EVALUATION OF FEROX^{tm} TREATED FUEL

AT

McCARTNEY CONSTRUCTION CO., INC.
ANNISTON, AL

FOR USE IN ASTEC DOUBLE-BARREL
ASPHALT PLANT

Report Prepared by Lindsay Allen

FEROX PETROCHEMICAL CORPORATION
WINTER PARK, FL

FEBRUARY 3, 1993

EXECUTIVE SUMMARY

The Carbon Mass Balance test, conducted and completed at McCartney Construction on an ASTEC Industries, Inc. double-barrel asphalt plant on January 29, 1993, confirms that the addition of FEROX™ to the fuel will reduce fuel consumption and harmful emissions.

The overall reduction in fuel consumption during this test was determined to be 26.38% at a production level of 38 and 18.12% for a production level of 47.

Reduction of harmful emissions was determined to be 24.05% for CO, 8.66% for unburned hydrocarbons, 20.42% for CO2 at a production level of 38. Reduction of harmful emissions were determined to be 16.42% for CO, 38.82% for unburned hydrocarbons, and 14.99% for CO2 at a production level of 47.

Further studies into the long term effects of the use of FEROX™ treated fuel should be conducted. Tests should be conducted on other asphalt equipment to determine if production rates can be increased by reducing harmful emissions particularly in those areas (California) where stricter emissions controls are limiting production .

Finally, FEROX™ treated fuel should be used in all combustion equipment at McCartney Construction. The benefits of reduced fuel consumption, reduced emissions, reduced particulate emissions, and reduced maintenance costs apply to all combustion equipment, not just the asphalt plant, but also the loaders, haulers, pick-up trucks, and excavators.

INTRODUCTION

The formulation in the aftermarket combustion improver called FEROX™ has undergone extensive testing in EPA recognized independent and university affiliated laboratories. These tests have demonstrated that the improver can provide fuel savings, reduced emissions, and reduced operating and maintenance costs.

Field testing substantiates laboratory findings with even greater average improvements and also reveals the improver can be an effective means of further reducing operating costs by inhibiting the formation of hard carbon build-up on critical equipment surfaces.

This reports summarizes the results of controlled back-to-back field tests conducted in cooperation with McCartney Construction Company and Astec Industries, Inc., on a double-barrel asphalt plant that used fuel treated with and without FEROX™. The test procedure applied to determine fuel consumption was the Carbon Mass Balance Exhaust Emission Test at given equipment operating conditions.

Astec Industries, Inc. manufactures an open-flame double-barrel asphalt plant, in which production is being limited due to constraints associated with flame flight length. Material (aggregate) is falling through the flame, quenching the flame, causing high levels of CO and unburned hydrocarbon emissions. Production is being limited, particularly in states enforcing stringent CO and HC emission standards (like California) because emissions are approaching upper limits. Astec has obtained a couple of gallons of FEROX and wants to run some treated fuel through the plant to determine the effect on emissions and fuel consumption. How long should they run the treated fuel through the machine before he will see any differences? What differences should they see?

DISCUSSION

TEST DESCRIPTION

An ASTEC asphalt plant owned by McCartney Construction Company, located in Anniston, AL was chosen for FEROX evaluation. The plant was brought up to normal operating conditions. Once stable operating conditions were established, exhaust readings were taken to determine baseline conditions (i.e. conditions with the use of No. 2 diesel fuel without FEROX treatment). This baseline tests consisted of measuring exhaust emission levels of CO_2, CO, unburned hydrocarbons, O_2, and exhaust temperatures, at 10 minute intervals.

Fuel was then treated with FEROX at the recommended ratio of 5000 parts fuel to 1 part FEROX. The same parameters were measured during the treated portion of the test as were measured during the baseline test.

A new exhaust particulate filter was installed before both the baseline and treated fuel test series.

