Pollution Comparison of Off-Road Diesel and U.S. Sustainable Energy Corporation's Alternative Fuel

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Abstract

Three fuels were studied in this paper for emission of pollutants from the exhaust of the combusted fuels. The fuels were commercially available diesel, a soy based alternative fuel produced by U.S. Sustainable Energy Corporation and a 50/50 blend of the commercial diesel and the alternative fuel. Pollutant emissions looked for were CO, NO, NO_2, and SO_2 and were measured with Dean Analytical Instrument 6000. Results were looked at on the basis lowest environmental footprints in an attempt to identify the best fuel alternative. It was determined that the 50/50 blended fuels produced the most interesting results. Results indicating that further investigation into blend ratios is well worth considering.

1 Introduction

Alternative fuels are becoming increasingly important in today's global economy. [1] Foreign dependence on oil poses a significant problem for America's economic outlook and the increased pollution from traditional fossil fuels has widespread effects on the health of our nation. [2,3,4] The development of new alternative fuels that are cheap to produce is important, but if these new fuels can also reduce the environmental impact that they cause then these fuels can be considered even more valuable. It is with these factors and goals in mind

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that U.S. Sustainable Energy Corporation has produced a new alternative fuel , Rivera. Rivera processed alternative fuel is designed to replace most if not all petroleum based diesel fuels by being a renewable, sustainable fuel with a small environmental footprint.

The goal of this experiment is assess the environmental footprint of the Rivera processed alternative fuel. This is determined by using a modified EPA Methods 10 and 7a experiments [5]) with purchased commercial diesel, reveria alternate fuel, and a 50/50 blend of both fuels. The results will show the tempature of the exhaust, the CO, NO, NO_2 and SO_2 concentrations vented into the atmosphere from the combustion of these fuels in commercially available engines.

2 Experimental

2.1 Sample Preparation and Instrumentation

The diesel used for the experiment was purchased commercially by U.S. Sustainable Energy Corporation from Buffalo Services. Rivera processed alternative fuel is produced by U.S. Sustainable Energy Corporation via a proprietary method that takes soy beans and converts them into a "bio-diesel" fuel.

Pollution measurements were made with a Dean Analytical Instrument 6000 (hereafter DAI6000). The DAI6000 is a DEQ approved instrument [6] for EPA methods 10 and 7a [5] and uses electrochemical sensors to detect CO, NO, NO_2, and SO_2 concentrations in gas flow.

The engine used to combust the fuels for testing was a PowerPro 65 Airman. This unit was purchased new specifically for this experiment so no previous contamination or engine would factor into the results.

2.2 Pollution Measurements

Two different experiments were run for each fuel studied. The first experiment involved using each fuel in an engine in a idle/non-stressed mode. The second experiment involved using an engine with a full load. Table 1 provides the engine parameters used for each experiment reported in this paper.

Table 2 shows the calibration values for the DAI6000 instruments used in all experiments.

Table 1

Parameters for the Power Pro 65 Airman Engine	Value
Intake Manifold Pressure (atm)	1
Intake Manifold Temperature (°F)	90
Engine Speed (rpm)	1900

Table 2
Parameters for DAI6000

Criteria	Cylinder Value	Initial Response	Final Response	% Drift
CO	894	900	900	0
O_2	0	21	21	0
NO	899	900	900	0

Tables 3&4 give the experimental run parameters for the idle (unloaded) and stressed (loaded) engine evaluations.

Table 3
Idle Engine Run

Fuel Blend	Time Interval	# of Measurements
Commercial Diesel	15 min	3
Rivera Processed Alternative Fuel	5 min	4
50/50 Blend	5 min	3

Table 4
Loaded Engine Run

Fuel Blend	Time Interval	# of Measurements
Commercial Diesel	5 min	2
Rivera Processed Alternative Fuel	5 min	5
50/50 Blend	5 min	4

3 Results and Discussion

Results presented here in two forms, bar graphs and tables. The tables show all raw data recorded in the field at time of the experiment. Discrepancies in the number of recorded values for different fuels is related to various factors. A chief factor limiting the number of measurements that could be taken with the loaded engine runs was the engine's load varying beyond controllable parameters. This led us to be unable to keep the engine throttle level consistent. The bar graphs are presented with the mean values of the data their respective tables.

