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APPLICATION OF BLEND FUEL ON SOUND EMISSION AND EXHAUST GAS TEMPERATURE IN SINGLE CYLINDER DIESEL ENGINE

Faheem Ahmed Solangi

Department of Mechanical Engineering, Quaid e Awam University of Engineering, Sciences and Technology, Nawabshah

Altaf Alam Noonari

Department of energy system Engineering, Balochistan university of Engineering & Technology Khuzdar

Muhammad Kashif Abbasi

Department of Industrial and Manufacturing Engineering, Quaid e Awam University of Engineering, Sciences and Technology, Nawabshah

Ali Murtaza Ansari

Faculty of Engineering and science and technology (FEST) Hamdard university North Nazimabad (KDA) Karachi

Muhammad Moosa Jakhrani

PhD scholar, Department of Electrical Engineering, Quaid e Awam University of Engineering, Sciences and Technology, Nawabshah ***Corresponding author:*** *faheemahmed_5@yahoo.com*

Article Info

Abstract

Blend fuel is one of the substitute oils for CI engines which are familiar for instantane-ous decrease of lubricant oil debris and sound emissions. However, a very small portion of research work was carried out to study the outcome of blend fuel utilization. In this ex-perimental work, two types of blend fuels DF95WCO5 and DF65WCO20Pe15 were se-lected and compared with diesel fuel. Noise emission is one of the most essential pa-rameter that is affected by fuel used. Fuel blends containing n-pentanol, waste cooking oil, and diesel have gained popularity as a substitute ternary blend for CI engines. Rare investigations on n-pentanol blends have been reported; yet the reduction in noise emission could be significant. In this research, experimental work, deals with the charac-teristic work on exhaust gas temperature for petroleum diesel blend with waste cooking oil DF95WCO5 as binary and ternary n-pentanol in the proportion of DF65WCO20Pe15. The trials were performed on a single-cylinder water-cooled four-stroke compression-ignition (CI) engine to analyze the abovementioned impact. However, DF65WCO20Pe15 produced some better results when compared to DF. The outcomes coming from the test fuels revealed that the ternary blend DF65WCO20Pe15 of n-pentanol to diesel has caused to reducing the exhaust gas temperature in difference to the petroleum diesel. It is to be observed that the n-pentanol ought to be used as a partial substitute for diesel fuel in the CI engine applications according to the research consequences