EXPECTED OBSERVATIONS

The customer should see some immediate differences. Open-flame surface modification takes time, but they will see the change in the combustion chemistry immediately. They will see a reduction in unburned hydrocarbons, CO and particulate emissions. If, however, the carbon monoxide relates to reduction back from CO_2 and that reduction is occurring on catalytic surfaces within the equipment, then that reduction in CO will not occur until you have modified the surfaces of the equipment. In addition, the customer should see an immediate observable difference in the flame - as soon as treated fuel gets in there. They won't see an immediate drop in acid corrosion, although with continued use they should experience this benefit. Acid corrosion relates to vanadium, sodium and sulfur in the fuel. Vanadium pentoxide is formed as a result of the combustion of vanadium containing fuel. Vanadium Pentoxide allows the conversion of SO_2 to SO_3 which forms sulfuric acid. Cold-end corrosion results from the condensation of the sulfuric acid. FEROX will prevent the formation of vanadium pentoxide. It only allows the formation of lower vanadium oxides that are not catalytic with SO_2 to form sulfuric acid. If the customer has an existing piece of equipment that has a lot of vanadium pentoxide (i.e. has been burning fuels containing vanadium for some time), the process to modify the surface will take a little time.

ACTUAL EFFECTS ON EMISSIONS, FUEL CONSUMPTION, AND PARTICULATE FORMATION

Figure 1 depictS results obtained from the Carbon Mass Balance test of FEROX treated fuel in an ASTEC double-barrel asphalt plant. At the relatively lower production rate of 38, the overall reduction in emissions for carbon monoxide (CO) was 24.05%, unburned hydrocarbons (HC) was 8.66%, and carbon dioxide (CO2) was 20.42%. Completing the carbon mass balance, we conclude an overall reduction in carbon emissions of 26.38% (which represents an overall reduction in fuel consumption, see Appendix 1 and 2 for raw data and an explanation of the carbon mass balance test). We have chosen to use "pf" (un-adjusted performance factor) since the inlet suction is maintained at a constant level of 0.21 inches of water for both the baseline and treated. This coupled with constant delta P across the baghouse indicates the same volume flow rates for both baseline and treated portions of the test. Hence, no need for PF (adjusted performance factors). Similarly, for a higher production rate of 47% controller position, overall emission reductions in harmful emissions were CO = 16.42%, HC = 38.82%, and CO2 = 14.99%. Again completing the overall carbon balance, we conclude an overall reduction in fuel consumption of 18.12%.

In addition, we experienced a decrease in particulate formation as indicated in Figure 2 - a photograph of particulate filters before and after the addition of FEROX. As can be seen in the photo, a significantly larger amount of particulates were caught by the filter used prior to fuel treatment.

MECHANISM FOR DECREASING PARTICULATE AND DEPOSIT FORMATION

During combustion you have intermediate particles that form. Without FEROX treatment, these particles tend to stick or agglomerate to each other as well as to combustion surfaces which are more difficult to combust. What FEROX does is to modify the surface chemistry characteristics of these particles so that they do not stick to each other nor do they stick to the surfaces. When these intermediate particles impact equipment surfaces they have a certain velocity and a certain mass, and they simply erode existing deposits away with time. Because FEROX modifies the surface of particles so that they do not stick to each other nor equipment surfaces, they do not re-adhere to the surface after a particle is eroded away. That's also why when engines are taken apart after long use, any particles that are present can easily be wiped away. FEROX treated fuel prevents re-deposition, it allows particles to erode existing deposited material which end up in the particulate ash until it is all gradually removed. In normal operations, this eroding and re-depositing is continually taking place.

EFFECT ON FLAME LENGTH

The customer will see a shortening of the flame length. Experience has shown that FEROX shortens the flame, keeping it more compact, keeping the heat of the flame closer to the tip, which keeps tips cleaner. Its does this because it modifies the surface of the atomized particles causing more complete combustion sooner. We are not sure exactly how much shortening of the flame you can expect. It's not going to cut it in half or anything like that, but you should get a noticeable shortening.

We did notice a change in the flame. It appeared that the flame was brighter (indicating increase in heat intensity at the nozzle). It also appeared that the flame "condensed" somewhat. Although these observations are subjective, they do indicate a shortening of the flame and could explain a decrease in the effect of the aggregate quenching.

CONCLUSIONS

1. **The use of fuel treated with FEROX™ will result in reduction in fuel consumption.** The overall reduction in fuel consumption during this test was determined to be 26.38% at a production level of 38 and 18.12% for a production level of 47.

