ISSN 1454 - 8003
Proceedings of 2019 International Conference on Hydraulics and Pneumatics - HERVEX
November 13-15, Băile Govora, Romania

EFFECT OF TEMPERATURE ON THE LUBRICATION PROPERTIES OF DIESEL-SESAME OIL BLENDS

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Abstract: *Injectors and fuel pumps of diesel engines are lubricated by the fuel itself. So, the lubricity is very important issue for the engines. In this research, the effect of temperature variation on the friction coefficient as the lubrication property of diesel-Sesame oil blends was investigated by using four ball wear testing machine. The tests were conducted for fuel blends D90S10 (90% diesel and 10% Sesame oil by volume contained), D85S15, D80S20 and D100 according to ASTM D4172 and at temperatures of 25, 50, 75°C for 1500 and 3600 seconds. The results showed that the lubricity increases as a consequence of increasing Sesame oil in the fuel blend. The effect of temperature on the friction coefficient for test duration of 3600 seconds is more than that of test duration of 1500 seconds as a result of fuel degradation and losing fuel film stability between the balls.*

Keywords: *Friction, Four-ball Wear Testing Machine, Temperature, Sesame oil, Diesel*

1. Introduction

Injectors and fuel pumps of diesel engines are lubricated by the fuel itself. So, the lubricity is very important issue for the engines. Temperature of the fuel inlet can effect on lubrication of the engine fuel system, injectors and fuel pumps [1, 2]. There is not appropriate lubricating properties for conventional diesel fuels [3]; Recently there has been an increased concern in enhancing the use of biodegradable vegetable oils in lubricants because of environmental, economic and supply issues. Moreover, vegetable oils are also the alternative fuels that can blended with diesel fuel and used in CI engines[4]. In recent years, there are some studies about wear and lubrication properties of diesel blended with biofuels especially biodiesel[5]. Anastopoulos et al. [6] reported improved lubrication performance for blend levels with as little as 1% biodiesel. In Haseeb et al. [3] research, the authors found that with an increase in temperature, both friction and wear were higher slightly. Masjuki and Maleque [7] reported corrosion and oxidation in the lubricant after using more than 5% biodiesel derived from palm oil. Maru et al. [8] studied frictional properties of biodiesel according to Stribeck curves and demonstrated animal fat biodiesel lubrication has lower friction coefficient compared to soybean methyl ester oil. Fazal et al. [9] indicated that there were other relevant parameters (auto-oxidation, moisture absorption, viscosity and density of fuel) which significantly affect friction and corrosion in biodiesel and tribological properties. Lacey et al. [10] noted that sulphur included compounds in diesel fuel provided natural lubricity and that this helped to improve frictional and lubricity properties in the fuel. Habibullah et al. [11] studied the tribology characteristics of Calophyllum inophyllum biodiesel as lubricity enhancer by applying four ball tribometer. The result showed that diesel fuel has 16% and 40% higher friction coefficient and wear scar diameter than pure biodiesel respectively. Dhar and Agarwal [12] investigated the tribological properties of Karanja biodiesel blends compared to mineral diesel in the long term test. The results showed that that there is significant deterioration of lubricating oil because of higher concentration of wear trace metals in the oil of the engine fuelled with biodiesel compared to mineral diesel. According to the literature, it can be observed there is a lack of research to find lubrication properties of diesel-vegetable oils blends under various temperature conditions. Since Sesame oil is a conventional vegetable oil in Iran so in the present study, the effect of temperature variation on the friction coefficient as the lubrication property of diesel-Sesame oil blends was investigated by using four ball wear testing machine. The tests were conducted for fuel blends D90S10 (90% diesel and 10% Sesame oil by volume contained), D85S15, D80S20 and D100 according to ASTM D4172 and at temperatures of 25, 50, 75°C for 1500 and 3600 seconds.

