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Effect of some BED blends on the equivalence ratio, exhaust oxygen fraction and water and oil temperature of a diesel engine

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ABSTRACT

Nowadays, natural-based oxygenated fuels, especially biodiesel and ethanol, have been considered as substitutes for fossil fuels. Because of relatively lower energy content of oxygenated fuels, it is necessary to blend them with fossil ones. In this research, authors conducted an investigation on some BED blends to determine and compare their effects on equivalence ratio, exhaust oxygen fraction and water and oil temperature in a diesel engine. For this purpose, 18 different blendes of ethanol and biodiesel with net diesel fuel were tested in a MT4-244 engine[1] considering two engine speeds in full load condition. In almost all samples the equivalence ratio decreased with increasing of biodiesel and ethanol percents. Exhaust oxygen fraction in all of samples increased with increasing of biodiesel and ethanol percents, whereas the engine water and oil temperatures slightly reduced.

1. Introduction

Nowadays, Importance of the energy and its role on the economic and the politics is remarkable for every one. This object is considered not only for developed industrial, but also for petroleum exporter countries, because of the fact that petroleum is not infinite source. Another problem of the petroleum energy, considering nature of these fuels, is contaminant components that reversely affect on environment. The engine production legislations will become harder and harder due to increase of the number of vehicles and emission of greenhouse gases in the world. At present time, more than 700 million automobiles are moving in the roads in all of the world and around 65 million automobiles are annually added to them. This number of vehicles with billion tons of annual consumption of petroleum compounds emits the million tons of pollutants so that life of many people, especially in crowded cities, is facing serious risks. So incidence of respiratory and cardiovascular diseases caused by pollutants in recent years increased concerns and forced global organizations to prove more strict regulations in the field of fuel and engine productions. But grows of machinery production and fuel consumption is too high that presence of sever regulations can not prevent destructive effects of these fuels [1]. For this

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purpose, currently, scientists carried their researches in four important sections [2]:

1. Modify the internal combustion engines (for example; changes on combustion chamber, injection systems …).
2. Innovate the new power generation systems (for example; six stroke engines).
3. Use of specific catalysts to decrease the engines' emission.
4. Innovate and develop the new and more appropriate fuels (such as alcohol fuels, hydrogen, biodiesel …).

The previous researches in this field show that the best method to decrease the pollutants is focusing on fuel and increasing the fuel quality and specially identify the new fuel sources.

One of the recently researched fuels is biodiesel. Biodiesel is defined as the mono-alkyl esters of fatty acids derived from vegetable oils or animal fats by converting the triglyceride fats to an ester via transesterification. In simple terms, biodiesel produced when a vegetable oil or animal fat chemically reacted with an alcohol to produce a fatty acid alkyl ester [2,3].

Biodiesel is not new, it was produced many years before invention of diesel engine, i.e. 1853, by German's scientists, Duffy and Patrick. The consumption of alternative fuels in internal combustion engine is a result of invention of compression ignition engine by Rudolf Diesel. For first time, he used peanut oil as fuel in his compression ignition engine in 10th August of 1893 in Ovgsberg, Germany. Nowadays, this is an interested fuel due to its potential as a renewable energy [2,3].

Also biodiesel is well-known as a good alternative fuel for diesel engines because it can be used safely in small blending ratios with normal diesel fuel due to reduce the some exhaust emissions from engines with same engine efficiency [4]. The main difference between biodiesel and net diesel fuel is the amount of oxygen. Amount of oxygen in biodiesel is about 10–12% (depending on the type of extracted vegetable oil) but in net diesel fuel is zero. Other difference is presence of sulfur in diesel fuel that converted to sulfur oxides in combustion process or when exhausting, while it is not exist in biodiesel [2,3].

Kalligeros et al., 2003, measured fuel consumption and exhaust emissions from a single cylinder diesel engine using pure marine diesel fuel and the blends containing two types of biodiesel (sunflower oil and olive oil) at proportions up to 50%. They reported equal performance for two types of biodiesel and significantly effects on decreasing of particulate matter, unburned hydrocarbons, nitrogen oxide and carbon monoxide emissions. But they observed slight increase of the volumetric fuel consumption as a result of two types of experimented biodiesels [5].

Another renewable source of fuel that has been considered in recent decades is alcohol fuels and specially ethanol. Ethanol is oxygenated compound which produced from plants sources and can be simply obtained from agriculture products. It increases flammability in diesel and gasoline engine. It is remarkable that ethanol not been used in net form but it was blended in different percents with petrol and even diesel fuels. Ethanol blended fuels, not only has lower toxic emission as pollutant than gasoline and diesel, but also has lower price in comparison with them [6].

Ajav et al., 1998, investigated on effects of diesel and vaporized ethanol in compression ignition engine. They reported that the vaporized ethanol caused to partially reduce diesel fuel consumption, exhaust temperature and lubricating oil temperature and to increase power output, thermal efficiency and exhaust emissions [7].

In the internal combustion engine, equivalence ratio is one of the important economical performance parameters of a fuel because maximum engine performance and minimum amount of exhaust toxic gases can be only obtained in special range of equivalence ratio. If the appropriate ratio of air-fuel mixture is not produced, not only a partly of fuel energy will be wasted because of insufficient combustion, but also exhaust toxic emission will be increased. This, addition to economy losses, can enhance environmental problems, and subsequently, aspirate and heart diseases.

To reach a complete and powerful combustion in an engine, a certain ratio of air-fuel mixture should be obtained considering different condition of work and operations. The control of correct ratio of air-fuel mixture in a spark ignition engines that equipped with carburetor system is fairly better and easier than common diesel engine. Because diesel engine is not capable automatic adjustment of correct fuel injection. Thus in such conditions a part of fuel energy not been released and emission of toxic gases is increased [8]. Nowadays, using intelligent electronic systems in fuel delivery part of diesel engine (e.g. common rail injection system) partly compensates disadvantages of these old systems. In addition, using of clean fuel in such modern systems can improve the combustion process and decrease the exhaust emission. It can be said that oxygenated fuels, in some cases, even without modern equipments, can progress the combustion and increase the engine performance efficiency and decrease contaminates.

Najafi (2006) investigated on the effect of various percent of biodiesel and diesel fuels on equivalence ratio. The results showed that the increasing the biodiesel percentage in the blends, the enhancement the equivalence ratio [3]. Agarwal 2006 curried out a set of researches to found the effect of different blends of biodiesel and diesel fuel on engine oil temperature. His results at all engine test loads showed that the engine oil temperature significantly decreased with increasing of biodiesel. He reported that 20% increasing of biodiesel in the blended fuel caused the 40 °C decreasing of engine oil temperature [9].

Objective of this research is investigation on equivalence ratio of some BED blends (i.e. blends of biodiesel, ethanol and diesel fuel). The biodiesel used in this research was produced from sunflower oil. Also effects of the blends on exhaust oxygen fraction, water temperature and oil temperature of diesel engine were measured and compared.

2. Materials and methods

2.1. *Biodiesel fuel*

The biodiesel fuel for this research was produced by transesterification reaction from sunflower oil. The molar ratio of ethanol and oil was 6:1. Biodiesel properties were shown in Table 1.