2. **The use of fuel treated with FEROX™ will result in a reduction in harmful emissions.** The overall reduction in harmful emissions during this test was determined to be 24.05% for CO, 8.66% for unburned hydrocarbons, 20.42% for CO_2 at a production level of 38. Reduction of harmful emissions were determined to be 16.42% for CO, 38.82% for unburned hydrocarbons, and 14.99% for CO_2 at a production level of 47.

3. **The use of fuel treated with FEROX™ will result in a reduction in particulate formation.** Examination of particulate filters shows a significant reduction in particulate formation between tests using untreated and treated fuel.

4. **The use of fuel treated with FEROX™ should allow higher production rates for a given level of harmful emissions.** This would be most beneficial in areas where production is being limited due to restrictions on emissions.

RECOMMENDATIONS

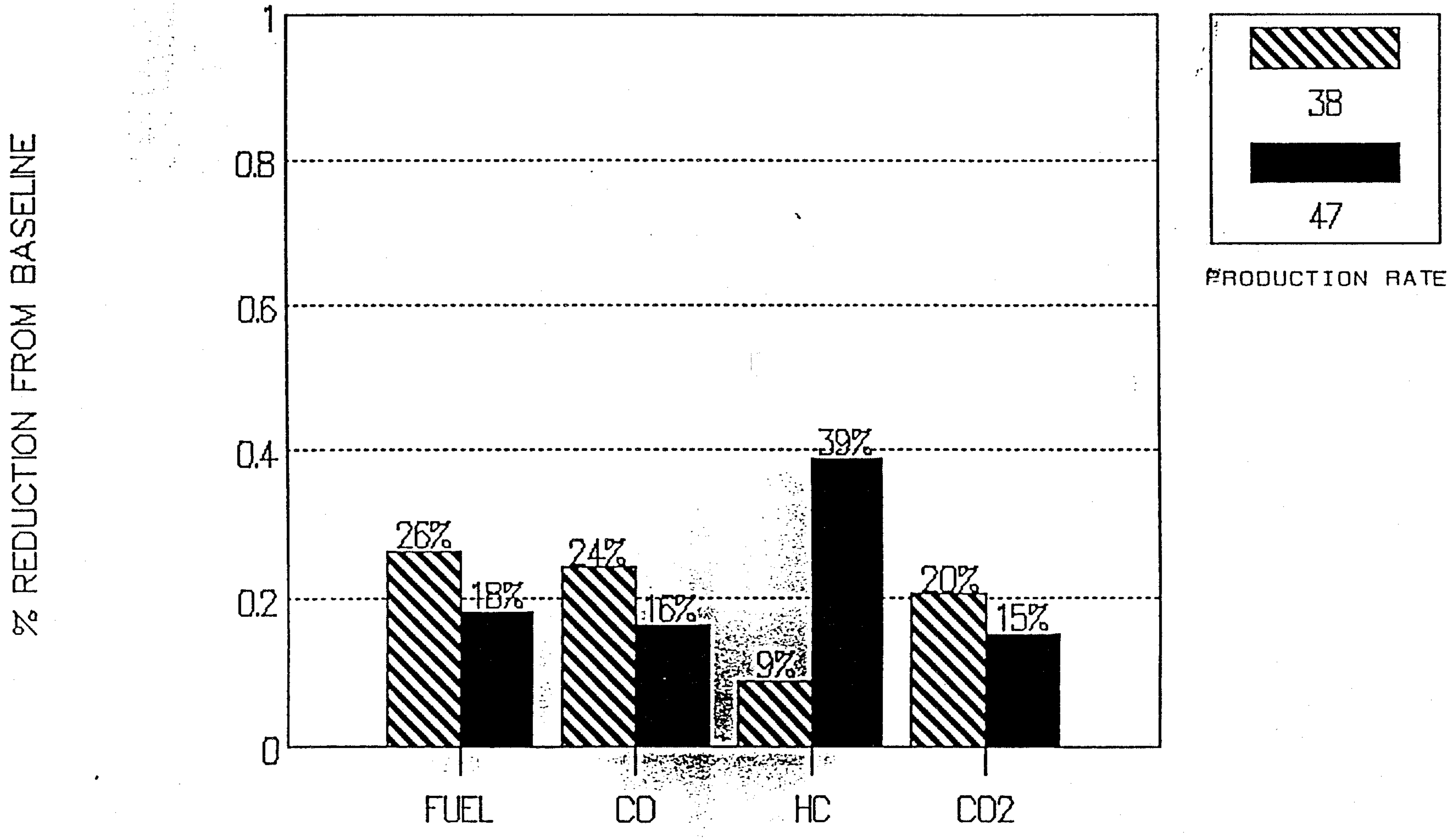
1. **Continue the use of fuel treated with FEROX™ in the double-barrel asphalt plant at** McCartney Construction to take advantage of the longer term benefits derived from the use of FEROXtm treated fuel. These benefits include but are not limited to fuel consumption per pound of mix produced; decreased maintenance costs; decreased acid corrosion; and improved burner operation.

