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EVALUATION OF FPC-1 FUEL PERFORMANCE CATALYST

AT

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BY

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ABSTRACT

This report summarizes the findings of a field trial conducted by Walbon & Co., Wildwood, Florida, to determine the effectiveness of a unique combustion catalyst, FPC-1, upon engine performance, fuel efficiency and exhaust emissions. The principal test method was steady-state engine test utilizing the carbon mass balance technique for determining fuel consumption. The method also permits the analysis of exhaust emissions and smoke.

Walbon fleet managers also provided miles per gallon records for analysis. Although not as controlled as the steady-state test, these data are supportive of steady-state test findings. The two test determined the addition of FPC-1 to the fuel created the following benefits:

(1) Fuel consumption was reduced b a fleet average of 6.57% using the carbon mass balance method for determining fuel consumption. This could result in annual fuel savings of approximately $56,000, as demonstrated in Appendix 4.

(2) An increase in miles per gallon of approximately 4.5% was observed when Comparing baseline fuel fleet records to FPC-1 treated fuel fleet records.

(3) Smoke emissions were reduced 40% after FPC-1 fuel treatment.

(4) Carbon monoxide emissions were reduced 15% with FPC-1 treated fuel.

INTRODUCTION

FPC-1 Fuel Performance Catalyst is a burn rate modifier or catalyst proven to reduce fuel consumption and increase engine horsepower in several recognized, independent laboratory tests, and dozens of independent field trials. The catalyst also has a positive impact upon the products of incomplete combustion, primarily soot (smoke).

The intent of the current trial at Walbon & Company is to determine the degree of fuel consumption, and smoke reduction resulting from the addition of FPC-1 catalyst to the #2 diesel fueling a select fleet of Series 60 powered long haul tractors. The test methodology for determining fuel consumption is the carbon mass balance (cmb). The cmb method measures the carbon containing products of the combustion process (CO_2, CO, HC) found in the exhaust, rather than directly measuring fuel flow into the engine.

This report summarizes the results of baseline fuel consumption and emissions data, and computes the engine performance factors (mass flow rates) for the same.

DISCUSSION

The carbon mass balance eliminates virtually all of the variables associated with field testing for fuel consumption changes. The method requires no modifications to fuel lines or engines, and can be conducted in a short period of time at minimal expense.

Instead of measuring fuel flow into the engine (ie., the weight or volume of the fuel), measurements are made of the exhaust gases leaving the engine. More precisely, the carbon containing gases in the exhaust are measured. The method is based upon the Law of Conservation of Matter, which states that atoms can neither be created nor destroyed. Since the engines only source of carbon is the fuel it consumes, the carbon measured in the exhaust must come from the fuel. By measuring the carbon going out of the engine in the form of products of combustion, the amount of carbon entering the engine can be determined.

CARBON BALANCE CALCULATION

The carbon leaving the engine is mainly in the form of carbon dioxide (CO_2), carbon monoxide (CO), unburned hydrocarbons (HC), and particulate (smoke). By collecting these data while the engine is operating at a given load and speed, the fuel flow rate into the engine can be accurately determined. When engine load and speed, along with other factors influencing fuel consumption are reproduced and/or monitored to make appropriate corrections, the carbon balance can be used to confidently determine changes in fuel consumption that might result from the use of a fuel catalyst, such as FPC-1.

With the carbon balance, engine efficiency is expressed in terms of engine performance factors. To calculate any change in engine performance, separate measurements are made with the engine running on base fuel (untreated) and FPC-1 treated fuel. Any changes are stated as percentage changes from baseline.

A copy of the carbon balance equations is found on Figure 1 (Appendix 1). A sample calculation for illustration purposes is also attached (see Figure 2, Appendix 1). Additionally, the carbon balance can be used to determine the effect of FPC-1 upon harmful emissions such as carbon monoxide and smoke.

INSTRUMENTATION

Precision, state-of-the-art instrumentation is used to measure the concentrations of carbon containing gases in the exhaust stream and other factors related to fuel consumption and engine performance. The instruments and their purposes are listed below:

1) A Sun Electric SGA-9000 non dispersive infrared (NDIR) four gas analyzer- measures the volume percent of CO2, CO, and oxygen (O2) in the exhaust, and the parts per million (ppm) of HC.

2) EPA C/M Calibration Gases- known gases used to internally calibrate the NDIR Analyzer.

3) A twenty (20) foot sampling train and stainless steel exhaust gas probe- inserted Into the engine exhaust pipe draws a sample of exhaust gases to the analyzer.

