HAMERSLEY IRON MARANDOO SITE

Evaluation of FTC Combustion Catalyst as a means of reducing Geenhouse Gas Emissions and diesel fuel costs in mobile mining equipment.

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C O N T E N T S

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*E*XECUTIVE *S*UMMARY

The FTC/FPC Combustion Catalysts manufactured and marketed by Fuel Technology have proven in laboratory and field trials to significantly reduce fuel consumption under comparable load conditions and to also substantially reduce carbon emissions.

Following meetings with Hamersley Iron's Performance Engineer – Mobile Equipment, James Campbell, it was agreed that a fuel efficiency study should be conducted on selected haul trucks at the Marandoo site employing two International Engineering test procedures namely "Specific Fuel Consumption" (SFC) and "Carbon Mass Balance" (CMB). This trial commenced on 13th May 2003 and was completed on 31st July 2003.

The net average efficiency gain (reduction in fuel consumption) measured by the CMB and SFC test methods was **5.3%.**

*B*ACKGROUND

The FTC Combustion Catalyst is the only fuel chemical yet proven by the world's leading testing authority, Southwest Research Institute (Texas) to improve fuel efficiency in an as new 2500HP diesel engine operating at its most efficient state. SwRI also determined that FTC does not alter the physical or chemical properties of diesel fuel.

SwRI also determined, using the Caterpillar 1G2 Test (ASTM 509A) that there are no detrimental effects that could cause increased wear or deposit problems following catalyst treatment of fuel.

These findings have been verified by countless field studies in diverse applications, which have confirmed efficiency benefits for mine mobile equipment. Maintenance benefits documented include reduced wear metal profiles in lubricating oil and reduced soot. Combustion and exhaust spaces become essentially free of any hard carbon with continuous catalyst use.

FTC's action in producing fuel efficiency gains is to promote a faster fuel burn which releases the fuel's energy more efficiently. That is, a larger portion of the fuel burn occurs when the piston is closer to top dead centre.

*I*NTRODUCTION

Equipment provided for this fuel efficiency evaluation comprised of three Unit Rig 4000 series trucks, No's 34, 35 and 42. Trucks 34 and 35 were selected as FTC treated test trucks and are powered by MTU engines. Truck 42 was untreated and used as a control to identify any outside variables should they exist and is powered by a Cummins engine.

Fuel Technology Pty Ltd supplied, on loan, an air operated FTC catalyst-metering system which was calibrated allowing fuel to be FTC treated at time of each test truck refuelling.

Trucks 34 and 35 were selected for the SFC test, which were conducted over a circuit of 2.2 km, marked out on a haul ramp in an area where no changes to the profile would occur over the test period. The CMB, which is a static test, was conducted on all three test trucks adjacent to the refuelling bay.

TEST METHODS

The 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, (HC,CO,CO_2 and O_2) temperature and the gas flow rate calculated from the differential pressure and exhaust stack cross sectional area. This is an engineering standard test (AS2077-1982) and has been used by the US EPA since 1974 as the “Standard Federal Test Procedure” for fuel economy and emission testing. (*Horiba four gas analyser photograph No.* 1)

Each test truck was driven to the refuelling area where CMB test probe was positioned in the exhausts independently. With the assistance of on site personnel the test truck engine was run at high idle while emissions were recorded. Exhaust smoke samples via “Bosch Smoke” testing equipment were also recorded at this time.

The Specific Fuel Consumption (SFC) test procedure requires measurement of the mass of fuel consumed related to the work performed in hauling a measured load of ore over a defined distance.

A start point was selected on a reproducible section of the ramp haul and windrow markers marked. A point near the crusher was defined as the end point of the haul route. The distance between these points was measured at 2.2km.

MacNaught Model M10 flow transducers complete with thermocouple probes were connected to the truck’s fuel tank outlet and return fuel pipelines (*Photograph No. 2*).

These transducers, which have been calibrated to $\pm$ 0.25% by a NATA certified laboratory, are connected to a KEP Minitrol Totaliser mounted in the truck cab. The thermocouple probes are connected to a dual reading digital thermometer, also mounted in the cab workstation (*Photograph No. 3*).

