FPC-2 FUEL CATALYST TEST
FOR
FUEL EFFICIENCY & EMISSIONS
REDUCTIONS BY
DEVALL DIESEL
ON THE
FRANCIS M. DEVALL

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EXECUTIVE SUMMARY

The FPC Catalysts manufactured and marketed by FPC INTERNATIONAL have proven in laboratory and field testing, to reduce fuel consumption in the range 3% to 10% under comparable load conditions, and to also significantly reduce carbon emissions.

Following discussions with Manager of Devall Diesel, Mr. Mike Devall, it was agreed that an FPC fuel efficiency study should be conducted on a twin engine, 16V92 Detroit powered tug boat, operating in the Gulf of Mexico.

Although both engines were operated on FPC fuel catalyst dosed fuel, only one engine was subjected to the test procedure to determine the effect of the fuel catalyst upon fuel economy and emissions. A baseline test was conducted, after which the engines were treated by pouring the catalyst down the sounding tubes.

The 16V92 engine treated with FPC showed an average **10%** improved fuel efficiency during steady-state testing (bollard pull).

The treated engine also demonstrated a large percentage reduction in smoke in the range **31%**, and a **50%** reduction in carbon monoxide emissions. Carbon Dioxide reductions, based upon the measured reduction in fuel consumption, are also substantial.

INTRODUCTION

Baseline (untreated) fuel efficiency tests were conducted on the 16V92 main engine on 5 June, 2000, employing the carbon mass balance (CMB) test procedure.

FPC International supplied three cases of FPC catalyst, containing one gallon containers that could be carried onboard the Francis M. Devall for the duration of the test period. The one gallon containers had graduated treatment markings, which made it easy for crew members to measure the correct quantity of the catalyst, to pour into the tanks with each fuelling. The tugboat, Francis M. Devall, was operated on FPC catalyst treated fuel for several hundred hours in order to achieve the complete conditioning of the engine observed in many laboratories and field studies.

At the end of the engine-conditioning period (July 25, 2000), the engine test was repeated reproducing all engine parameters. The results of this study are documented in this report.

TEST METHOD

Carbon Mass Balance (CMB) is a procedure whereby the mass of carbon in the exhaust is calculated as a measure of the fuel being burned. The elements measured in this test include the exhaust gas composition, its temperature and the gas flow rate calculated from the differential pressure and exhaust stack cross sectional area. The CMB is central to the both US-EPA (FTP and HFET) and Australian engineering standard tests (AS2077-1982), although in field testing we are unable to employ a chassis dynamometer. However, in the case of tugboat trials, the engine can be loaded by means of a bollard pull type test procedure, simulating a dynamometer.

The carbon balance formulae and equations employed in calculating the carbon flow are contained in the *Appendices.*

INSTRUMENTATION

Precision state of the art instrumentation was 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 purpose are listed below:

- *Measurement of exhaust gas constituents HC, CO, CO_2 and O_2 by Horiba-Mexa 4 gas infrared gas analyser.*
- *Temperature measurement by Fluke Model 52K/J digital thermometer.*
- *Exhaust differential pressure by Dwyer Magnehelic.*
- *Ambient pressure determination by use of Thommen 2000 TX altimeter/barometer.*
- *The exhaust smoke particulates are also measured during this test program.*
- *Exhaust gas sample evaluation of particulate by use of a Bacharach TrueSpot smoke meter.*
- *The Horiba infrared gas analyser was serviced and calibrated prior to each series of engine efficiency tests.*

TEST RESULTS

1. **Fuel Efficiency**

A summary of the CMB fuel efficiency results achieved in this test program are provided in the following table

TABLE 1

Baseline (untreated) and FPC treated fuel CMB data and calculated rate of fuel flow

FPC International **CARBON BALANCE RESULTS**

COMPANY :	Devall Diesel	LOCATION :	Port Arthur
EQUIPMENT :	Tugboat	UNIT NR. :	Francis M. Devall
ENG. TYPE :	Detroit Diesel	MODEL :	16V92
RATING :		FUEL :	#2D

BASELINE TEST **DATE : 06/05/00**

ENG. HOURS/MILES:		ENG. RPM:	1550
AMB. TEMP (C):	27.3	STACK(mm):	250
BAROMETRIC(mb):	1020	LOAD:	full push

	TEST 1	*TEST 2*	*TEST 3*	*TEST 4*	*TEST 5*	AVERAGE	% ST.DEV
PRES DIFF (Pa):	1417	1417	1417	1417	1417	1417	0.00
EXHST TEMP (C):	263.6	263.8	264.7	263.8	269.4	265	0.93
HC (ppm) :	10	20	20	10	10	14.0	39.12
CO (%) :	0.06	0.06	0.06	0.06	0.06	0.060	0.00
CO2 (%) :	8.21	8.25	8.28	8.33	8.26	8.27	0.53
O2 (%) :	11.70	11.72	11.52	11.70	12.40	11.81	2.89
CARB FLOW(g/s):	59.201	59.516	59.687	60.043	59.209	59.531	0.59
REYNOLDS NR. :	1.47E+05						