Keywords: *Diesel, Waste cooking oil, Sound emission, Exhaust gas temperature*

Introduction

Automobile growth has accelerated the depletion of crude oil reserves such as petroleum diesel and gasoline, result ing in the depletion of specific fossil fuel reserves. The use of baseline petroleum diesel fuels also has an impact on the environment, which is a chief source of concern in the globe [1]. Furthermore, the increased need for energy in various industries, including transportation and electricity generation, is a direct outcome of people's rising level of life. The diesel engine is crucial due of its efficiency and longevity [2]. Because of strict pollution restrictions and declining crude oil reserves, renewable and alternative fuels are becoming increasingly important [3]. An important element in increasing the effectiveness and controlling the discharge of an IC [4]. It has been discovered that leftover cooking oil, helping to alleviate both the waste disposal problem and the fuel crisis [5]. When illegal substances are deposited into municipal solid waste and sewage systems, problems develop. Despite being a cheaper and more accessible alternative to petroleum diesel, WCO's elevated high viscosity is a significant disadvantage. To avoid this issue, a tiny percentage, such as 5%, can be mixed together and checked for engine compatibility. [6]. Internal combustion engines are responsible for a diverse range of noises and sounds, the majority of which are caused by the combustion of fuel (CI engines) [7-8], which crops the so-called combustion noise. n-pentanol is also recognized as a strong applicant to increase the combination stability. [9] It is well known that n-pentanol, which is used as an effective improver for diesel/methanol mixes, possesses numerous advantages over biodiesel. These advantages include advanced oxygen, decreased viscosity and surface tension, and high volatility [10]. In its most basic form, the unwelcome sound signature of a CI engine may be traced back to the severe and erratic self-ignition of the fuels. As a result, being able to separate the noise caused by combustion from the total amount of noise would be a key worry [11]. As a result, the limited number of research that have been published on the subject of noise emissions caused by engines powered by various alcohol/diesel fuel combinations [12] The temperature of the outgoing gas is associated with the ignition process that takes place within the cylinder and the activities that take place "post combustion" inside the drain manifold [13]. When adding the temperature of the exhaust gas, it is also possible to engage in the examination of the engine and the organization of its upkeep for improved machine lifetime [14]. For instance, factors such as a contaminated, adverse weather conditions, and restricted airflow to or through the radiator can all contribute to an increase in the temperature of the exhaust gas [15]. In addition, the temperature of the exhaust gas can be used to estimate the temperatures of the pistons, cylinder heads, and cylinder liners. This is a crucial consideration for the advanced next generation of high-performance engines that operate close to the limits of the engine materials [16]. Practical implementation of such a model necessitates extensive deliberation on a variety of factors, such as selected points for temperature recognition along the emission streak, which are unique to each engine, the type of thermocouple connection, and the thermal properties of the intervening materials. These characteristics likely to significantly alter torque-predictive skills [17]. EGT is, without a doubt, one of the most important factors that can be required. This is due to the fact that it is illustrative of many events that take place within the burning chambers, and it is responsible for the efficient operation of equipment that is located alongside the exhaust channel [18]. Therefore, an alternative to vegetable oil, such as non-edible WCO, is suitable for biodiesel production. Annually, WCOs are produced by processing plants such as fastfood restaurants, post-processing factories, and others, ready for disposal [19-20]. The WCO and gutter oil has been collected, recycled, refined, and reprocessed again as cooking oil that received many negative comments claiming it would cause serious health hazards [21]. Moreover, the crude oil source depletion and its extraction and processing difficulties have rendered it expensive. There is a need to modify the source to something that should be renewable, reliable, economically feasible, and environmentally benign [22, 23]. One source is waste cooking oil (WCO), as the cooking oil goes through the complex reactions of polymerization, oxidation, and hydrolysis when used for frying purposes. The nutritional value decreases, and some decomposition products like polymeric triglycerides and polar compounds are formed [24, 25]. In this study, diesel, waste cooking oil, and n-pentanol fuel mixes were each subjected to a series of experimental tests on a single-cylinder diesel engine in order to investigate the level of noise emitted while the engine was in a stationary state. It is frequently required to have knowledge of the temperature of the exhaust gas in order to provide insight on the phenomena related to heat transfer, burning, and gas stream or for the conformation.

1. Material and Methods

This study was carried out on a single cylinder diesel engine installed in Mechanical Engineering Department's thermos dynamic laboratory at QUEST Nawabshah. The essential fuel qualities are provided in Table 1.

Table 1: Fuel characterization

Properties	**Diesel Fuel**	**Waste Cooking oil**	**N-Pentanol**
Viscosity Cst at 40c	2.28	52	2.89
Density g/ml	835	900	814.4
Flash Point ^{o}C	78	271	49
Oxygen (wt %)	0	20	8.47
Calorific Valve MJ/Kg	42.5	37.68	34.75
Cetane Number	50	54	20

Table 2: Properties of test Fuels

Properties	D100	D95WC05	D65WC015Pe15	Test Method
Calorific Valve MJ/Kg	42.5	39	40	ASTMD240
Viscosity Cst at 40c	2.28	2.338571	1.948706	ASTM D-88
Density g/ml	0.835	0.836281	0.835178	ASTM D-854
Flash Point ^{o}C	78	85	94	ASTM D-92
Cetane Number	50	53	55.5	ASTMD4737

Table 3: Engine Specifications

Model	**Single-Cylinder, Horizontal, water cooled four stroke pre-combustion chamber**
Bore	75mm
Stroke	80mm
Output (12 hours rating)	4.4kW/2600r/min
Displacement	0.353L
Compression Ratio	21-23
Piston mean speed	6.93 m/s
Specific fuel consumption	278.8 m/kW h
Cooling water consumption	1360 m/kW h
Injection Pressure	14.2 + 0.5 MPa
Valves clearance	Inlet valve 0.15-0.25mm
At cooled condition	Exhaust valve 0.25-0.35mm

