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EVALUATION OF FPC-1 FUEL PERFORMANCE CATALYST

AT

DEEP SOUTH TRUCKING

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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 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 8%. This report summarizes the results of controlled back-to-back field tests conducted in cooperation with Deep South Trucking, with and without FPC-1 added to the fuel. The test procedure applied was the Carbon Balance Exhaust Emission Tests at a given engine load and speed.

ENGINES TESTED

The following engine makes were tested:

3 x 350 Cats
1 x 310 Cats

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 $O2$.

A Fluke Model 51 type k thermometer and wet/dry probe for measuring exhaust gas, fuel, and ambient temperature.

A Dwyer magnehelic and pitot tube for exhaust pressure differential measurement.

A hand held photo tachometer for engine speed (rpm) determination where dash mounted tachometers are not available.

A hydrometer for fuel specific gravity (density) measurement.

A Hewlett Packard Model 41C programmable calculator for the calculation of the engine performance factors.

TEST PROCEDURES

Carbon Balance

The carbon balance technique for determining changes in fuel consumption has been recognized by the US Environment Protection Agency (EPA) since 1973. The method relies upon the measurement of vehicle exhaust emissions to determine fuel consumption rather than direct measurement (volumetric or gravimetric) of fuel consumption.

The fuel consumption test method utilized in this study involves the measurement of exhaust gases of a stationary vehicle at a steady engine load and rpm. 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.
Four trucks were tested for both baseline and treated fuel segments. Each unit was tested under steady-state conditions at a specific engine speed (rpm) while the transmission was in neutral.

Table 1 below summarizes the percent change in fuel consumption documented with the carbon balance on an individual unit basis.

Table 1: Summary of Carbon Balance Fuel Consumption Changes

Unit No.	Engine	RPM	% Change Fuel Consumed
138	350 Cat	1800	-11.48
138	350 Cat	1600	-16.58
141	350 Cat	1900	-17.42
146	350 Cat	1900	- 8.39
149	310 Cat	2200	+5.77

CONCLUSIONS

The series of tests conducted on a number of Cat powered trucks verify that the addition of FPC-1 to the fuel will reduce fuel consumption and harmful emissions.

1) The reduction in fuel consumption, as determined by the carbon balance method, was in the range of +5.77% to -17.42%, with a fleet average reduction of 9.62%.

2) Carbon monoxide (CO) emissions were reduced 29.70%. Emissions of unburned hydrocarbons were reduced 5.28%.

APPENDICES

CARBON BALANCE METHOD TECHNICAL APPROACH:

A fleet of diesel powered equipment owned and operated by Deep South Trucking was selected for the FPC-1 field test.

All instruments were calibrated prior to both baseline and treated fuel data collection. The SGA-9000 was calibrated using Scott Calibration Gases (I/M Protocol Gases), 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, oil, and exhaust temperature. No exhaust gas measurements were made until each engine had stabilized at the rpm selected for the test. # 2 Diesel fuel was exclusively used throughout the evaluation.

The baseline fuel consumption test consisted of a minimum of five sets of measurements of CO_2, CO, unburned hydrocarbons (measured as CH_4), O_2, and exhaust temperature made at 90 second intervals. Each engine was tested in the same manner.

After the baseline test, on May 1, 1992, the fuel storage tank, from which the fleet is exclusively fueled, was treated with FPC-1 at the recommended level of 1 oz. of catalyst to 40 gallons of diesel fuel (1:5000 volume ratio). The equipment was then operated with the treated fuel as normal until July 1, 1992, when the treated fuel test was run. At this time, the test described above was repeated for each engine, only this time with FPC-1 treated fuel.

Throughout the entire fuel consumption test, an internal 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 molecular weight of each constituent, and the temperature of the exhaust stream, 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 engine operating conditions are essentially the same throughout the test. Engines with known mechanical problems or having undergone repairs affecting fuel consumption are removed from the sample.

A sample calculation is found in Figure 2. All performance factors are rounded off to the nearest meaningful place in the sample.

SAMPLE CALCULATION FOR THE CARBON MASS BALANCE

Figure 2

Baseline:

Equation 1 Volume Fractions

VFCO2 = 1.932/100
= 0.01932

VFO2 = 18.95/100
= 0.1895

VFHC = 9.75/1,000,000
= 0.00000975

VFCO = 0.02/100
= 0.0002

Equation 2 Molecular Weight

$$\text{Mwt1} = (0.00000975)(86) + (0.0002)(28) + (0.01932)(44) + (0.1895)(32) + [(1 - 0.00000975 - 0.0002 - 0.1895 - 0.01932)(28)]$$

Mwt1 = 29.0677

Equation 3 Calculated Performance Factor

$$\text{pf1} = \frac{2952.3 \times 29.0677}{86(0.00000975) + 13.89(0.0002) + 13.89(0.01932)}$$

pf1 = 316,000 (rounded to nearest meaningful place)

Treated:

Equation 1 Volume Fractions

VFCO2 = 1.832/100
= 0.01832

VFO2 = 18.16/100
= 0.1816

VFHC = 10.2/1,000,000
= 0.0000102
VFCO = .02/100
= 0.0002

Equation 2 Molecular Weight

Mwt2 = (0.0000102)(86)+(0.0002)(28)+(0.01832)(44)+(0.1816)(32)
+[(1-0.0000102-0.0002-0.1816-0.01832)(28)]

Mwt2 = 29.0201

Equation 3 Calculated Performance Factor

$$pf2 = \frac{2952.3 \times 29.0201}{86(0.0000102)+13.89(0.0002)+13.89(0.01832)}$$

pf2 = 332,000 (rounded)

Equation 4 Percent Change in Engine Performance Factor:

% Change PF = [(332,000 - 316,000)/316,000](100)

= + 4.8%

A + 4.8% change in the calculated engine performance factor equates to a 4.8% reduction in fuel consumption.

Calculation of Fuel Consumption Changes

Table 1

Unit 138/1800 RPM

Mwt1	29.0396	Mwt2	29.0125
pf1	296,108	pf2	341,670
PF1	313,765	PF2	354,448

% Change PF = [(354,448 - 313,765)/313,765] (100)

% Change PF = + 11.48

Table 2

Unit 138/1600 RPM

Mwt1	29.0307	Mwt2	28.9845
pf1	338,345	pf2	397,506
PF1	396,688	PF2	462,455

% Change PF = [(462,455 - 396,688)/396,688] (100)

% Change PF = + 16.58

Table 3

Unit 141/1900 RPM

Mwt1	29.0721	Mwt2	29.0483
pf1	265,736	pf2	306,098
PF1	240,615	PF2	282,535

% Change PF = [(282,535 - 240,615)/240,615] (100)

% Change PF = + 17.42

Table 4

Unit 146/1900 RPM

Mwt1	29.0538	Mwt2	29.0564
pf1	282,254	pf2	291,541
PF1	284,860	PF2	308,786

% Change PF = [(308,786 - 284,860)/284,860] (100)

% Change PF = + 8.39

Table 5

Unit 149/2200 RPM

Mwt1	29.0646	Mwt2	29.0790
pf1	270,215	pf2	266,791
PF1	246,536	PF2	232,323

% Change PF = [(232,323 - 246,536)/246,536] (100)

% Change PF = - 5.77