4) A Fluke Model 52 hand held digital thermometer and wet/dry thermocouple Probe- measures exhaust, ambient, and fuel temperature.

5) A Dwyer Magnehelic 2000 Series Pressure Gauge and pitot tube- measures Exhaust air velocity and/or pressure.

6) A Monarch Contact/Noncontact digital tachometer and magnetic tape- measures Engine rpm when dash mounted tachometers are unavailable.

7) A hydrometer and flask- determines fuel specific gravity (density).

8) Barometric pressure is acquired from local airport or weather station

9) A Bacharach True Spot Smokemeter- for smoke density determination.

With the exception of engine speed, fuel density, and ambient readings, all data are collected by simply inserting probes into the exhaust stream while the engine is running at a fixed rpm and load, and the vehicle is stationary. No modifications or device installation are made to the fuel system, nor are normal equipment work cycles disrupted. After baseline testing, the test fleet was operated with FPC-1 fuel treatment approximately 300 to 500 hours to ensure complete engine conditioning.

TECHNICAL APPROACH

The following technical approach was observed during the baseline test, and was reproduced during the treated fuel test segment:

1) All instruments are calibrated according to accepted protocol.

2) A sample of fuel is drawn from the fuel tank on each piece of equipment. Using a hydrometer, fuel specific gravity is recorded.

3) Each piece of equipment to be tested is parked, brakes locked, and run out-of – gear at a specific engine speed (RPM) until engine water, oil, and exhaust temperature, and exhaust pressure have stabilized. Engine speed is controlled using either a hand held phototach or the tachometer in the cab.

4) Engine hours (or mileage) are taken form hour meters or odometers installed on the equipment.

5) After engine stabilization, the exhaust gas sampling probe is inserted into the exhaust stream. The Autocal button is depressed and after the LED readouts clear, test personnel take multiple readings of carbon dioxide, carbon monoxide, unburned hydrocarbons, and oxygen, along with engine speed, exhaust temperature and pressure.

6) Periodically, ambient air temperature, atmospheric pressure, and relative humidity are recorded. Temperature readings are taken at the test site. Other ambient readings are acquired from local weather information services.

7) All data are recorded until technicians are confident the information is consistent and reproducible.

8) After completing the baseline, all test fleet fuel will be treated with FPC-1. All equipment will operate as normal for approximately 300 to 500 hours, at which time the above procedure will be reproduced without alteration, except for PFC-1 fuel treatment in the test fleet.

In lieu of bulk fuel treatment, FPC-1 was packaged in concentrations for individual truck treatment at each fueling.

The data relative to the rate of fuel consumption were used by RDI and Walbon & Company managers/engineers to calculate the percent change in fuel consumption before and after FPC-1 fuel treatment.

BASELINE AND TREATED DATA CALCULATIONS

The data collected during the baseline and treated fuel carbon balance tests are summarized on the attached computer printouts (Appendix 2). From these data the volume fraction (VF) of each gas is determined and the average molecular weight (Mwt) of the exhaust gases computed. Next, the engine performance factor (pf) based upon the carbon mass in the exhaust is computed. The pf is finally corrected for intake air temperature and pressure (barometric), and total exhaust mass yielding a corrected engine performance factor (PF). The baseline and treated PF's are tabulated on Table 1 of Appendix 2. Table 2 of Appendix 2 summarizes the effect of FPC-1 on carbon monoxide. Smoke spot (smoke density)numbers are found on Table 3 of Appendix 2.

DISCUSSION OF RESULTS\

Fuel Consumption Reduction

Truck #162 was not available for treated fuel testing, and therefore, has been removed from the test sample.

Truck #156 saw a large reduction in fuel consumption after FPC-1 fuel treatment. The remaining four trucks realized reductions similar to those observed in previous laboratory and field tests with FPC-1. The fuel savings with #156 were also nearly twice the average of the other four trucks and therefore is considered an anomaly and has not been included in the conclusions.

The average improvement in fuel consumption for the four trucks in the Walbon & Company test fleet was 6.57%. The baseline and treated PF's are presented on Table 1 of Appendix 2.

Smoke and Emissions Reduction

Smoke emissions were reduced in all trucks tested. Reductions in smoke density in the exhaust of the trucks averaged 40.5%. These data are found on Table 3 of Appendix 2. Carbon monoxide, although not a critical parameter in this test, was reduced 15% (see Table 2).