As the temperature of the fuel can vary relative to ambient temperature changes as well as increase significantly during a working shift, constant temperature monitoring is required to enable calculation of the mass of fuel consumed for each haul.

Prior to the test commencing a fuel sample is drawn and the density measured at the observed temperature and then corrected to the industry standard of 15°C by use of the Institute of Petroleum Density Correction Table, Volume VIII, Table 53B.

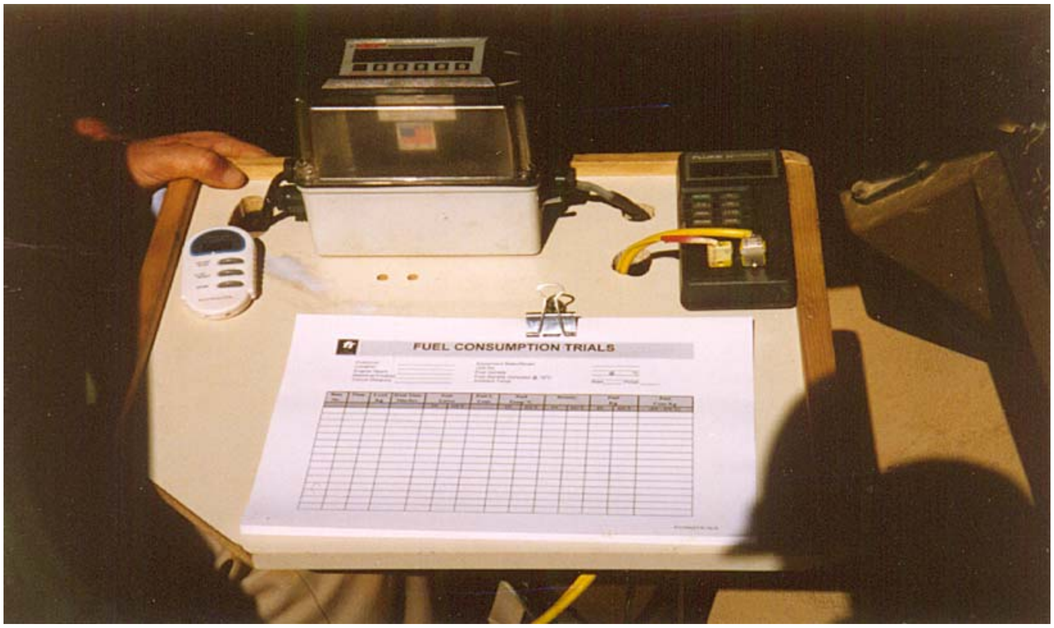
Following loading of the truck at each cycle, the truck was driven to the pit ramp marker and stopped. The Minitrol totaliser and stopwatch are zeroed. At the signal “GO” the driver accelerates and the test engineer activates the totaliser and stopwatch. The truck is driven at full throttle to avoid driver variables over the haul route. Fuel temperatures are recorded at the mid haul point. Upon arrival at the end marker the stopwatch and Minitrol totaliser readings are recorded.

Test Equipment

Photograph No. 1

Comment [FT1]:

Photograph No. 2



Photograph No. 3

TEST RESULTS

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

TABLE 1

Carbon Balance Fuel Consumption Test Results

Unit No.	Untreated 13/5/03 Carbon flow g/s	Treated 31/7/03 Carbon flow g/s	Variation
34 Top Exhaust	5.282	4.906	
34 Bottom Exhaust	5.236	4.905	
TOTAL g/s	**10.518**	**9.811**	**-6.7%**
35 Top Exhaust	3.919	3.727	
35 Bottom Exhaust	3.533	3.354	
TOTAL g/s	**7.452**	**7.081**	**-5.0%**
42 Top Exhaust	3.824	3.820	
42 Bottom Exhaust	3.852	3.881	
TOTAL g/s	**7.676**	**7.701**	**0.3%**
AVERAGE EXCLUDING # 42	**8.985**	**8.446**	**- 6%**

The CMB test procedure provides confirmation that addition of the Catalyst to the fuel supply has resulted in a reduction in carbon flow (fuel consumption) of **6%** excluding control truck 42. Tests conducted on truck 42 indicate that during these tests no outside variables were measured. The computer printouts of results and raw data sheets are contained in the *Appendix.*

*B*OSCH *S*MOKE *M*EASUREMENTS

A Bosch smoke test is also undertaken during conduct of the CMB test and the results are shown in the following table. Smoke patches in *Appendix*.

