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EVALUATION OF COMBUSTION CHARACTERISTICS AND EXHAUST EMISSION OF VCR ENGINE USING DIESEL AND TURMERIC LEAF OIL (TLO) AND THEIR BLENDS

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ABSTRACT
Nowadays, most people are familiar with biofuels, which are thought to be an alternative fuel for the different kinds of engines used in the automotive industry. The most widely utilised engine is the market-available variable compression ratio (VCR) engine. Furthermore, the depletion of conventional fuel has made it difficult for researchers to operate engines utilising alternative fuels in the current environment. In the contemporary investigation, the performance of the VCR engine with pure diesel, biofuel, specifically pure turmeric leaf oil (TLO), in different blend percentages are used to evaluate performance based on output system of measurement such as braking thermal efficiency (BTE), specific fuel consumption (SFC) and exhaust emissions. Blends such as B70 (i.e. 70% diesel and 30% turmeric leaf oil), B60 (i.e. 60% diesel and 40% TLO), and B50 (i.e. 50% diesel and 50% TLO) are considered maintaining CR as 19.5:1 at constant speed of 1500 rpm. The results show that, in B70 have performed better when compare to pure diesel and pure TLO along with various blend.

Keywords:
Turmeric Leaf Oil (TLO), Diesel, Brake Thermal Efficiency (BTE), Specific Fuel Consumption (SFC), Variable Compression Engine (VCR)

1. Introduction
Several issues need to be solved with biodiesel in order for it to be successful, such as lowering oil prices, reducing carbon emissions, making production sustainable, preventing deforestation, and stopping soil erosion [1]. Biodiesel can be made for less money by using a lot of oils that aren't food, like Jatropha, Pongamia, animal fat, used cooking oil, and rubber seed oil. Rubber seeds are one type of oil seed that is not eaten and is not used for business [2]. Biofuels made from biomass are naturally available. Greenhouse gas emissions and other types of pollution are lower from sustainable energy sources than from fossil fuels. Because of this, fossil fuels can be used instead of biofuels in the power and energy businesses. Bio-fuels made from different kinds of edible and non-edible seeds, veggie oils, and bio-gases are great for meeting the power needs of rural and regional areas [3]. It is now more reliable for rural places to get the power they need from renewable sources like biodiesel and biogas instead of fossil fuels. Biodiesel can be made from anything that has fatty acids in it, whether they are free molecules that are saturated or unsaturated. Because of this, waste greases, used cooking oil, non-edible oil, and mixtures of veggie oils and fats can all be reused to make biodiesel. Several food and non-edible oils are used to make biodiesel in India. These include jatropha oil, coconut oil, palm oil, pongamia oil, rice bran oil, and rubber seed oil in Asia [4]. Plus, biodiesel has very little sulphur, a high flash and fire point, better lubricity, a high cetane index, and is naturally non-toxic [5]. Because biodiesel is a better lubricant, it helps keep engine parts from wearing out. Because it boils at a higher temperature than diesel, biodiesel makes it easier to use in diesel engines.
In India, the Western Ghats of Kerala, Karnataka, and Tamil Nadu are the best places to grow rubber for its latex. The hilly areas of northeast India and the coasts of Goa, Andhra Pradesh, Orissa, and Maharashtra are also good places to grow rubber. The states of Tamil Nadu, Kerala, and Karnataka