2. Use fuel treated with FEROX™ in all combustion equipment at McCartney Construction. This includes but not limited to: loaders, haulers, excavators, and pick-up trucks. The benefits of reduced fuel consumption, reduced harmful emissions, reduced particulate emissions, and reduced maintenance costss apply to all combustion equipment not just the asphalt plant.

3. Begin using fuel treated with FEROX™ in all ASTEC equipment, particularly that equipment in which production is being limited due to emissions standards.

FIGURE 1

REDUCTIONS W/ FEROX TREATED FUEL
FIELD TRIALS ASTEC ASPHALT PLANT



APPENDICES

CARBON MASS BALANCE FIELD DATA FORM

COMPANY: ASTEC

BASELINE: TREATED: X TEST DATE: 01/29/93

EQUIPMENT TETED: ASPHALT PLANT MILES: N/A

ENGINE TYPE: COUBLE BARREL HOURS: 3 YEARS

EXHAUST STACK DIA. (IN): 20 ID#:

BP(Hg): 25.5 @ T (F): 63

FUEL: NO. 2 DIESEL SG:.8475 @ T (F): 64 AFTER TEST T (F):

AMBIENT T (F): 64

START TIME: 3:00 PM

RUN	TIME	EXH. TEMP	PV	CO	HC	CO2	O2	REMARKS
1	3:10	203.40	N/A	0.92	31	3.16	15.00	PRODUCTION = 38
2	3:20	197.00		0.90	35	3.00	15.00	
3	3:30	194.70		0.88	38	3.02	14.60	CAL
4	3:40	192.20		0.85	38	3.06	15.20	
5	3:50	194.60		0.88	39	2.94	15.10	
6	4:00	190.00		0.93	43	3.09	15.00	
7								
8								
9								
10								

FINISH TIME:

		EXH. TEMP	PV	CO	HC	CO2	O2
AVERAGE		195.32	0.00	0.89	37	3.04	14.98
				VFCO	VFHC	VFCO2	VFO2
				0.0089	3.73E-05	0.0304	0.1498

MOLECULAR WEIGHT 29.0887

pf2 156073.3

PF2 (ADJUSTED) ERR

%CHANGE pf = 26.38%

%CHANGE PF = ERR

	% CO	% HC	% CO2	% O2
EMISSION REDUCTIONS	24.05%	18.66%	20.42%	0.22%

(MEASURED AS % CHANGE IN VOL %)

COMBUSTION FUEL TECHNOLOGY

CARBON MASS BALANCE CALCULATION PROGRAM

FILE: \QUATTRO\CBAL.WKQ

DATE CREATED: AUGUST 12, 1992

UPDATED WITH PF ADJUSTED: SEPTEMBER 21, 1992

CARBON MASS BALANCE FIELD DATA FORM

COMPANY: ASTEC

BASELINE: X TREATED: TEST DATE: 01/29/93

EQUIPMENT TESTED: ASPHALT PLANT MILES: N/A

ENGINE TYPE: DOUBLE BARREL HOURS: 3 YEARS

EXHAUST STACK DIA. (IN): 20 ID#:

BP(Hg): 25.5 @ T (F): 63

FUEL: NO. 2 DIESEL SG:.845 @ T (F): 64 AFTER TEST T (F):

