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Effects of Using JP8-Diesel Fuel Mixtures in a Pump Injector Engine on Engine Performance

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Abstract: JP-8 fuel used in the aviation industry, especially in military fields, is used as a common military fuel between NATO countries. As the basic substance of JP-8 fuel, kerosene flares at high temperatures directly increases aircraft safety and freezing point is around -49 ° C, it is advantageous to use easily in fuel systems. In this study, the effects of jp-8 and diesel fuel mixtures on engine performance were investigated experimentally. A 3-cylinder, four-stroke, turbocharged diesel engine with pump injector fuel system was used for this purpose. 5% JP8 was added to diesel fuel. It was used as a fuel in the engine and the obtained values were analyzed according to the diesel fuel..

Keywords: JP8, Diesel fuel, engine emissions, engine performance

1. Introduction

Since the industrial revolution, industrial energy has been suppied by fossil fuels. It leads to an incease in the atmosphere of the Earth and the rate of cabon dioxide and harmful compounds (Sungur, Topaloglu 2018). To reduce the amount of crude oil in the environment and to limit the use of alternative fuels for internal combustion engines. In this frame, it is important that the fuel is a propellant (JP) fuel, JP- 8. In order to improve the efficiency of the fuel distribution system, the US Department of Defense (DoD) introduced a single fuel (JP-8) policy for all its air and ground vehicles. JP-8. Ultra Low Sulfur Diesel. Thus, it is very important, to study the autoignition, combustion, and emissions characteristics of different types of JP-8 fuels used in military diesel engines (Wei, Liu et al. 2019). Unlike conventional diesel fuels, JP-8 has a wide variation, in particular cetane number, volatility and formulation. One of the reasons for the change in JP-8 properties may be refinery and unrefined oil sources. (Uyumaz, Solmaz et al. 2014).

Turbocharged diesel suggestion of high power density, hardness and reasonable reliability. While the Commercial World relies on fuels specifically designed for use in diesel engines, the reduction of army logistics has reduced the total number of fuels. (Fernandes, Fuschetto et al. 2007, Lee and Bae 2011, Asokan, Senthur Prabu et al. 2019). Further, one for both airplane jet engines and vehicle diesels offers a chance for great benefits in weather conditions. (Sundararaj, Kumar et al. 2019).

JP-8 or JP8 (for "Jet Propellant 8") is a jet fuel used in a variety of US military. MIL-DTL-83133 and British Defense Standard 91-87 and similar to Jet A-1 of commercial aviation, but with the addition of corrosion inhibitor and anti-icing additives (Ning, Duan et al. 2019, Sogut, Seçgin et al. 2019).

A kerosene-based fuel, JP-8 is projected to remain in use at least until 2025. It was beginning introduced at NATO bases in 1978. Its NATO code is F-34. The various properties of JP-8 fuel

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are shown in Table 1(Lee and Bae 2011, Lee, Oh et al. 2012, Lee, Lee et al. 2015).

2. Material and Method

From fossil diesel fuel and JP-8 fuel. This mixture was prepared by adding 5% by volume JP-8 to the diesel fuel. He opened the chamber of the newly prepared fuels and was allowed to bind within 48 hours and any phase separation and collapse were observed. Before all tests, the fuel system was flushed from the previous fuel. The engine is heated to operating temperature. The tests were repeated 3 times and averaged the measured values.

This level has a tester consisting of diesel engine and hydraulic dynamometer to compare diesel fuel and JP8 diesel fuel. A Volkswagen brand three-cylinder, four-stroke, water-cooled pump injector diesel engine is used in the experiments. 2. The manufacture of a hydraulic dynamometer with a shear power of 100 kW in the experiments.

Table 1. Diesel and JP8 Properties

Property	Diesel	JP-8	Test Method
Density @ 15°C, kg/L	0.8334	0.8001	ASTM D-1298
Distillation, °C 10% Rec. Temperature 50% Rec. Temperature 90% Rec. Temperature	 218 283 348	 151 200 238	ASTM D-86
Sulfur Content, % wt	0.033	0.2532	ASTM D-4294
Copper Strip Corrosion	1A	1A	ASTM D-130
Flash Point	65	44.5 (D-56)	ASTM D-93
Kin. Viscosity @ 40°C, cSt	2.92 (40°C)	4.05 (-20 °C)	ASTM D-445
Cetane Index	57	53	ASTM D-4737
Cetane Number	55	51	FuelTech IQT
CFPP	-7	n/a	IP-309
Freezing Point	n/a	-48	ASTM D-2386
WSD, μm	455	720	CEC F-06-A-96
Conductivity (pS/m)	n/a	420	ASTM D-2624

Table 2. The technical characteristics of the diesel engine used in the study

Type of engine	4 stroke
Engine volume	1422 cc
Number of cylinders	3
Diameter of cylinder	79.50 mm
Stroke length	95.50 mm
Maximum power	52 kW @ 4000 rpm
Maximum Torque	155 Nm @ 1600 rpm
Compression ratio	19.5:1
Fuel system	Pump injector
Fuel Type	Diesel

The characteristics of the engine dynamometer used in the experiments are given in Table 3.