ANALYSIS OF FLEET MILES PER GALLON

As pointed out in the Walbon & Company interim report, determining the effect of FPC-1 upon fuel consumption (mpg) is less reliable using fleet mpg records than when using the carbon mass balance test method. Although the collection of the fleet mileage and fuel consumption data is relatively easy to do, it is far more difficult to ascertain the impact of uncontrolled variables upon these data. These variables are many (load, idle time, drivers, fuel energy content and combustion characteristics, weather conditions, road conditions, etc.) and are constantly changing. Increases in engine efficiency can be masked by these changes in driving conditions. For this reason, RDI recommends the

CMB above all other methods. However, if a large body of data can be collected before and after FPC-1 fuel treatment, and while weather conditions are similar, a statistical analysis of these data will reveal the positive trend in fuel savings created by the use of FPC-1. This positive trend will be directly reflected in your bottom line.

The Walbon & Company fleet treated with FPC-1 experienced a general improvement in fuel economy. Of particular interest to Walbon fleet managers was Truck #194. This truck was not available for baseline carbon balance testing but was selected by the Wildwood terminal manager for mpg comparison before and after FPC-1 fuel treatment. It was selected because of it's history of high mpg, and low idle time. It was felt that this truck was the most reliable for comparison purposes.

Truck #194 saw a steady increase in mpg after FPC-1 fuel treatment. The baseline mpgs for #194 averaged 7.3. The first month after FPC-1 treatment, mpg on #194 increased to 7.5. By the end of the treated test period, mpg for #194 had climbed to 7.7 This equals a 5.3% increase in fuel economy in less than 2 months treatment.

For trend analysis purposes, log book entries made at both the Wildwood and Rosemount terminals were reviewed for a period beginning May 1st through September 20th. May, June and July were reviewed to establish baseline performance trends and August through September 20th, the FPC-1 treated period, was reviewed for comparison of the Test Fleet to the rest of the fleet not treated with FPC-1. Walbon & Company reviews these entries for their monthly driver by driver Idle Report. This same information was analyzed on a truck by truck basis to establish the fleet performance trends.

The Test Fleet consisted of Trucks 156, 162, 171, 176, 192, & 194. Trucks not treated with FPC-1, referred to here as other, consisted of the balance of the Walbon & Company fleet excluding 143, 145, and 147 which were added to the fleet in August.

	AVG MPG	**AVG % IDLE**
Test fleet baseline period	6.391	26.05%
Test fleet treated period	6.661	27.50%
% Improvement	4.225%	
Other Fleet-baseline period	6.395	28.15%
Other Fleet-treated period	6.345	37.07%
% Improvement	-0.78%	

These improvements in efficiency are considered conservative as there is a conditioning period at the beginning of the testing phase. Also, by treating the individual trucks as opposed to bulk treating the fuel, we were unable to verify that each truck in the test fleet was treated with FPC-1 at each fueling. In random conversations with some of the drivers, it became apparent that some of the newer drivers were not made aware of the test and therefore did not treat the vehicle at each fueling. A couple of missed treatments would have an impact on the overall effectiveness of FPC-1 in reducing fuel consumption. Although the test indicated positive results, we feel that had we been bulk treating or provided a more complete orientation with the drivers, the field trial results would have been more significant.

Refrigeration Units

Although testing of Walbon & Company refrigeration units was not conducted as part of this test, significant cost benefit can also be realized by operating these units with FPC-1 treated fuel. Testing of 84 refrigeration units at T.G. Lee Dairies in Orlando resulted in a 10.2% improvement in hours per gallon while these units operated with FPC-1. Complete test results and reference information can be made available.

CONCLUSIONS

1) Fuel consumption was reduced by a fleet average of 6.57% using the carbon mass balance method for determining fuel consumption This could result in annual fuel savings of approximately $56,000, as demonstrated in Appendix 4.

2) An increase in miles per gallon of approximately 4 to 4.5% was observed when comparing baseline fuel fleet records to FPC-1 treated fuel fleet records.

3) Smoke emissions were reduced 40% after FPC-1 fuel treatment.

4) Carbon monoxide emissions were reduced 15% with FPC-1 treated fuel.

RECOMMENDATION

Based on the aforementioned conclusions, Walbon & Company should proceed with treatment of the entire fuel supply. The logistics of treating the trucks when fueling at retail locations on the road can be organized and implemented in a manner so as to minimize administrative burden to fleet personnel.

Monitoring and analysis of fleet maintenance and fuel records as well as additional Carbon Mass Balance testing will be conducted as part of the FPC-1 treatment program.