AMBIENT T (F): 64

START TIME: 12:00 NOON

RUN	TIME	EXH. TEMP	PV	CO	HC	CO2	O2	REMARKS
1	12:00	199.50	N/A	1.11	37	3.95	14.70	PRODUCTION = 38
2	12:10	201.80		1.21	43	3.68	14.50	CAL
3	12:20	196.60		1.11	39	3.68	15.40	
4	12:30	199.00		1.13	44	3.84	15.20	CAL
5	12:40	200.40		1.20	43	3.84	15.20	
6	12:50	203.80		1.25	40	3.68	15.50	CAL
7	1:00	204.60		1.14	44	3.85	14.50	CAL
8	1:10	204.40		1.26	37	4.09	14.60	CAL
9								
10								

FINISH TIME:

		EXH. TEMP	PV	CO	HC	CO2	O2
AVERAGES		201.26	0.00	1.18	41	3.83	14.95
				VFCO	VFHC	VFCO2	VFO2
				0.0118	4.09E-05	0.0383	0.1495

MOLECULAR WEIGHT: 29.21257

pf1: 123495

PF1 (ADJUSTED): ERR

COMBUSTION FUEL TECHNOLOGY

CARBON MASS BALANCE CALCULATION PROGRAM

FILE: \QUATTRO\CBAL.WKQ

DATE CREATED: AUGUST 12, 1992

UPDATED WITH PF ADJUSTED: SEPTEMBER 21, 1992

CARBON MASS BALANCE FIELD DATA FORM

COMPANY: ASTEC

BASELINE: X TREATED: TEST DATE: 01/29/93

EQUIPMENT TESTED: ASPHALT PLANT MILES: N/A

ENGINE TYPE: DOUBLE BARREL HOURS: 3 YEARS

EXHAUST STACK DIA. (IN): 20 ID#:

BP(Hg): 25.5 @ T (F): 63

FUEL: NO. 2 DIESEL SG:.845 @ T (F): 64 AFTER TEST T (F):

AMBIENT T (F): 64

START TIME: 2:20 PM

RUN	TIME	EXH. TEMP	PV	CO	HC	CO2	O2	REMARKS
1	2:20 PM	216.00	N/A	1.68	39	4.12	13.90	PRODUCTION = 47
2	2:30	199.00		1.71	46	4.15	13.20	
3	2:40	199.00		1.71	48	4.19	13.00	CAL
4	2:45			1.41	39	3.96	14.00	
5	2:50	206.40		1.45	39	3.90	13.80	
6	3:00			1.66	44	4.10	13.20	
7								
8								
9								
10								

FINISH TIME: 3:00 PM

AVERAGES	205.10	0.00	1.60	43	4.07	13.52	
			VFCO	VFHC	VFCO2	VFO2	
			0.0160	4.25E-05	0.0407	0.1352	

MOLECULAR WEIGHT: 29.19433

pf1: 108870.1

PF1 (ADJUSTED): ERR

CARBON MASS BALANCE FIELD DATA FORM

COMPANY: ASTEC
BASELINE: TREATED: X TEST DATE: 01/29/93
EQUIPMENT TETED: ASPHALT PLANT MILES: N/A
ENGINE TYPE: COUBLE BARREL HOURS: 3 YEARS
EXHAUST STACK DIA. (IN): 20 ID#:
BP(Hg): 25.5 @ T (F): 63
FUEL: NO. 2 DIESEL SG:.8475 @ T (F): 64 AFTER TEST T (F):
AMBIENT T (F): 64
START TIME: 4:00 PM

RUN	TIME	EXH. TEMP	PV	CO	HC	CO2	O2	REMARKS
1	4:05 PM	195.32	N/A	1.34	26	3.46	14.60	PRODUCTION = 48
2								
3								
4								
5								
6								
7								
8								
9								
10								

FINISH TIME:

AVERAGE	195.32	0.00	1.34	26	3.46	14.60
			VFCO	VFHC	VFCO2	VFO2
			0.0134	2.60E-05	0.0346	0.1460

MOLECULAR WEIGHT 29.13911
pf2 128599.5
PF2 (ADJUSTED) ERR
%CHANGE pf = 18.12%
%CHANGE PF = ERR

	CO	HC	CO2	O2
EMISSIONS REDUCTION	16.42%	38.82%	14.99%	-8.01%

(MEASURED AS % CHANGE IN VOL %)