have traditionally grown rubber trees in the Kanyakumari district. About 85% of all rubber plants are grown in these states. 7.35 lakh hectares are used to grow rubber trees, and 9.1 lakh metric tonnes are produced every year [6]. Rubber trees make ovoid shells with three seeds that are about 2 to 3 cm long, brown, and weigh 3 to 4 g each. The planation field is used to collect seeds, and the kernels are taken out by breaking the shells. The dried kernels are crushed and then screened to get the oil. In this case, rubber seed is thought of as a raw material for making biofuel. Nowadays, rubber seed oil is used more in the process of making biodiesel [7].
Vegetable oils come from an endless number of oil seed crops. You can use these veggie oils instead of diesel fuels. It looks like vegetable oils and their esters are the best possible replacements to diesel fuel. In addition, they cause gum to form and burning to move slowly. Several studies have been done to find ways to make engines that run on veggie oils work better [8]. The need for energy comes from rising demand and falling supply, which is why alternative energy sources are getting a lot of attention. In this way, pure oxygenated diesel fuels have gotten a lot of attention because there are more and more problems around the world. Because they naturally have a high viscosity, vegetable oils get almost the same heat values as diesel fuel [9]. The country's people, industries, cities, and economy are all growing, which is putting a lot of pressure on energy resources. It might not be around for much longer and could be replaced with a better fuel. All of these people use a lot of fuel from different carbon sources to meet their energy needs. It has been shown that using biodiesel has helped solve these problems. The findings show that most biodiesel has higher BTE, lower SFC, and less HC, CO, and PM emissions [10]. Main reason for the fast loss of fossil fuels and pollution in the environment is the growing transportation sector. This problem can be fixed by using biofuels instead, which are both technically and economically possible. For making biodiesel [11], vegetable oils that can't be eaten could be used instead of standard food crops that can be eaten. Burning fossil fuels pollutes the environment. Also, the uneven distribution of fossil fuels makes a lot of scholars look for other sources of energy. A small group of researchers looked into using vegetable oil directly in CI engines. In the end, it turns out that the oil that can't be eaten is a good replacement for diesel fuel [12].

2. Materials and Methods used in an Experiment:

You can change the compression ratio by loosening all the bolts that hold the turning block in place. Then, the lock nut is taken off, and the adjuster is fixed for 19.5 compression ratio. Finally, all the lock nut are turned tight. The following is an experiment that was done on a Variable Compression Ratio (VCR) engine. Different blends pure diesel, Pure Turmeric Leaf Oil (TLO), Blends percentages with mixing ratio of diesel and TLO, B70 (70% of Diesel and 30% Turmeric Leaf Oil), B60 (60% of Diesel and 40% Turmeric Leaf Oil), and B50 (50% of Diesel and 50% Turmeric Leaf Oil), were tested for performance, emissions, and combustion parameters on a VCR engine running at a constant speed of 1500 rpm at different loads 5kg, 6kg, 7kg, 8kg and 9kg [13-16]. The compression ratio considered in the present work is maintained at 19.5:1.

Figure 1: Experimental setup

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A water-cooled, 4-stroke, CI engine compression ratio of 19.5:1 is used in the experiment. It produces 3.2 kW at 1500 rpm and is connected to a governor for applying the loads. The steady speed of 1500 rpm is controlled by the governor built into the engine. The exhaust from the engine goes through an exhaust gas calorimeter that is joined to the exhaust manifold. During the tests, the engine is run at 1500 rpm and diesel fuel for 5 hours to reach a steady state. The test rig is calibrated every so often. At compression ratio (CR) 19.5:1, loads of 5kg, 6kg, 7kg, 8kg and 9kg are considered to performance and results obtained are evaluated. Brake thermal efficiency, specific fuel consumption are recorded to study the performance of the VCR engine. The computer also records temperature of the exhaust gas, and different emissions like CO, CO_2, and HC, at CR 19.5:1.

3. Results and Discussions

The performance parameters such as brake thermal efficiency, specific fuel consumption, exhaust gas temperature, and emission parameters such as CO_2, CO, and HC are discussed. The experimental work starts with a ground work study of engine running on diesel in order to determine the basic engines operating parameters, combustion characteristics and exhaust emissions levels, and later was tested on turmeric leaf oil to study the performance of VCR engine with different blend ratios.