Table 3. The characteristics of engine dynamometers

Model	BT-190 FR
Capacity	100 kW
Maximum rotation	6000 rpm
Maximum torque	750 Nm

The technical information on the exhaust emission device used in the experiments is given in Table 4.

Measurement Ranges	Unit	Value
CO	%	0-9.99
CO_2	%	0.19.99
HC	ppm	0-2500
λ	%	0-1.99
O_2	%	0-20.8
NOx	ppm	0-2000
Operation temperature	°C	5-40
Supply voltages	V	12

The test setup is shown in Figure 1.

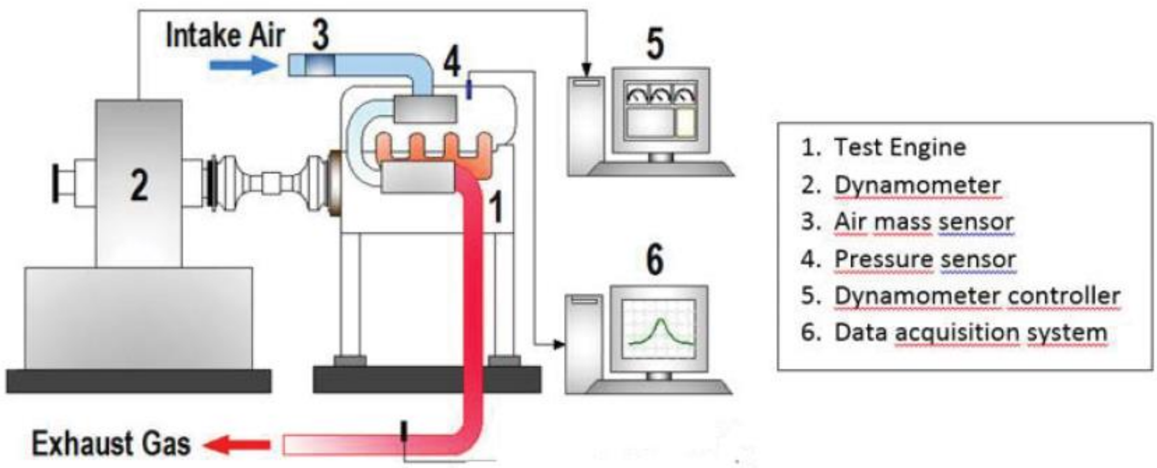

Figure 1. Engine test equipment

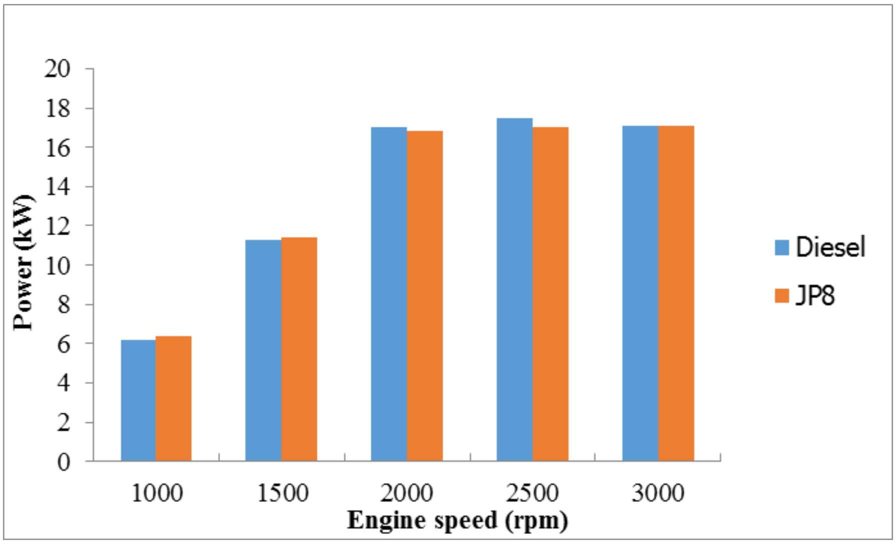

Figure 2. Variation of engine power with engine speed

The changing of the engine torque values is shown in Figure 3. The engine torque numbers showed a reduction with the reduction of the engine brake power. When this shape is analyzed, it can be shown that the max. torque numbers is gain at 2000 rpm. Engine torque at 2000 rpm is measured as 81 Nm with diesel fuel use. The values are very close to each other when using both fuels.

