



TRC0906

Evaluation of Biodiesel in Department Vehicles

Melana Snow

Final Report

2014

Arkansas State Highway & Transportation Department

Transportation Research Committee

Final Report

TRC 0906

Evaluation of Biodiesel in Department Vehicles



Final Report

TRC 0906 Evaluation of Biodiesel in Department Vehicles

By

Melana Snow
Engineer

Research Section
System Information & Research Division
Arkansas State Highway and Transportation Department

Conducted in Cooperation with the U.S. Department of Transportation
Federal Highway Administration

February 2014

The contents of this report reflect the views of the author, who are responsible for the facts and accuracy of the information presented herein. The contents do not necessarily reflect the official views or policies of the Arkansas State Highway and Transportation Department or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation. The U.S. Government assumes no liability for the contents or use thereof.

Table of Contents

List of Figures and Tables	ii
Chapter 1 Introduction.....	1
Chapter 2 Literature Review.....	2
Chapter 3 Work Plan	3
Chapter 4 Discussion of Results	5
Chapter 5 Conclusions & Recommendations.....	8
Conclusion.....	8
Recommendations	8
References.....	9
Appendix A.....	10

List of Figures and Tables

Table 1	3
Figure 1	4
Figure 2	4
Figure 3	4
Figure 4	4
Table 2	5
Figure 5	6
Figure 6	6
Figure 7	7

Introduction Chapter 1

Biodiesel is an alternative fuel source to be used in the place of standard petroleum. The fuel mixture is known as B20, which is a blend of 20% biodiesel and 80% petroleum diesel. Biodiesel can be made from a variety of renewable resources, such as vegetable oils (soybeans or other crops), recycled cooking grease, or animal fats. These feedstocks are used to manufacture a mixture of chemicals called fatty acid methyl esters (biodiesel). According to the Environmental Protection Agency (EPA), the use of B20 reduces fuel emissions and greenhouse gases. All diesel fuels release harmful emissions, such as nitrogen oxides, particulate matter, carbon monoxide, and hydrocarbons. The use of B20 significantly reduces these emissions. (LTAP, 2007)

There is an abundant supply of the necessary ingredients to make B20 here in Arkansas from our soybean production and our slaughter house waste. The B20 fuel can either be brought in from an outside source like normal fuel or it can be hand mixed in the tank. (LTAP, 2007)

In an effort to have a more reliable and environmentally friendly fuel source the Arkansas Highway and Transportation Department (AHTD) did a comparative study between three different types of diesel vehicles spread over the state to compare B20 to standard petroleum diesel. Over a span of three years, specific data was collected on the trucks in order to have sufficient data to analyze.

Chapter 2 Literature Review

Our country has a large dependence on foreign petroleum. So in an effort to reduce this dependence the use of biodiesel has become a viable option. Biodiesel is an oxygenated fuel or blending component made from vegetable oils, waste cooking oil, or animal fats by reaction of the triglyceride fats with methanol to form methyl esters via transesterification. By using the biodiesel blend (B20) it will reduce the amount of petroleum consumption which will in turn reduce our dependence on foreign petroleum. The use of B20 in place of petroleum has a significant reduction in emissions. Reduction of particulate matter, carbon monoxide, and hydrocarbon emissions can be achieved with the use of B20. (USPS, 2005)

The Energy Policy Act of 1992 (EPAAct) was amended in 1996 to include biodiesel in its approved list of alternative fuels. EPAAct requires a percentage of light duty vehicles in federal and state agencies to be alternative fuel vehicles. By EPAAct, AHTD is required to have 75% of our light-duty fleet vehicles to be alternative fuel vehicles (AFV). The act was amended in 1998 to allow for current vehicles either heavy-duty or light-duty to run on B20 and qualify for the AFV purchase credit. (USPS, 2005)

The main issue when it comes to B20 use is the uncertainty in the product. No one knows what the long term use of B20 will cause in the vehicles. So a lot of people are very cautious when it comes to making the switch. There are unknown variables such as what effect does B20 have on the engine and the fuel system. So in order to address these issues AHTD initiated a study with its own fleet vehicles.

