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EVALUATION OF FPC-1 FUEL PERFORMANCE CATALYST

BY

REGIONAL TRANSIT SYSTEM
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INTRODUCTION

FPC-1 is a complex combustion catalyst which, when added to liquid hydrocarbon fuels at a ratio of 1:5000 effectively improves the combustion reaction, resulting in increased engine efficiency and reduced fuel consumption.

Field and laboratory tests alike indicate a potential to reduce fuel consumption in diesel fleets in the range of 4% to 9%. This report summarizes the results of controlled back-to-back field tests conducted with the cooperation of Regional Transit System, Gainesville, Florida with and without FPC-1 added to the fuel. The test procedures applied were the Carbon Balance Exhaust Emissions Test at a given load and engine speed.

The Carbon Balance Test includes an analysis of engine exhaust with and without FPC-1 treated fuel.

EQUIPMENT TESTED

2 - 6V92 Detroits
1 - 8.2 Detroit
2 - 6V71 Detroits

TEST EQUIPMENT

The equipment and instruments involved in the carbon balance test program were:

Sun Electric SGA-9000 non-dispersive infrared analyzer (NDIR) for measuring the exhaust gas constituents, HC (unburned hydrocarbons as hexane gas), CO, CO2, and O2.

An IMC and Fluke high temperature thermometer and probes for measuring exhaust gas and ambient temperature.

TEST PROCEDURE

The carbon balance technique for determining changes in fuel consumption has been recognized by the U.S. Environmental Protection Agency (EPA) since 1973. The method relies upon the measurement of engine exhaust emissions to determine fuel consumption rather than direct measurement (volumetric or gravimetric) of fuel consumption. The method produces a value of engine fuel consumption with FPC-1 relative to a baseline value established with the same vehicle.

Engine speed and load are duplicated from test to test, and measurements of exhaust and ambient temperature are made. Under these conditions a minimum of five readings were taken for each parameter after stabilization of the exhaust temperature. Five units were tested for both baseline and treated fuel segments. Each test unit was tested under steady-state conditions at a stabilized rpm. Table 1 summarizes the test results.

Results indicate a reduction in fuel consumption for all units tested. The general trend of improved (reduced) fuel consumption is within the general parameters of reduced fuel consumption achievable by the use of FPC-1 Fuel Performance Catalyst. All regulated emissions were also reduced.

Also a qualitative smoke reduction test was performed during the Regional Transit System Test. This was done by attaching a 25 micron filter to the exhaust gas sampling train for both the baseline and treated fuel test segments. The filter traps unburned fuel exhausted fro the engine as visible smoke or particulate. The filters used during the treated fuel segment of the test were cleaner indicating a significant reduction in smoke while using FPC-1 treated fuel.

CONCLUSION

The series of test conducted on a number of Detroit powered equipment confirm that the addition of FPC-1 to the fuel will reduce fuel consumption.

1. The reduction in fuel consumption in the fleet averaged 7.36%.

2. Carbon monoxide (CO) emissions were reduced 20.0%. The emission levels of unburned hydrocarbons (HC) were reduced 41.6%.

3. Also, the particulate filter trap comparison indicated FPC-1 treated fuel burns cleaner and emits less smoke

APPENDICES

<u>CARBON BALANCE METHOD TECHNICAL APPROACH:</u>

A fleet of diesel powered transit buses owned and operated by Regional Transit System were selected for the FPC-1 evaluation. The SGA-9000 exhaust analyzer and the thermocouple instrumentation were calibrated and a leak test on the sampling hose and connections was performed. Each engine was then brought up to stable operating temperature as indicated by the engine water temperature and exhaust temperature. No exhaust gas measurements were made until each engine had stabilized at the operating condition selected for the test. No. 2 Diesel fuel was exclusively used throughout the evaluation.

The baseline fuel consumption tests consisted of a minimum of five sets of measurements of CO2, CO, unburned hydrocarbons (measured as hexane gas), O2 and exhaust temperature, made at approximately 90 second intervals for each engine.

After the baseline test, on April 5, 1990, the fuel storage tank, from which the fleet is exclusively fueled, was treated with FPC-1 at the recommended level of 1 oz. catalyst to 40 gallons of diesel fuel (1:5000 volume ratio). The equipment then operated with the treated fuel until August 13, 1990, when the fuel consumption test described above was repeated.

Throughout the entire fuel consumption test, an interval self-calibration of the exhaust analyzer was performed after every two sets of measurements to correct instrument drift, if any. A new analyzer exhaust gas filter was installed before both the baseline and treated fuel test series.

From the exhaust gas concentrations measured during the test, the average molecular weight of the gases containing carbon can be calculated and the fuel consumption may be expressed as a “performance factor” which relates the fuel consumption of the treated fuel to the baseline. The calculations are based on the assumption that the fuel characteristics, engine operating conditions and test conditions are essentially the same throughout the test.

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Table 1

Summary of Exhaust Gases

	Baseline Fuel	Treated Fuel
CO	.011%	.008%
HC	5.18ppm	3.03ppm
CO2	1.478%	1.378%
O2	19.0%	18.8%

Table 2

Calculation of the Carbon Mass Balance

Baseline:

Equation 1 Volume Fractions

VFCO2	= 1.478/100
	= .01478
VFO2	= 19.0/100
	= .19
VFHC	= 5.18/1,000,000
	= .00000518
VFCO	= .01/100
	= .0001

Equation 2 Molecular Weight

Mwt1 = (.00000518)(86)+(.0001)(28)+(.01479)(44)+(.1900)(32)+
[(1-.00000518-.0001-.01478-.1900)(28)]

Mwt1 = 28.99678

Equation 3 Calculated Performance Factor

$$pf1 = \frac{2952.3 \times 28.99678}{86(.00000518)+13.89(.0001)+13.89(.01478)}$$

pf1 = 413,304 (rounded to the nearest meaningful place)

Treated:

Equation 1 Volume Fractions

VFCO2 = 1.378/100
= .01378

VFO2 = 18.8/100
= .188

VFHC = 3.03/1,000,000
= .00000303

VFCO = .008/100
= .00008

Equation 2 Molecular Weight

Mwt2 = (.00000303)(86)+(.00008)(28)+(.01378)(44)+(.188))(32)+
[(1-.00000174-.00008-.01378-.188)(28)]

Mwt2 = 28.9726

Equation 3 Calculated Performance Factor

$$pf2 = \frac{2952.3 \text{ x } 28.9726}{86(.00000303)+13.89(.00008)+13.89(.01378)}$$

pf2 = 443,719 (rounded to nearest meaningful place)

Final Equation for Fuel Savings

Equation 5 Percent change in engine performance and fuel economy

% Change F.E. = [443,719 - 413,304/413,304](100) = 7.36%