FEROX PETROCHEMICAL CORPORATION

RAW DATA
FIELD TEST ASTEC CORPORATION
01/29/93

MACHINE: ASTEC DOUBLE BARREL ASPHALT PLANT
nO. 2 DIESEL FUEL - SPECIFIC GRAVITY: 0.845

TIME	TEMP	CO	HC	CO2	O2	COMMENTS
12:00 PM	199.5	1.11	37	3.95	14.7	PRODUCTION = 38
12:10	201.8	1.21	43	3.68	14.5	CAL
12:20	196.6	1.11	39	3.68	15.4	
12:30	199	1.13	44	3.84	15.2	CAL
12:40	200.4	1.2	43	3.84	15.2	
12:50	203.8	1.25	40	3.68	15.5	CAL
1:00	204.6	1.14	44	3.85	14.5	CAL
1:10	204.4	1.26	37	4.09	14.6	CAL
AVERAGES:	201.26	1.18	40.88	3.83	14.95	
ST.DEV.:	2.70	0.06	2.80	0.14	0.39	
2:20 PM	216	1.68	39	4.12	13.9	PRODUCTION = 47
2:30	199	1.71	46	4.15	13.2	
2:40	199	1.71	48	4.19	13	CAL
2:45		1.41	39	3.96	14	
2:50	206.4	1.45	39	3.9	13.8	
3:00		1.66	44	4.1	13.2	
AVERAGES:	205.10	1.60	42.50	4.07	13.52	
ST. DEV.:	6.98	0.12	3.69	0.10	0.39	
ADDED CATALYST 3:00 PM						ELECTRONIC RECALIBRA1
3:10	203.4	0.92	31	3.16	15	PRODUCTION = 38
3:20	197	0.9	35	3	15	
3:30	194.7	0.88	38	3.02	14.6	CAL
3:40	192.2	0.85	38	3.06	15.2	
3:50	194.6	0.88	39	2.94	15.1	
4:00	190	0.93	43	3.09	15	
AVERAGES:	195.32	0.89	37.33	3.04	14.98	
ST.DEV.:	4.22	0.03	3.68	0.07	0.19	
4:05	202.8	1.34	26	3.46	14.6	PRODUCTION = 48
4:10	207.4	1.59	26	4.14	13.2	PRODUCTION = 57
4:15	209.4	1.71	31	4.7	12	CAL

4:20	220.4	1.48	19	4.52	12.9	PRODUCTION = 67
4:30	220	1.38	17	4.58	12.4	CAL

DATA TAKEN 1-29-93 @ McCARTNEY'S
8'Ø PORT DOUBLE BARREL

AMBIENT ≈ 55°F

TIME	11:26	12:10	12:20	12:30	12:40	12:50	1:00	1:10	3:15	340
BURNER SUCTION	.25	.24	.26	.21	.22	.22	.21	.21	.22	.21
ΔP BAGHOUSE	2	1.75	2	1.75	1.75	1.75	1.75	1.75	1.75	1.75
% EXHAUST FAN	70	70	70	70	70	70	70	70	70	70
TPH MIX	166	172	157	166	165	162	189	188	160	154
% RAP	10	10	10	10	10	10	10	10	10	10
% H_2O AGG	2.9									
% H_2O RAP	4.7									
% AC	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	5.1	5.1
DRUM EXIT TEMP	220	210	210	228	220	220	210	220	210	210
% BURNER	38	38	38	38	38	38	47	47	38	38
GPM No.2	6.3	6	6	6	6	6	6	6	6	5
MIX TEMP	307	314	303	290	289	297	277	267	323	30
GAL/TON MIX	2.27	2.09	2.29	2.17	2.18	2.22	1.91	1.92	2.25	1.9

GR 2-1-93 2

DATA TAKEN 1-29-93 @ McCARTNEY

TIME	3:50	4:00	4:15			
BURNER SUCTION	.21	.2	.21			
SP BAGHOUSE	1.75	1.75	2			
% EXHAUST FAN	70	70	70			
TPH MIX	156	159	242			
% RAP	10	10	10			
% H2O AGG	2.9					
% H2O RAP	6.7					
% AC	5.1	5.1	5.1			
DRUM EXIT TEMP	218	215	250			
% BURNER	38	48	65			
GPM No.2	6	6	9			
MIX TEMP	312	311	284			
GAL No2/TON MIX	2.31	2.26	2.23			

CARBON MASS BALANCE TECHNIQUE

The carbon balance technique for determining changes in fuel consumption has been recognized by the U.S. 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.