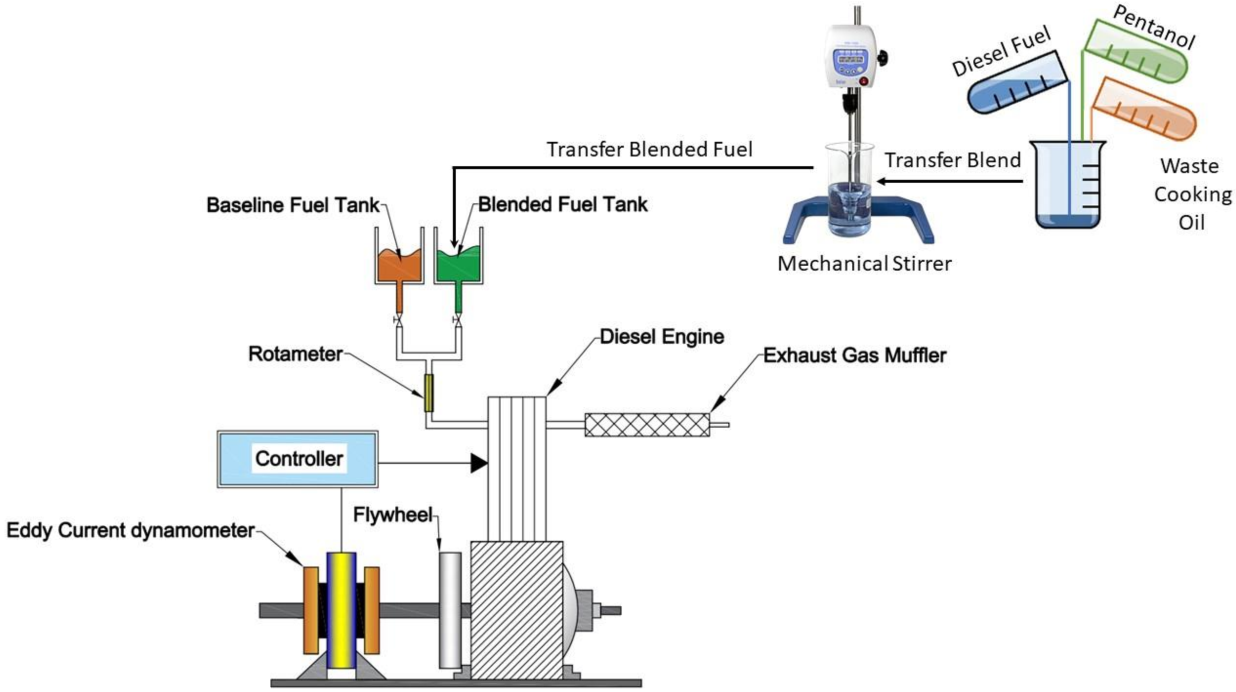

Figure 1: The schematic diagram of engine test bed.

The investigational arrangements are presented in Fig. 1.The single-cylinder CI engine is mounted on a test bench. The primary configurations are shown in Table 3. To establish the baseline specifications, the engine was first run on DF before being run on blend fuels. Each test was performed three times in order to calculate the means. Acoustic (sound that moves through the air) measurements were made using a digital sound level meter. Typically, it is a hand-held device with a microphone 1 meter away from the engine is kept constant. The microphone's diaphragm replies to variations in air pressure brought on by sound waves. Because of this, the device is occasionally referred to as an SPL (sound pressure level) meter. It was necessary to utilize the equipment to determine the microphone's sensitivity. The device be able to precisely change the electrical signal back to a sound pressure using this information, and it can show the resulting sound pressure level (decibels dB). The EGT was measured using a K-type thermocouple sensor and expressed as a Celsius temperature. A thermocouple is a device that consists of two electrical conductors that are dissimilar to one another and that generate electrical junctions at different temperatures. It includes a thermocouple probe and a thermocouple reading display metre. The temperature quantification display metre was used to display the temperatures in degrees Celsius that were measured.