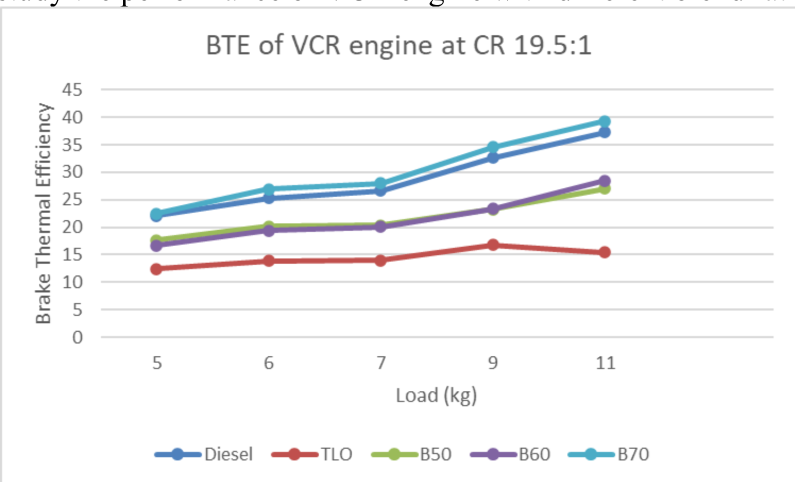

Figure 2: BTE of VCR engine with dissimilar fuels and blends at CR 19.5:1

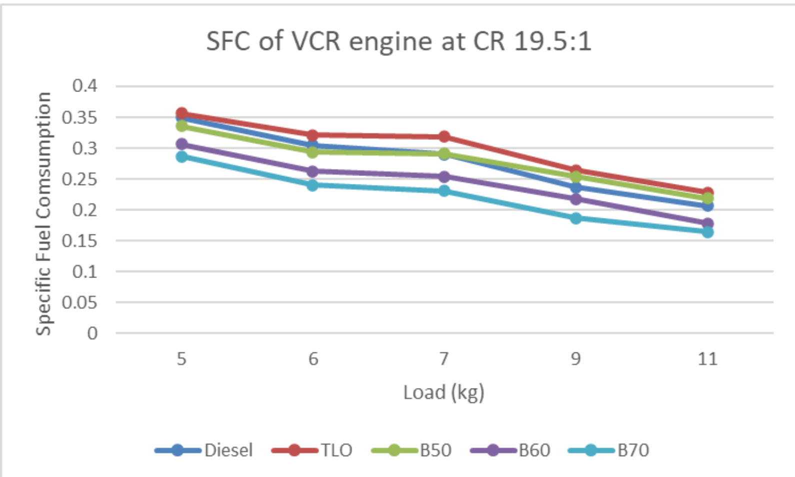

Figure 3: Specific fuel consumption of VCR engine with dissimilar fuels and blends at CR 19.5:1

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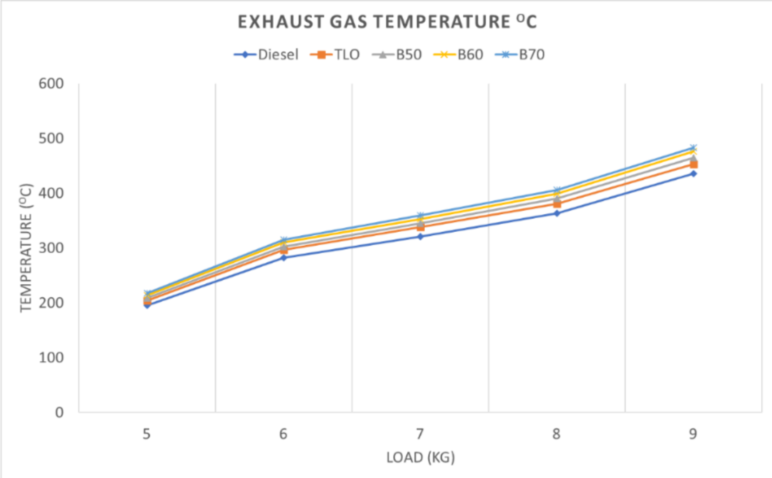

Figure 4: Exhaust gas temperature from VCR engine for different fuels

All of the fuel types shown in fig. 4 have their exhaust gases get hotter as the engine load goes up. This is likely to happen because carrying more weight usually means burning more fuel, which raises the temperature. When the engine is under more stress, the temperature of the waste gas rises for all fuel types. Diesel has the lowest temperature and B70 has the highest. The differences between these fuels are not very big.