3.1 Idle Engine Results

Table 5
Idle Engine Run Results

Fuel	CO (ppm)	NO (ppm)	NO_2 (ppm)	SO_2 (ppm)
Commercial Diesel	256,252,252	100,120,100	0,0,0	200,175,200
Rivera Alternative	548,568,568,564	320,360,360,360	0,0,0,0	150,180,175,100
50/50 Blend	232,228,236	200,180,200	0,0,0	200,200,200

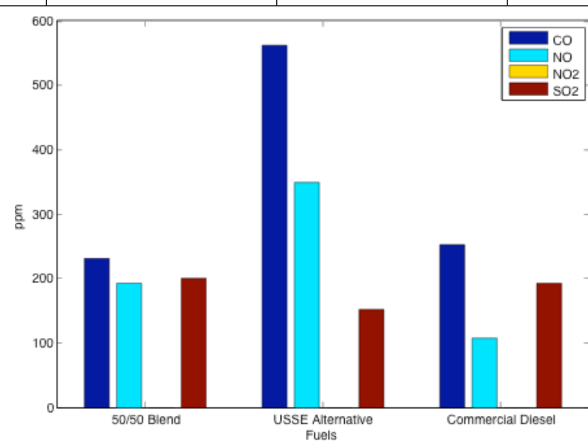

Fig. 1. Bar graph of the idle engine run results. Values presented are the averaged values from Table 5.

3.2 Loaded/Stressed Engine Results

Table 6
Loaded Engine Run Results

Fuel	CO (ppm)	NO (ppm)	NO_2 (ppm)	SO_2 (ppm)
Commercial Diesel	152,76,88,68	760,820,820,800	10,15,10,5	300,250,200,250
Rivera Alternative	208,196,320,140,160	740,960,580,1400,1430	0,0,0,30,40	150,180,170,1030,1110
50/50 Blend	64,56	860,860	10,20	350,400

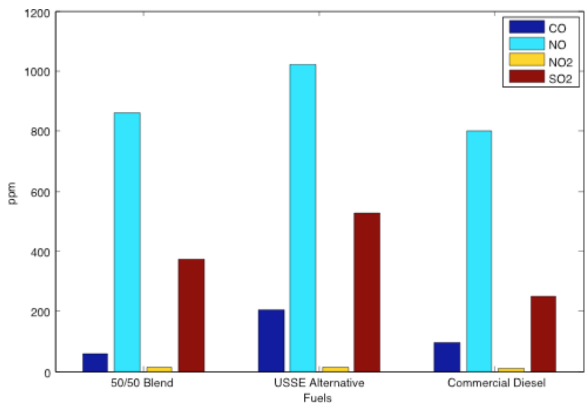

Fig. 2. Bar graph of the loaded engine run results. Values presented are the averaged values from Table 6. The engine load was not in equilibrium thus the numbers for NO and SO_2 are significantly higher than they would be under normal conditions.

3.3 *Discussion*

For the idle engine runs the purchased diesel produced the least amount of pollutants across the board when compared to the Rivera processed alternative fuelalternative fuel. However, when compared to the 50/50 blend there was no statistical difference between the CO, SO_2 emissions. The NO and NO_2 emissions were lower on the purchased diesel compared to the 50/50 blend.

The loaded engine runs produced similar results, with the 50/50 blend producing the lowest CO pollution out of all the engine runs. The SO_2 emissions were much higher no matter what fuels were used with Rivera processed alternative having the highest SO_2 with the loaded engine runs.

On the subject of engine exhaust temperatures the loaded was certainly higher for all fuels with the 50/50 blend being the highest and the lowest temperature belonging to purchased diesel. The unloaded engine runs had exhaust temperatures remain relatively constant across all fuels.

NO and NO_2 measurements were the highest for the Rivera processed alternative fuel but the 50/50 fuel blend and the purchased diesel was statistically the same.

4 Conclusions and Recommendations

While at first glance the Rivera processed alternative fuel underperforms in pollution when compared with the off-road purchased diesel, however, this small performance issue can mostly be attributed to the engine design being geared towards petroleum based fuels. However, the 50/50 blend of the two fuels shows remarkable potential as an alternative fuel. The 50/50 blend had the lowest CO emission of all fuels and engine loads and the NO and NO_2 were statistically the same as the purchased diesel.

The SO_2 emissions could be explained by the use of the off-road diesel, which has high sulphur content to begin with. The use of a commercial diesel with no sulphur could substantially lower the SO_2 emissions of the 50/50 blend making it the best fuel option of the three presented here. It should also be stated that a 50/50 blend might not be the optimum mix ratio. Further emission studies of a variety of mix ratios (such as 25/75, 30/70, 80/20, etc..) could yield a fuel with an even lower environmental footprint than the minimums presented here.

Engine exhaust temperatures are significantly higher for both the 50/50 blend and Rivera processed alternative fuel but with future engines expected to be running bio-fuels their max operating temperatures should raise to meet the new exhaust temperatures.

For future tests it is recommended that we use all loaded conditions since the loaded condition gives the best pollution emission estimates. Longer time intervals and increased number of measurements will improve the results and with enough data a full statistical analysis could be performed on the emissions data.

It appears at this juncture that the blended fuels hold the most promise and further investigations into producing a better blend composition is warranted.

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