Chapter 3 Work Plan

The primary objective of the research project was to determine if B20 is a viable substitution for standard petroleum. 11 vehicles were selected in three different districts throughout the state. 6 of the vehicles ran on standard petroleum and 5 ran on B20. There were also 3 different types of diesel vehicles selected for the study. All of the vehicles used in the study were new diesel vehicles. There were three B20 tanks placed in all three districts. The B20 tanks were placed away from the petroleum tanks in order to avoid confusion. Table 1 lists the vehicle specification with their locations within the state. Figure 1 displays AHTD district locations. Each vehicle was provided with an operator's data log in order to record any and all maintenance work conducted on the vehicle including fuel fill ups. The maintenance data that was observed was lubricity, degradation of components, and oil analysis. Fuel data was also monitored such as fuel cost, fuel filters, and fuel efficiency. Operators were also interviewed in order to get first hand comments on the operation of the vehicles. The data was collected for 3 years in order to get ample amount of data to analyze. Figure 2, Figure 3, and Figure 4 display the three different types of diesel vehicles used in the study.

Table 1: Vehicle Data

District	Vehicle #	Year	Make	Model	Fuel Type
District 3	6851	2009	Dodge	Ram 4500	Petroleum
District 3	6852	2009	Dodge	Ram 4500	Petroleum
District 3	6853	2009	Dodge	Ram 4500	B20
District 3	7601	2009	Chevrolet	CC 7042	Petroleum
District 3	7602	2009	Chevrolet	CC 7042	Petroleum
District 3	7603	2009	Chevrolet	CC 7042	B20
District 3	7610	2009	Chevrolet	CC 7042	B20
District 5	7661	2009	International	7800	B20
District 5	7662	2009	International	7800	Petroleum
District 6	7672	2009	International	7800	Petroleum
District 6	7805	2009	International	7800	B20

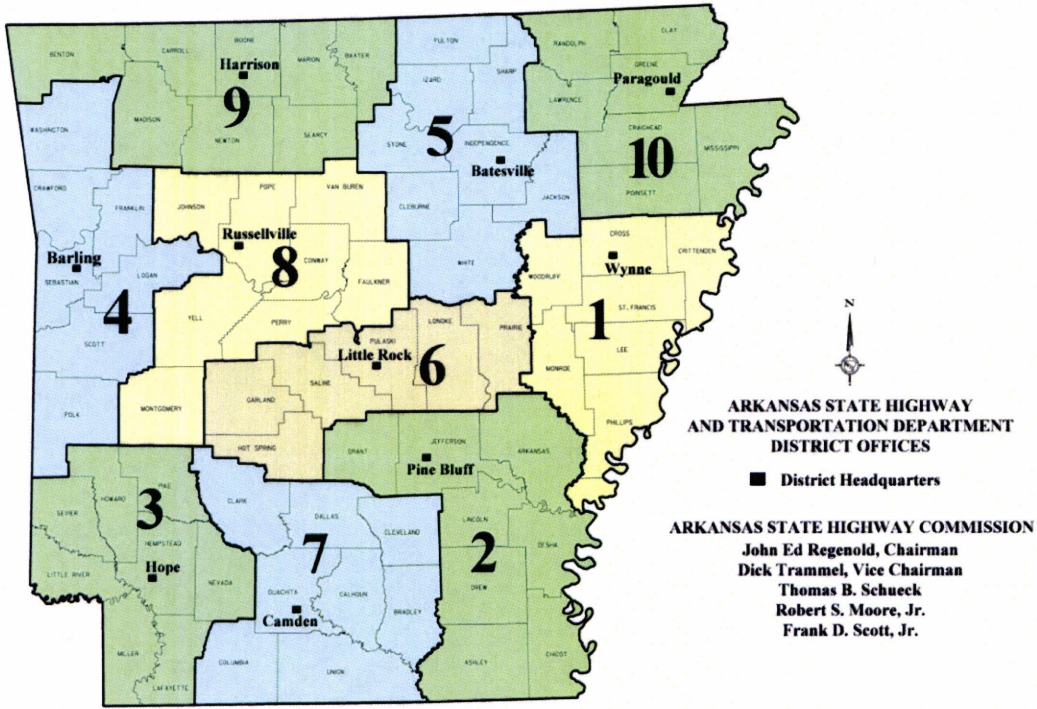


Figure 1: AHTD District Map



Figure 2: Dodge Ram 4500



Figure 3: Chevrolet CC7042 6 yd. Dump Truck



Figure 4: International 7800 12 yd. Dump Truck

Chapter 4 Discussion of Results

After analyzing the data from the operator's data logs it became evident the B20 fueled vehicles did not operate as well as the petroleum vehicles. The data was summed for each month and miles per gallon (MPG) was calculated for each month. Then the monthly MPG was averaged. In almost every case, the standard petroleum vehicle had a higher average MPG compared to its B20 counterpart. Table 2 displays the average MPG for each vehicle.

