palm oil and palm oil-castor oil blend are derived from renewable resources and biodegradable lubricant. More study is required on pour point, oxidation stability, friction in the engine parts according to lubricant properties to obtained good biodegradable renewable lubricant.

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