2. Methods

Friction characteristics of fuel mixtures were studied under steady-state condition by using the four-ball wear testing machine according to ASTM D4172 standard. Fig. 1 shows the four-ball wear testing machine with the temperature control system. The test balls and prepared fuel blend according to the Table 1. The HMI controller records the friction torque and calculated the friction coefficient by following the Eq. (1). The test conditions in the present study are described in Table 1.

$$\text{Coefficient of friction}(\mu) = \frac{T\sqrt{6}}{3Wr} \quad (1)$$

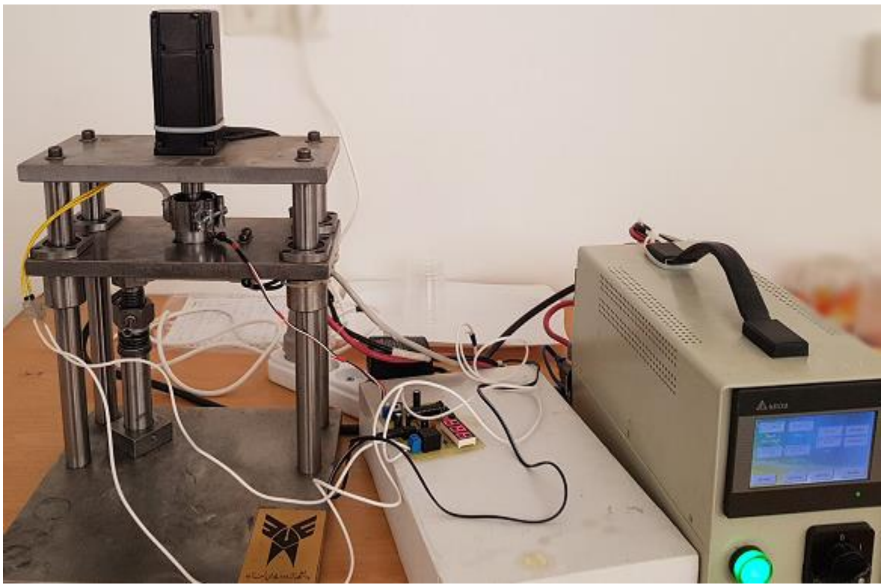

Fig. 1. The four-ball wear testing machine

Table 1: Tests conditions

Item	Value
Applied load (N)	392
Rotation (rpm)	1200
Test duration (s)	1500, 3600
Fuel blends	D90S10, D85S15, D80S20,D100

2.1 Results and discussion

Steady state friction coefficient averaged over the last 1500 seconds was calculated from the recorded torque and is plotted in Fig. 2 as a function of test temperature. Fig. 3 shows the friction coefficients versus test temperature for test duration of 3600 seconds.