Table 2: Vehicle Average MPG

District	Vehicle #	Model	Fuel Type	Avg. MPG
District 3	6851	Ram 4500	Petroleum	12.71
District 3	6852	Ram 4500	Petroleum	12.13
District 3	6853	Ram 4500	B20	12.26
District 3	7601	CC 7042	Petroleum	N/A
District 3	7602	CC 7042	Petroleum	7.70
District 3	7603	CC 7042	B20	5.65
District 3	7610	CC 7042	B20	7.72
District 5	7661	7800	B20	5.91
District 5	7662	7800	Petroleum	6.09
District 6	7672	7800	Petroleum	6.40
District 6	7805	7800	B20	N/A

A couple of the B20 vehicles also had filter issues. The filters would clog quicker than the standard petroleum vehicles. There was also an issue where an operator had to change his fuel filter six times over four days in District 5. Later that month in the same district, the filter on the pump had to be changed five times in one day. This filter issue is a known issue when using B20 fuels. Figure 5, Figure 6, and Figure 7 display graphs for each vehicle in each district. There is not a graph for district 6 because the B20 data was not usable for analysis. For some vehicle logs, there wasn't data for every month. In Figure 6, that is evident in the dip in the graph down to one. When the

average MPG was calculated it did not include the months that did not have any mileage data.