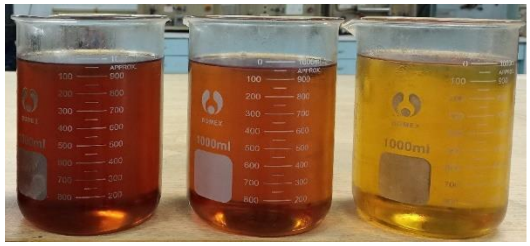

Figure 2: Physical appearance of tested fuels.

Engine exhaust gas temperature has been carried out in the thermodynamic laboratory in the Department of Mechanical Engineering. To carry out experimental work, a one-cylinder straight type water chilled 4-stroke diesel engine is employed.

2. Result and Discussions

The sound level in different directions was measured using two blend fuels and DF in the engine, and only the front side from each fuel sample produced the highest sound level between the front and rear directions. As a result, front and back sides were designated in Figs. 2 and 3. Figs. 2 and 3 typically demonstrated that both emulsion fuels had lower sound levels as compared to reference bassline fuel. Owed to the high viscosities of emulsified fuels, which produced damping and lubricity and consequently resulted in reduced of sound level, reduction in sound level compared to diesel fuel was encouraged. High cetane number emulsion fuels also decreased ignition delay, which causes the extreme pressure rise rate to lower engine sound level. Additionally, it was found that, due to improved combustion efficiency, engine noise emissions dropped as fuel oxygen content in emulsion fuels increased. Additionally, it was found that DF60WC020Pe15 generated the least amount of noise under the same load of all the test fuel samples.

3.1 Engine Noise Emission Analysis

The automotive manufacturers make a massive energy to enhance noise emission and sound level of engines because they are part of the vehicle signature of the product. The experimental study of both is of great attention and plays an evident role from the ecological prospective. In this context, the utilization of diesel/alcohol fuel emulsion in CI engines has dragged more attention. In order to calculate noise emission from different locations such front, back, rear and top as a digital sound pressure level dB meter has been used. In the combustion phenomenon, one of the most important parameters is the ignition delay. However, in case of higher ignition delay period (owing to CN number), it injects more fuel prior to starts to ignite. This makes the combustion pressure rise rate higher, as a higher amount of mass is exploded, which causes the noise to increase. Fig.8 and 9 showed the sound level at directions (front and Rear) of the engine test bed along with average of both directions when engine was fuelled with diesel fuel (DF) and two blends such as, DF95WC05, DF65WC020Pe15. From Figures, it was observed that the sound level for both blends decreased compared to DF. N-pentanol has a higher oxygen content, which allows for proper combustion to occur inside the engine. Using waste cooking oil instead of diesel and WCO blends may result in lower noise levels due to proper combustion inside the engine.

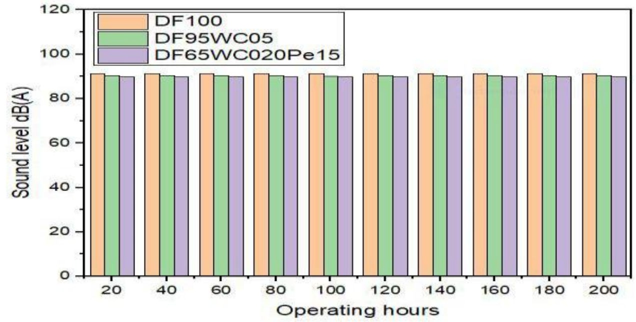

Figure 3: Front position of sound level for test fuels.

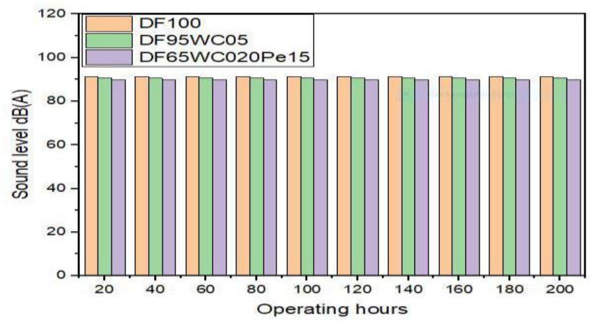

Figure 4: Rear position of sound level for test fuels

2.2 Exhaust gas temperature

This parameter focused on the conception of the burning operation or else known as the in-cylinder temperature by identifying the temperature of the combusted gas after it leave the engine [19]. The reduction in EGT is instigated by heat sink phenomenon. The sensation is produced by discrete water drops owing to fast vanishing of water. it caused in the water innermost stage partly captivating the calorific heat value of blend, thus declining the hot gas temperature [20]. Exhaust gas temperature values for diesel and waste cooking oil blend. Diesel fuel DF100 at 160 hour the highest was recorded to be as 283^{0}C, 287^{0}C and 290^{0}C, respectively. While, in case of DF95WCO5 on same engine operating hours were recorded as 294^{0}C, 296^{0}C and 297^{0}C