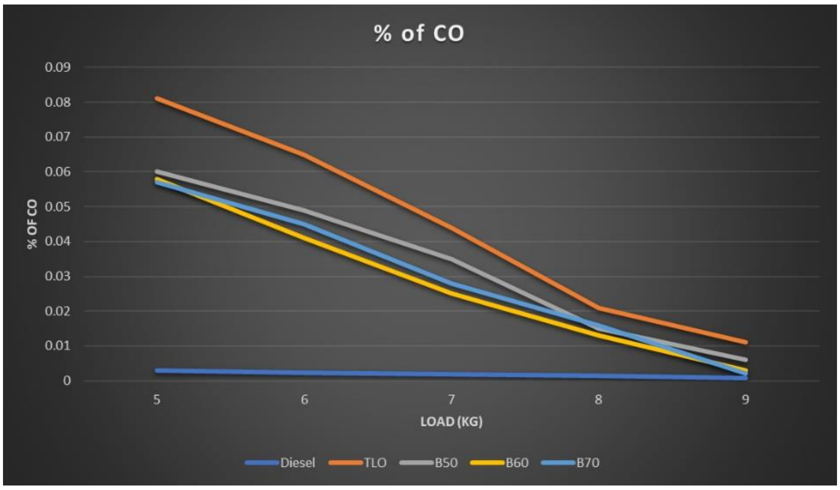

Figure 5: % of CO emission from VCR engine for different fuels

As the load goes up, the amount of CO in all fuels goes down as shown in fig.5. TLO starts out with a higher CO%, but it drops quickly as the load rises. Diesel gives off an incredibly low amount of CO no matter what it's carrying. As load goes up, CO emissions from all fuels go down. As the load goes up, biodiesel mixes, especially B70, do a better job of lowering CO emissions than TLO and Diesel.

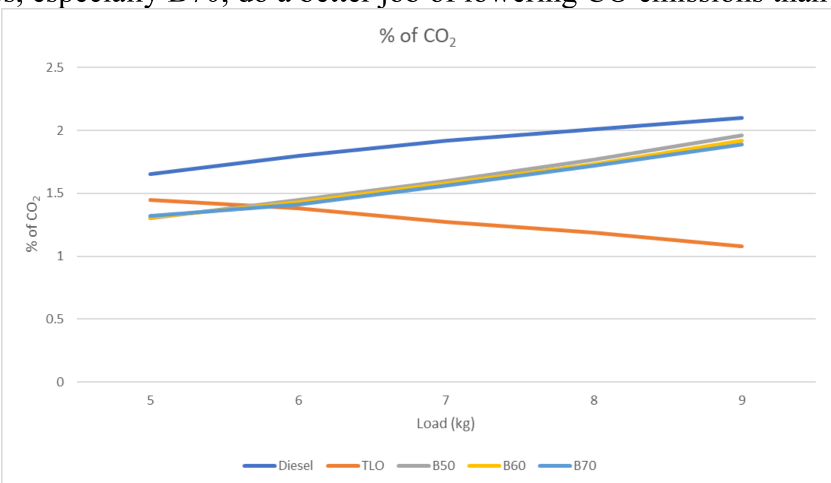

Figure 6: % of CO_2 emission from VCR engine for different fuels

The amount of CO_2 changes by fuel as the load grows as shown in fig.6. Diesel has a bigger percentage of CO_2 than TLO all the time. As the load goes up, biofuel blends (B50, B60, and B70) show a small rise in CO_2%. As the load goes up, TLO is the only fuel type whose CO_2 emissions go down, making it the best at lowering CO_2. The rise in CO_2 pollution is steadier in B60 and B70 than in B50. B70 grows a little more slowly than B50, but it's about the same uniformity as B60.