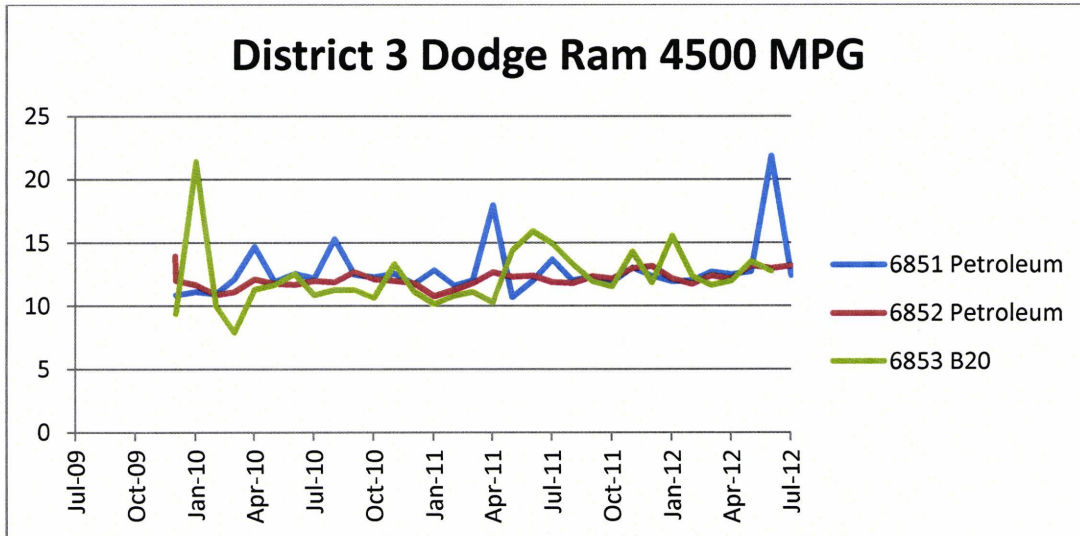


Figure 5: District 3 MPG Comparison

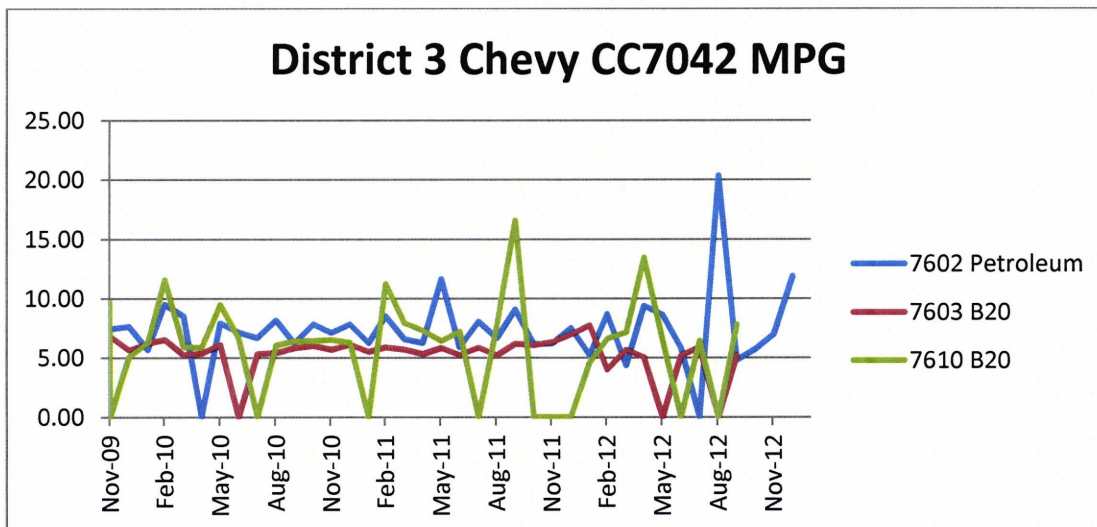


Figure 6: District 3 MPG Comparison

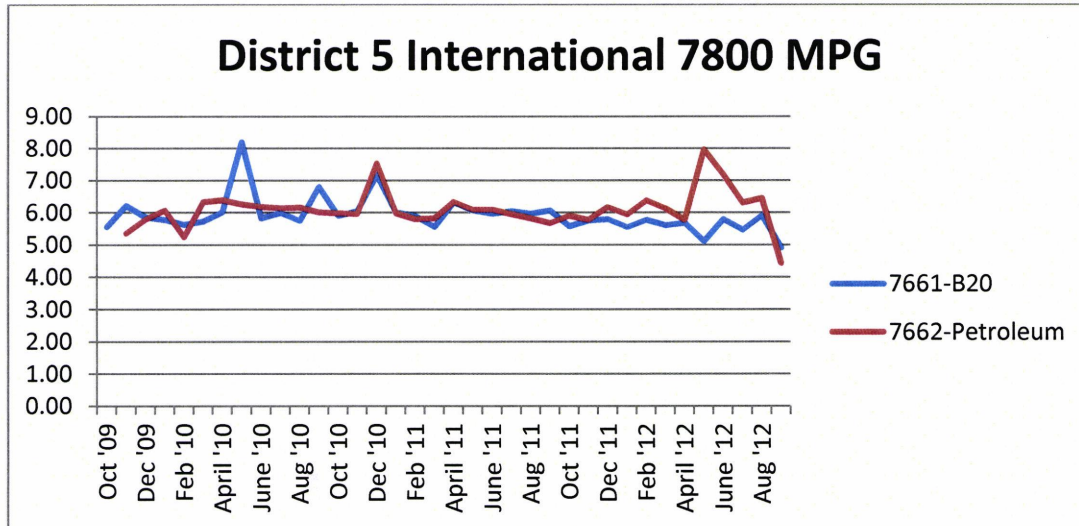


Figure 7: District 5 MPG Comparison

Based on the oil samples that were analyzed by SOS Services Fluids Analysis Laboratory, there weren't any differences that stood out between the B20 and petroleum oil samples. Each truck had different readings and some of them had similar issues such as increased copper readings, high dirt readings, and high aluminum readings. The oil sample reports can be found in Appendix B.

Chapter 5 Conclusions and Recommendations

Conclusions

Based on the collected data there seemed to be more issues related to the use of B20 in the vehicles compared to the standard petroleum. There were more filter issues with the B20 fuel and for the most part B20 did not get as good of gas mileage as the petroleum vehicles. The oil analysis did not shed any light on the mechanical issues that B20 might inflict on the vehicles. So based on the mileage logs and reports from operators B20 seems to more of a hindrance to use in place of the standard petroleum.

Recommendations

B20 as an alternative fuel source at this time is not a viable solution. The use of B20 seems to cause more problems than using petroleum. There would also be the added cost of placing B20 fuel tanks at every maintenance yard in the state. There is also the issue of filter issues that seem to be very prevalent when using B20 fuel. So rather than bring on more issues it would be easier and more cost efficient to continue using petroleum gasoline.

References

"Biodiesel Fuel." *Baystate Roads Program Local Technical Assistance Program (LTAP)* Tech Note # 47 (2007): 1-4. Print

United States Postal Service, Richard Fraer and Han Dinh, Kenneth Proc and Robert L. McCormick National Renewable Energy Laboratory-U.S. Department of Energy, Kevin Chandler Battelle, and Bruce Buchholz Lawrence Livermore National Laboratory- U.S. Department of Energy. *Operationg Experiences and Teardown Analysis for Engines Operated on Biodiesel Blends (B20)*. Rep. N.p.: n.p., n.d. Print.