Experimental Analysis of Biodiesel-Fueled Diesel Engine

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ABSTRACT

For this project our group is running an experiment on a small 1.9 liters diesel engine to compare performance of the engine running on diesel and biodiesel fuels. To do this we ran a base line test with regular petrol diesel so we have results to compare the biodiesel test to. Three mixtures of biodiesel and diesel will be used. The RPM, torque and power at three different throttle positions will be what we are comparing.

INTRODUCTION

We are applying thermodynamic techniques to an experimental procedure of the difference in biodiesel and regular diesel fuel. Biodiesel is defined as the monoalkyl esters of vegetable oils or animal fats. Biodiesel is mainly produced from soybean, rapeseed, and palm oils. The conversion of vegetable oils and animal fats into biodiesel is known as transesterification. This process of transesterification has been conducted as early as 1853. The first diesel engine ran off of peanut oil. Biodiesel has a flash point of 423 K compared to 337 K for petro diesel. Unlike petro diesel, biodiesel is biodegradable and non-toxic. It also significantly reduces toxic and other emissions when burned as a fuel. [1]

The major advantages of biodiesel are it has higher combustion efficiency and lower sulfur content. It is also an inherent lubricant. The major disadvantages of biodiesel are higher nitrogen oxide (NOx) emissions, lower energy content, and freezing in cold weather. [1]

An article was published in the Applied Mechanics and Materials journal that did a similar test. The engine they used for their test was a 2.5 liter, turbo charged, Mitsubishi. The test was conducted at four different engine RPMs and the fuels used were regular diesel, B5, B10, B15. Their test results are shown in Figure 1. At 3000 rpm the engine produced less torque and power as the amount of biodiesel was increased. At 1500, 2000, and 2500 RPM the engine produced more torque as the amount of biodiesel was increased. Powers produced by the engine and fuel consumption were hardly affected by the biodiesel. [2]

There have been many other tests performed similar to ours on different engines. According to an article published in the Renewable and Sustainable Energy Reviews journal 70.4

percent technical reports show biodiesel produced less power, this is due to biodiesel having a lower heating value than standard diesel fuel. It was also found that engine performance decreases with the increase in the percent of biodiesel. These losses are attributed to the lower heating value of biodiesel compared to standard diesel. Biodiesel also has a higher viscosity. [3]

From the U.S. Dept. of Energies website, the average price of Biodiesel B100 is $4.24/gallon. This is a little higher than their reported $3.91/gallon of petroleum diesel. Even though the fuel is a higher price, the biodiesel has no sulfur content which is one of the main concerns of the emissions control. [4]

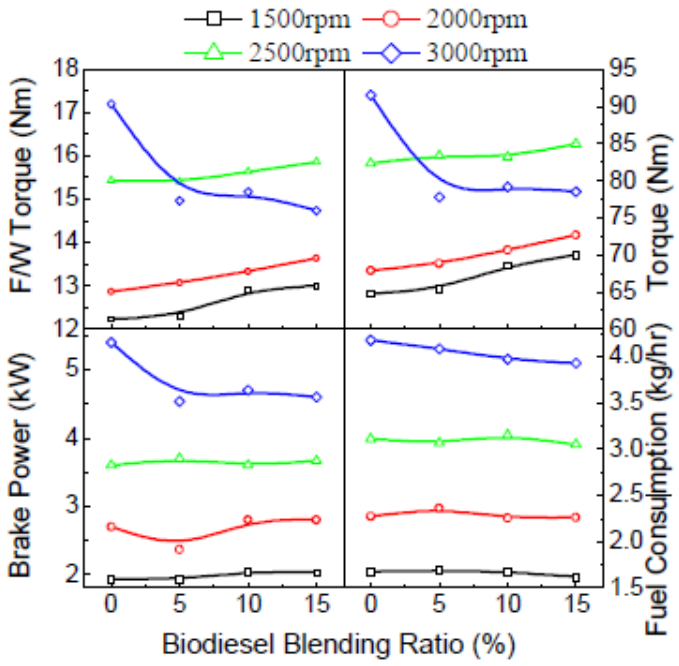

Figure 1: Test Results [2]

PROBLEM STATEMENT

The problem is whether it is more economical and efficient to use biodiesel rather than regular diesel.