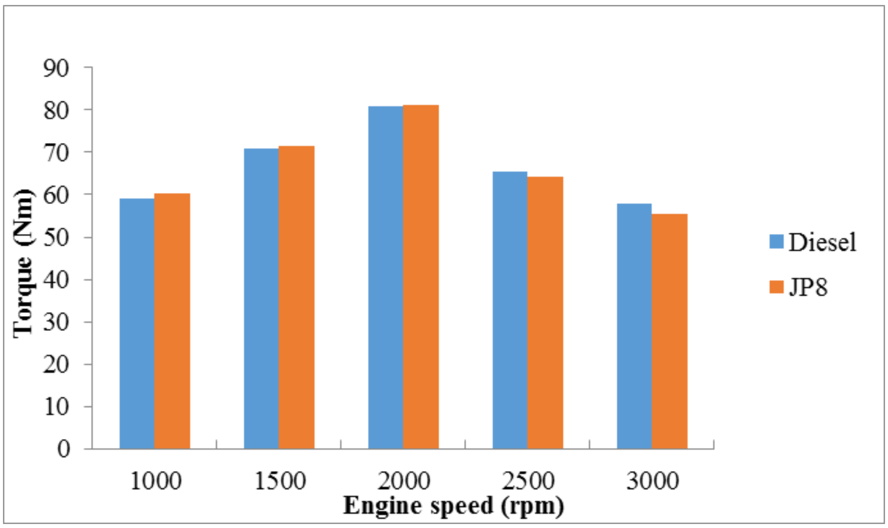

Figure 3. Variation of engine torque with engine speed

The values of specific fuel consumption according to engine speed can be seen in Figure. 4. The lowest specific fuel consumption with all fuels was achieved in the range of 1950-2200 rpm. At this rpm, the use of the JP8 compared to the diesel fuel and the specific fuel consumption values up to 10% increased. Due to the low heating value of the JP8 fuel, the fuel consumption and specific fuel consumption of the pump increases by using diesel fuel, sending more fuel owing to the pump to gain near power.

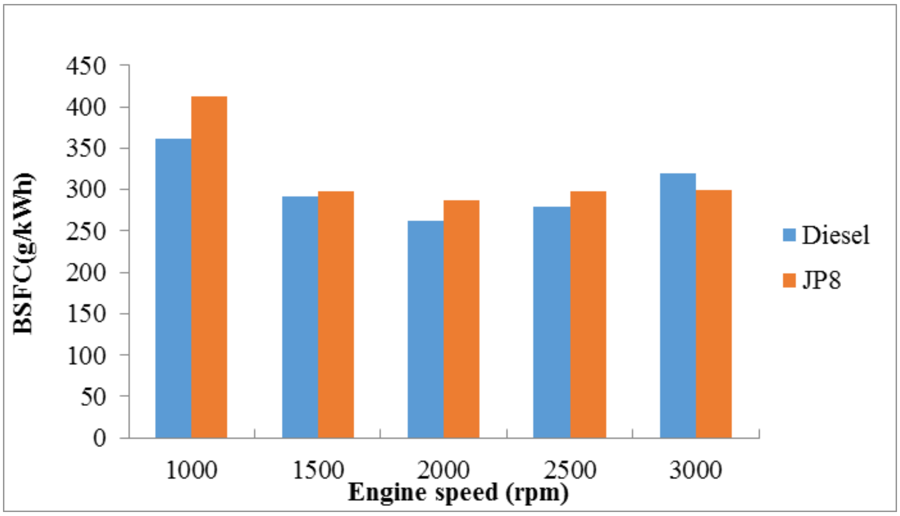

Figure 4. Relationship between specific fuel consumption and engine speed

4. Discussion and Conclusions

In this study, performance tests of fuel mixtures obtained by mixing 5% by volume of aviation fuel JP-8 to reference diesel fuel and diesel fuel were examined comparatively. A 3-cylinder, 4-stroke diesel engine with pump injector was used for these experiments. as a result of experiments although the lower thermal values of the JP-8 and the reference diesel fuel are very close to each other, the lower density of the JP-8 results in less energy being introduced into the unit volume of the cylinder and as a result of this, in blend fuels containing JP-8, a reduction in engine torque was observed due to the amount of JP-8 in the mixture.

Acknowledgements

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