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AN EVALUATION OF FPC-1 FUEL PERFORMANCE CATALYST

BY

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Report Prepared For:

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By

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Materials Herein Provided By

San Juan Coal Company,
U.H.I. Corporation,
And
J.R.C. Enterprises, Inc.

Introduction:

In meetings held between Mr. Randy Gates, Equipment Superintendent, and Mr. J.R. Challis, J.R.C. Enterprises, Inc., it was decided to institute a test program whereby the maximum savings that could be realized through the use of FPC-1 Fuel Performance Catalyst could be evaluated and documented. Mr. B. Edward Peterson, Director of Purchases, Utah International, Inc., also contacted regarding the use of FPC-1, requested they too be kept informed of the test procedures and eventual results for consideration of use in other Utah International, Inc. operations.

The test procedure decided upon was the carbon balance method and actual GPH (gallons per hour) consumption comparison on select equipment. Baseline tests with the MGA-90 were conducted on August 22, 1984. Treated tests were conducted on December 4 and 5, 1984. All test data was collected under the supervision of Mr. Sam Morris and was observed by Mr. Pete Farrow.

All fuel consumption records were provided by Mr. Calvin H. Tsosie. Baseline consumption was established by individual unit consumption by month from August, 1984 through January, 1985. Figure III attached hereto shows the specific units included in this test evaluation. These units were chosen by San Juan Coal Company as representative of the major fuel consuming equipment in their fleet.

Methodology

The carbon balance method is the state-of-the-art technique derived from EPA test procedures which also use exhaust gas emissions to determine changes in fuel economy. Test instruments included a Sun Electric Model MGA-90 Multiple Gas Analyzer and a IMC Digital Thermocouple. The purpose is to document changes in fuel flow with and without FPC-1 while at a steady state load manifested in a change in the carbon content of the exhaust gases being scavenged from the engine. A change in the total mass or molecular weight of the carbon content of these gases, while under identical load conditions, verifies a corresponding change in the fuel flow to the engine. Also, changes in harmful emissions can be confirmed.

Monthly fuel consumption records by unit in GPH (gallons per hour) were supplied by San Juan Coal Company from August, 1983, through July, 1984, to establish a GPH consumption Baseline without FPC-1. Duplicate monthly records were supplied on the same units for GPH consumption from August, 1984, through January, 1985, with FPC-1 treated fuel. Averages were then derived for each period to provide overall as well as individual unit comparisons, (see Figure III).

Results

The data from the Baseline and Treated tests via the carbon balance method were averaged on a cumulative basis and used to calculate performance factors. These performance factors were then used to determine the comparative change in fuel economy. Figure I presents the carbon balance formula. (These standard engineering calculations were provided by Dr. Geoffrey J. Germane, PhD. Mechanical Engineering, Brigham Young University.)

Figure II presents calculations and resultant percentage increase in fuel economy via the carbon balance method. An 8.7% increase in fuel economy was confirmed. It is important to note that this method of establishing changes in fuel economy is most acceptable because it eliminates the variables otherwise encountered in conventional fuel consumption comparisons.

Figure II also confirms an 11-1/2% reduction in CO2, a 97-3/4% reductions in HC, and 93-1/4% reduction in CO (it should be noted that CO was minimal as Baseline, nonetheless reduced) while O2 increased 47-1/3%. A 9-3/4% reduction in average operating temperature also occurred. Reduction in all carbon containing constituents with an increase in oxygen further confirms a reduction in fuel consumption.

Figure III presents the individual unit averages in fuel consumption from August, 1983, through July, 1984, without FPC-1 compared to consumption from August, 1984, through January, 1985, with FPC-1 treated fuel. The overall average confirmed a 6.08% increase in fuel economy.

Visable smoke in all test units was substantially reduced. However, it is questionable whether or not this reduction is to the extent normally realized in similar applications. Coupled with the fact that soot levels in a few oil samples on some of the test units occasionally have shown high readings, it is recommended that extensive idling of the equipment be substantially reduced to help eliminate these high soot readings and,most likely, further reduce the visable smoke which occurred in some of the equipment.