TREATED TEST **DATE : 7/25/00**

ENG. HOURS/MILE:	2100 miles	ENG. RPM:	1555
AMB. TEMP (C) :	34.2	STACK(mm):	250
BAROMETRIC(mb):	1020	LOAD:	full push

	TEST 1	*TEST 2*	*TEST 3*	*TEST 4*	*TEST 5*	AVERAGE	% ST.DEV
PRES DIFF (Pa):	1601	1601	1601	1601	1601	1601	0.00
EXHST TEMP (C):	282.1	292.7	298.9	309.8	312.7	299	4.19
HC (ppm) :	20	20	20	20	20	20.0	0.00
CO (%) :	0.03	0.03	0.03	0.03	0.03	0.030	0.00
CO2 (%) :	7.12	7.12	7.22	7.23	7.31	7.20	1.12
O2 (%) :	10.72	12.95	13.50	13.64	13.52	12.87	9.55
CARB FLOW(g/s):	53.619	53.032	53.456	53.021	53.473	53.320	0.52
REYNOLDS NR. :	1.51E+05		TOTAL HOURS/MILES ON TREATED FUEL:			2100 miles	

PERCENTAGE CHANGE IN FUEL CONSUMPTION ((TREATED-BASE)/BASE*100) : **-10.4 %**

NOTE: Only one exhaust pressure reading was taken during treated fuel testing due to the difficulty in reaching the exhaust stack opening. During the baseline test, exhaust temperature was stable, and exhaust pressure was steady. During the treated test segment, exhaust temperature continued to rise. The rise in temperature, due to the increased intake air temperature, would lead to greater exhaust pressure readings, and thus the worksheet corrects exhaust pressure accordingly.

Table 2 provides the average test results of the 16V92, before and after FPC fuel treatment.

TABLE 2

Test Segment	Fuel Flow (g/s)
Untreated	59.31
FPC Treated	53.32
Percent Chg	-10.40

The computer printouts of the calculated CMB test results together with raw data sheets are contained in the *Appendices*.

2. <u>Smoke Tests</u>

Concurrent with CMB data extraction, smoke measurements were conducted. The results of these tests are summarised in Table 3.

TABLE 3

Fuel Type	**Smoke Density**
Untreated	8.0
FPC Treated	5.5
Percent Chg	-31.0

The reduction in smoke density (the mass of the smoke particles) was reduced by **31%** after fuel treatment and engine conditioning with FPC fuel catalyst. A similar reduction in the emission levels of carbon monoxide was also measured.

3. <u>Greenhouse Gas Reduction</u>

Assuming that the average **10%** measured improved fuel efficiency was applied to the total Devall Diesel consumption of 18.9 million liters or 5 million gallons per annum, this would translate to a **16,306 tonnes per annum reduction in CO_2 emissions** based on the formula outlined in Worksheet 1 of the <u>*Electricity Supply Business Greenhouse Change Workbook*</u>, our estimate is based on the following calculations:

	(18,900 KL x 38.6 x 74.9)	÷	1000	=	54,642 tonnes
-10%	(17,010 KL x 38.6 x 74.9)	÷	1000	=	49,178 tonnes

CO_2 reduction by application FPC

54,642 - 49,178 = 5,463 tonnes

CONCLUSION

These carefully controlled engineering standard test procedures, conducted on the 16V92 main engine of the Francis Devall, provide clear evidence of reduced fuel consumption in the range of 10%.

The catalyst's effect on improved combustion is also evidenced by the substantial reduction in soot particulates (smoke) in the range of **31%**. The similar reduction in carbon monoxide likewise substantiates the improved combustion created by FPC.

A fuel efficiency gain of **10%** over the entire Devall Diesel fleet would reduce CO_2 emissions by **5,463 tonnes per annum**.

Additional to the fuel economy benefits measured and a reduction in smoke and greenhouse gas emissions, a significant reduction, over time, in engine maintenance costs will be realised following treatment with FPC-2. These savings are achieved through lower soot levels in the engine lubricating oil, which is a result of more complete combustion of the fuel, thereby reducing engine wear rates and resulting in less carbon build-up in combustion areas. FPC also acts as an effective biocide. Experience in North America has also demonstrated a substantial reduction in track wayside fires following the introduction of the catalyst to the fuel supply.

APPENDIX "A"

COMPUTER PRINTOUTS

APPENDIX "B"

RAW DATA SHEETS

Appendix"C"

Measurements using Carbon Balance Techniques