at same engine operating hours. It can be detected that the blend of WCO into the petroleum diesel fuel has produced higher then compared to diesel fuel in the exhaust gas temperature standards since the intensification of the burning response and considerable with the growing in the proportion of WCO as a binary blend. In the case of DF95WCO5Pe15 on same engine operating hours were recorded as 270^{0}C, 272^{0}C and 274^{0}C at same engine operating hours. However, the reduced exhaust gas temperature while using ternary blends. In comparison to pure diesel or blends of diesel/WCO and n-pentanol, more output power is obtained when a greater percentage of the available heat is transformed into mechanical work by the piston, as elaborated below.

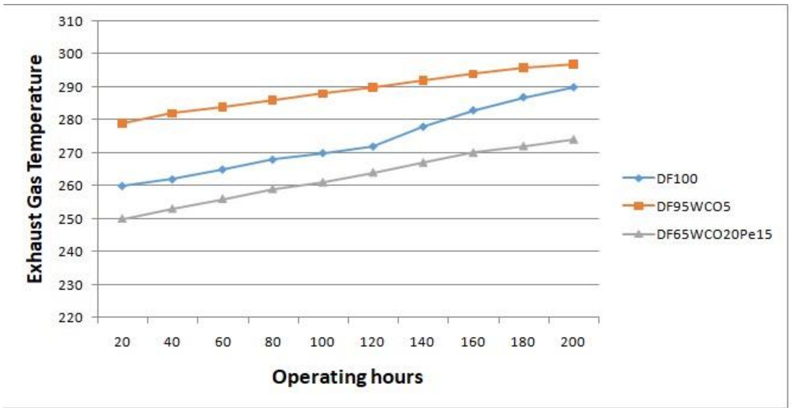

Figure 5: Engine Running Hours v/s Exhaust Gas Temperature.

Figure 3 demonstrates the difference in EGT with engine running hours when the fuel is used. Diesel fuel has higher emission gas temperature than binary blend, and it decreases with the blending proportion. Large cetane number values lessen the premixing period and go through the burning phasing untimely in the compression stroke. At constant load, diesel and waste cooking oil blend fuel have analogous to discharge gas temperature. The results of prior works express that the exploit of biodiesel proceeded to raise and decline in the emission temperature [21-22-23] diesel with extended high viscosity and ignition delay should contribute to the maximum combustion temperatures. This is also allied to the large CN of biodiesel that has the effect on falling the premixing time and rising burning effectiveness.

3. Conclusion

This experimental study focused the discussion on CI engine the lifetime by selecting fuels viz. DF100, DF95WC05 and DF65WC020Pe15 respectively. In this experimental work sound emissions were investigated using blend fuels such as DF95WCO5 and DF65WCO20Pe15and compared with diesel fuel.

- In the case of engine noise emission test, the lowest sound level compared to DF was observed by binary blend DF95WC05. Though, with addition of n-Pentanol as ternary blend DF65WC020Pe15 experimented better performance. This may be due to the influence of their respective fuel properties on decrease ignition delay and enhanced combustion efficiency due to increase in fuel oxygen content in the blends. It may be deduced that diesel/waste cooking oil/n-pentanol blends might be a favorable substitute to compression ignition engine for sound emission**.**
- It might be summarized that the mixture of WCO into the diesel fuel has instigated to go down in the exhaust gas temperature values since intensification of the burning reaction and considerable with the growing in the concentration of WCO as a binary blend. In the case of DF95WCO5Pe15 on same engine operating hours were recorded as 270^0C, 272^0C and 274^0C at same engine operating hours. However, the further reduced exhaust gas temperature while using ternary blends.

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