OBJECTIVES

The objective is to run tests on the VW SDI-1.9 diesel engine, as shown in Figure 2, in the IC engine lab. This engine is made by Volkswagen and is an inline four cylinder. It is direct injected, naturally aspirated, and has a displacement volume of 1.9 liters. It has a compression ratio of 19.5:1 and produces 44kW at 3600rpm. [5] Test will be conducted to evaluate the efficiency and power production of the engine while running on varying mixtures of diesel and biodiesel. By running the engine with the different mixtures of fuel that will be used, the RPM, torque, and power will be compared. Testing the emissions output of the engine would be

beneficial; however on our test unit we are unable to measure this. Therefore we will use data from other tests that are in relative research papers.

Figure 2: VW SID-1.9 Engine

METHODS

Our group intends to purchase an additional fuel tank for biodiesel. This will allow us to easily switch between diesel and biodiesel for our tests. We have found local suppliers for diesel and biodiesel. We plan to run our baseline test with diesel at three different throttle positions. Then we plan to run biodiesel to compare torque and power. The group will start by running B20, which is 80% petrol diesel and 20% biodiesel, then running B10 and B5. The test will begin by run the engine for 30 minutes on regular petro diesel to warm everything up. This amount of time was determined after running the baseline test and was the amount of time it took the engine to give consistent readings. The engine will then be turned off and tank will then be switched to the biodiesel tank. The engine will then be turned back on and will be set to the first throttle setting. After five minutes of running, a reading will be taken every minute for the next five minutes. The engine will then be set to the next throttle position and the process will be repeated. After the test has been run at the three throttle positions more diesel will be added to the tank to achieve the next desired mixture and the process will be repeated. By completing these tests we will be able to measure the differences in the two fuels.

PROGRESS

Our group was able to locate and purchase a fuel tank that was very similar to the original tank that was sent with the engine. With minor modifications we were able to make the fuel tank work to contain our biodiesel fuel.

We have run the base line test with petro diesel and decided to use 6, 17, and 23 percent throttle for our test as shown in Table 1. These throttle positions were chosen because they give us RPMs close to the experiment mentioned above. We did not feel convertible running the engine at 3000 RPM like in the experiment above.

We had a previous problem with obtaining the biodiesel; however we have been able to find a local supplier that offers B20 biodiesel. The supplier is the BP in Veto Ohio. They get there biodiesel from SOY DIESEL. With this being the highest percentage readily available to our group we plan to dilute the biodiesel in to regular diesel in 5, 10, and 20 percent mixtures in order to give us a greater range of tests. The brake setting will be at 5% for the entire test. Engine speed, torque, and power will be what we are comparing.

Sample No.	Throttle Setting [%]	Brake Setting [%]	Engine Speed [rpm]	Torque [Nm]	Calc Power [kW]
1	6	5	1740	80.9	14.74
2	6	5	1740	80.9	14.74
3	6	5	1740	80.9	14.74
4	6	5	1740	80.6	14.70
5	6	5	1740	80.7	14.72
6	17	5	2159	81.0	18.31
7	17	5	2159	80.7	18.26
8	17	5	2159	80.7	18.26
9	17	5	2159	80.5	18.21
10	17	5	2188	80.9	18.53
11	23	5	2578	80.6	21.77
12	23	5	2578	80.5	21.74
13	23	5	2607	80.6	22.02
14	23	5	2578	80.7	21.80
15	23	5	2607	80.5	21.99

Table 1: Base Line Test

EVALUATION

Until the biodiesel test is ran we don't have anything to compare our base line results to. When this project is completed the university will have a functioning diesel engine that can run

both regular diesel fuel and biodiesel fuel. This will be useful for test and labs and provides the school with a cost efficient demonstration tool.

REFERENCES

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