FIGURE I

CARBON BALANCE TECHNIQUE

Assumptions: C_8H_{15} and SG = 0.78
Time is constant
Load is constant
RPM is constant

Data:
pf1 = Calculated Performance Factor (Baseline)
pf2 = Calculated Performance Factor (Treated)
PF1 = Performance Factor (adjusted for Baseline exhaust mass
PF2 = Performance Factor (adjusted for Treated exhaust mass)
T = Temperature (F')
F = Flow (exhaust CFM)
SG = Specific Gravity
VF = Volume Fraction
$VFCO_2$ = "reading" divided by 100
VFO_2 = "reading" divided by 100
VFHC = "reading" divided by 1,000,000
VFCO = "reading" divided by 100

Equations:

$$Mwt=(VFHC)(86)+(VFCO)(28)+(VFCO_2)(44)+(VFO_2)(32)+[(1-VFHC-VFCO-VFCO_2-VFCO_2)(28)]$$

$$pf1 \text{ or } pf2 = \frac{2952.3 \times Mwt}{86(VFHC)+13.89(VFCO)+13.89(VFCO_2)}$$

$$PF1 \text{ or } PF2 = \frac{pf \times (T+460)}{F}$$

$$\text{Percent Increase or Decrease in Fuel Economy} = \frac{PF2 - PF1}{PF1} \times 100$$

FIGURE II

CUMULATIVE ANALYSIS

SAN JUAN COAL COMPANY

CO2	6.6	CO2	5.84
O2	8.14	O2	11.99
HC	4.9	HC	0.11
CO	0.037	CO	0.0025
Temp.	786.2'F	Temp.	709.5'F
Flow	815 CFM	Flow	807 CFM

Volume Fractions

vfHC	0.0000049	vfHC	0.0000001
vfCO	0.00037	vfCO	0.000025
vfCO2	0.0666	vfCO2	0.0584
vfO2	0.0814	vfO2	0.1199

Molecular Weights and Performance Factors

Mwt1	29.391484	Mwt2	29.414006
pf1	93240.106	pf2	107006.23
PF1	142571.56	PF2	155072.85

$$155072.85 - 142571.56 = \frac{12501.285}{142571.56} \times 100 = 8.7\%$$

FIGURE III

Test Equipment List

Average Fuel Consumption Summary

San Juan Coal I.D. Number		GPH Avg. Consump. W/O FPC-1 8/83-7/84	GPH Avg. Consump. With FPC-1 8/84 -1/85
GRD 103	16G Cat Grader (1980) W/Cat 3406	6.59	6.09 (-8.21%)
LDW 72	600C Dart Loader (1979) W/Cummins 2300TKD	25.41	24.00 (-5.88%)
+TKD 287	75C WABCO Truck (1983) W/Cummins VT-1710	6.78	6.99 (+3.10%)
TRD 429	D9H Cat Dozer (1878) W/Cat 353	9.86	8.72 (-13.07%)
TRD 442	D9L Cat Dozer (1982) W/Cat 3412	15.49	13.86 (-11.76%)
TRW 209	75B WABCO Truck (1972) W/Cummins	16.22	14.79 (-9.67%)
TRW 279	CH120 Euclid Truck (1979) W/Cummins VT-1710	15.92	14.63 (-8.82%)
TRW 280	Euclid Truck (1980) W/Cummins VT-1710	8.27	8.99 (+8.71%)
TRW 292	633D Cat Scraper (1983) W/Cat 3408	14.93*	14.62 (-2.12%)
TRW 293	633D Cat Scraper (1983) W/Cat 3408	16.55*	15.48 (-6.91%)

GPH Average Fuel Consumption Without FPC-1
From August, 1983 Through July, 1984.....13.60

GPH Average Fuel Consumption With FPC-1
From August, 1984 Through January, 1985.....12.82

* Because these units were purchased late in 1983, GPH averages on these two units are from January, 1984 through July, 1984.

\+ TKD 287 was rebuilt during test period and consequently has been removed from consideration by UHI Corporation. However, with this unit included, a 6.08% improvement was documented.