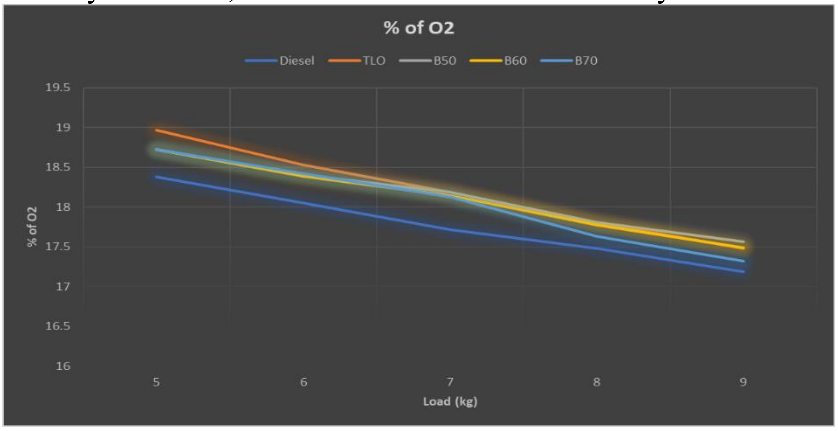

Figure 7: % of O_2 emission from VCR engine for different fuels

The amount of air in the exhaust. Oxygen levels that are too high mean that the burning process is not complete, while oxygen levels that are too low mean that most of the oxygen has been used up as shown in fig.7. As the load goes up, the numbers go down a little. Like gasoline, the values go down as the load goes up.

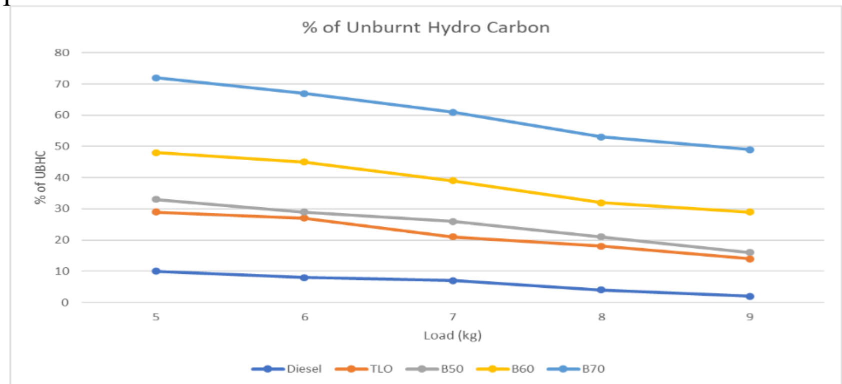

Figure 8: % of UBHC / UHC emission from VCR engine for different fuels

The number of unburned hydrocarbons (UBHC/UHC) in parts per million. Higher levels of hydrocarbons mean that the burning process is not complete as shown in fig.8. The numbers show that as the load goes up, HC levels go down, which means that the fuel burns more completely. Diesel has the lowest UHC values at all load levels. At 5 kg, they are 10, and at 9 kg, they are only 2.

4. Conclusions:

The study on the performance of VCR engine in terms of BTE, emissions and SFC with various blend percentages at 19.5 compression ratio is performed. The following are the some of the conclusion drawn:

1. When the blend B70 is used in VCR engine at CR 19.5, the brake thermal efficiency of the engine is higher in standard diesel and other blend ratios. The BTE value increase as the load on the engine increases.
2. The specific fuel consumption decreases with the increase in the load. The value is lower is B70 blend compare to other blends along with diesel.
3. As the load on the engine increases, the exhaust gas temperature rises for all fuel types, with diesel displaying the lowest possible temperature and B70 the highest.

4. As the load increases the HC emission of various blends are higher B70 this is due to viscosity of the fuel sprayed quality produces higher HC in terms of biofuels.
5. The CO and CO_2 of the B70 are slightly equal to diesel with the increase in loads due to incomplete combustion and inadequate supply of oxygen.

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