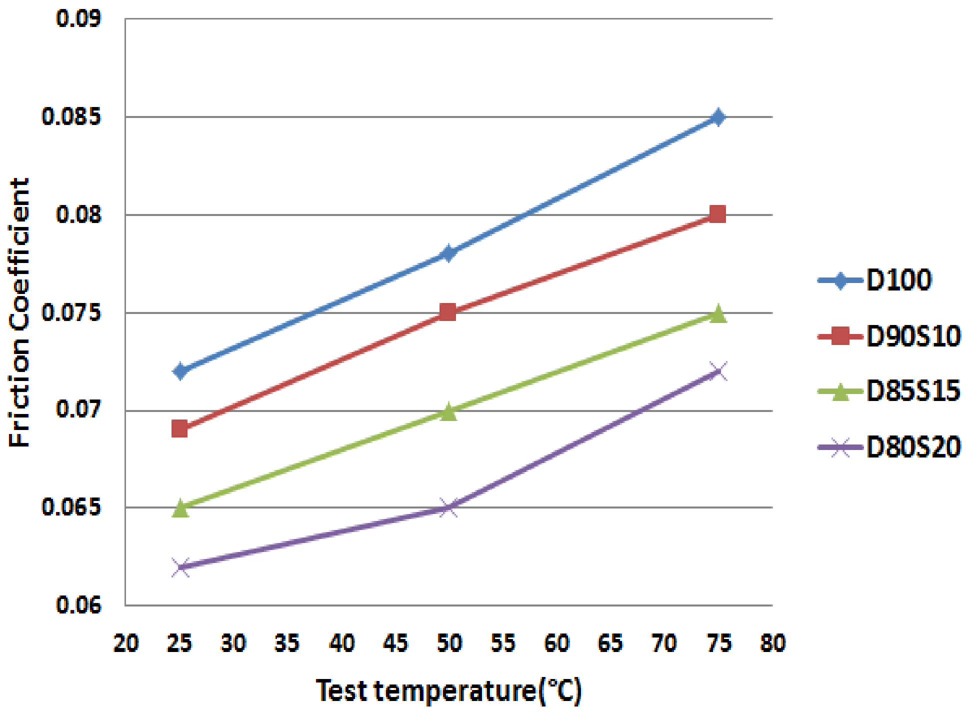

Fig. 2. The friction coefficients versus test temperature for test duration of 1500 s

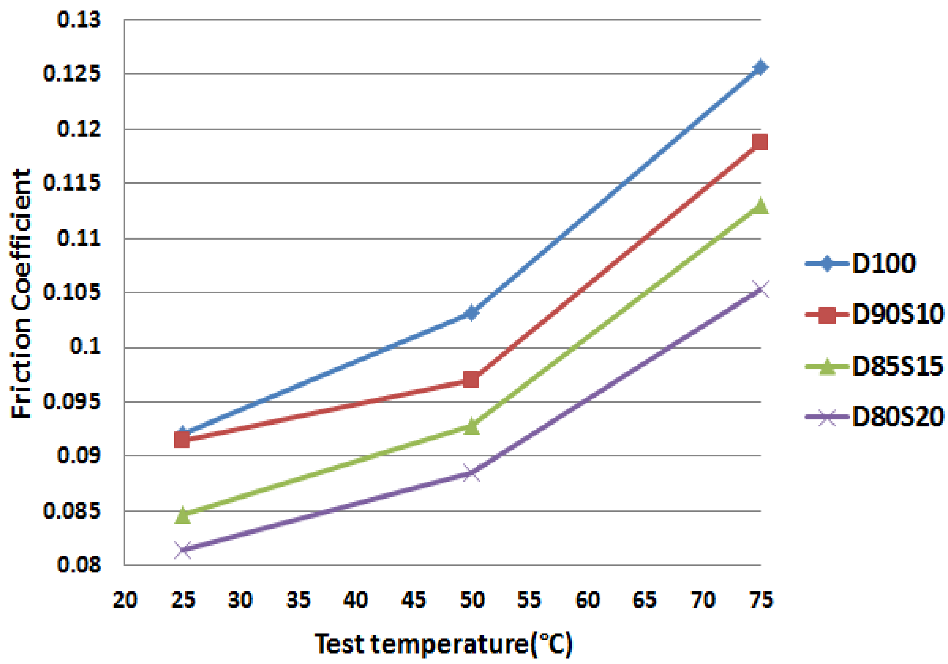

Fig. 3. The friction coefficients versus test temperature for test duration of 3600 s

The results showed that the lubricity increases as a consequence of increasing Sesame oil in the fuel blend. The reason could be due to the trace components in Sesame oil including free fatty acids, monoglycerides, diglycerides that improve the lubricity of the oil. In addition, the protective films can reduce thermal energy in sliding contact and thereby improve lubricity.

The results also indicated that the effect of temperature on the friction coefficient for test duration of 3600 seconds is more than test duration of 1500 seconds because of fuel degradation and losing fuel film stability between the balls. According to Clark et al. [13], viscosity of the fuel decreases with increasing of temperature. Another possible interpretation given by Masjuki et al. [14] is that the breakdown of boundary lubrication is due to the lower viscosity. In the other words, the stability of fuel film is depended on operating conditions such as load, temperature, speed as well as fluid viscosity and composition [15]. The present results suggest that at higher temperatures, these films seem to be less stable and thereby cause comparatively higher friction.

Acknowledgments

The author would like to thank the Aerospace and Energy Conversion Research Center at Najafabad Branch, Islamic Azad University for partly supporting this study.

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