This technique requires no modification to engines or fuel lines since it does not rely on measuring the amount of fuel entering the engine, but rather, the amount of carbon leaving it via the exhaust. This method is based on the conservation of matter which states that atoms can neither be destroyed nor created during a chemical reaction. Since combustion is a chemical reaction, any carbon atoms present in the fuel before combustion must necessarily be present in the exhaust, hence the name "Carbon Balance". Therefore, by measuring the rate at which carbon is exiting the exhaust stack, it is possible to state the rate at which it is entering the combustion chamber. By knowing the carbon/hydrogen composition of the fuel and its density it is then possible to state the rate at which fuel is being consumed.

To measure the amount of carbon leaving the engine, the following measurements must be made:

(a) Exhaust Gas Volumetric Flow Rates: this is determined by measuring the exhaust's velocity with a Pitot Tube.

(b) Temperature and Pressure: these measurements are needed to determine the equivalent volumetric flow rate at standard temperature and pressure conditions.

(c) Mass Per Unit Volume of Components Containing Carbon: these are determined by measuring the volume fractions of CO2, CO and HC and converting these to masses. (Carbon particulates can be included but represent a small fraction of total carbon flow.)

All these measurements can be made simply and quickly by inserting a probe into the end of the exhaust stack. A complete set of measurements can be made in approximately ten minutes per vehicle.

Engine speed and load are duplicated from baseline test to treated test. Measurements of exhaust and pressure temperatures, ambient temperatures, barometric pressures, fuel specific gravity, and exhaust emissions are made along with records of engine types and sizes, exhaust stack diameters, odometer, hub and/or hour readings in order to perform appropriate calculations. Under these conditions readings are taken for each parameter only after stabilization of the exhaust temperature has occured. Multiple data points are gathered for the purpose of stability, accuracy and reproducibility.

To calculate the improvement in an engine's performance with the use of FEROX, measurements are made with the engine running at a stabilized rpm and temperature on untreated fuel (baseline measurements) and treated fuel (treated measurements). Any improvements are stated as percentage changes from baseline. Any absolute errors which may arise in the calculation of fuel consumption will not normally affect the comparison figures since the errors will be of the same magnitude for the baseline and treated measurements.

From the exhaust gas concentrations measured during the test, the molecular weight of each constituent, the exhaust volume and the temperature of the exhaust stream, the fuel consumption may be expressed as a "performance factor" (PF) 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.

These measurements can be converted to the amount of carbon (fuel) entering the system. The advantage of using this method is that an engine can be loaded as accurately as possible and many operating variables such as climatic conditions, load, tire pressure, driver and gradient changes can be eliminated.

CARBON MASS BALANCE FORMULA

ASSUMPTIONS:

$C_{(8)}H_{(15)}$ and SG = 0.78
Time is constant
Load is constant

DATA:

Mwt = Molecular Weight
pf1 = Calculated Performance Factor (Baseline)
pf2 = Calculated Performance Factor (Treated)
T = Temperature (F)
F = Flow (exhaust CFM)
SG = Specific Gravity
VF = Volume Fraction

VFCO2 = "reading" / 100
VFO2 = "reading" / 100
VFHC = "reading" / 1,000,000
VFCO = "reading" / 100

EQUATIONS:

$$Mwt = (VFHC)(86) + (VFCO)(28) + (VFCO2)(44) + (VFO2)(32) + [(1-VFHC-VFCO-VFO2-VFCO2)(28)]$$

$$pf1 \text{ or } pf2 = \frac{2952.3 \times Mwt}{86(VFHC) + 13.89(VFCO) + 13.89(VFCO2)}$$

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

FUEL ECONOMY:

$$\text{PERCENT INCREASE (OR DECREASE)} = \frac{PF2 - PF1}{PF1} \times 100$$