TABLE 2

Bosch Smoke Results

Unit No.	Untreated 13/5/03	Treated 31/7/03	Variation
34 Top Exhaust	1.4	0.8	
34 Bottom Exhaust	1.0	0.9	
AVERAGE	**1.2**	**0.85**	**- 29%**
35 Top Exhaust	0.5	0.3	
35 Bottom Exhaust	0.8	0.4	
AVERAGE	**0.65**	**0.35**	**-46 %**
42 Top Exhaust	0.2	0.2	
42 Bottom Exhaust	0.2	0.2	
AVERAGE	**0.2**	**0.2**	**N/C**
Average Excluding # 42	**0.925**	**0.6**	**-35%**

*S*PECIFIC *F*UEL *C*ONSUMPTION

Specific Fuel Consumption tests conducted on trucks 34 and 35 in a working environment provided fuel efficiency gains of **5.5%** and **3.7%** respectively averaging **4.6%** when SAE recommended formula of Tonne/km per kg of fuel is applied. Computer printouts follow in tables 3 and 4. Graphical representation is graphs 1 and 2. Work sheets in *Appendix*.

Test Truck 34-Table 3

SPECIFIC FUEL CONSUMPTION TRUCK TRIAL

Customer: Hamersley Iron Marandoo
Date: 15/05/2003
Truck No; 34
Make/Model Unit Rig Series 4000

Engine Hrs 47920
Amb; Temp; Start deg; C 25.4
Amb; Temp; Finish deg; C 17.9
Circuit Distance Km 2.2
Unit Tare weight 157

Fuel Sample	Density	Temp Deg C
	0.829	28.5
Corrected	0.838	15

UNTREATED

Run No	Time	Load Tonnes	Haul Time		Haul Time	Fuel (Lt)		Fuel (Lt)	Fuel Temp		Density		Fuel (kg)		Fuel (kg)	Fuel (kg)	**Tonne/km**
			Mins	Secs	Mins	In	Out	Consumed	In	Out	In	Out	In	Out	Consumed	Per Tonne	**Per kg Fuel**
1	6.30	200	5	28	5.47	76.27	47.14	29.13	33.7	47.5	0.825	0.816	62.95	38.44	24.50	0.0686	**32.0533**
2	6.50	200	5	32	5.53	77.44	47.85	29.59	34.0	47.8	0.825	0.815	63.90	39.01	24.88	0.0697	**31.5629**
3	7.10	200	5	41	5.68	79.72	49.17	30.55	34.3	48.1	0.825	0.815	65.76	40.08	25.68	0.0719	**30.5811**
4	7.25	200	5	33	5.55	78.38	48.35	30.03	34.6	48.4	0.825	0.815	64.63	39.40	25.23	0.0707	**31.1275**
5	7.45	200	5	05	5.08	82.27	50.54	31.73	34.7	48.6	0.825	0.815	67.84	41.17	26.66	0.0747	**29.4544**
6	8.00	200	5	42	5.70	79.72	49.17	30.55	35.0	48.0	0.824	0.815	65.72	40.08	25.64	0.0718	**30.6345**
7	8.20	200	5	52	5.87	82.77	50.71	32.06	35.3	48.6	0.824	0.815	68.21	41.31	26.90	0.0753	**29.1999**
8	8.40	200	5	36	5.60	78.16	48.35	29.81	35.5	48.6	0.824	0.815	64.40	39.39	25.01	0.0701	**31.3996**
9	9.15	200	5	41	5.68	79.66	49.06	30.60	35.9	48.6	0.824	0.815	65.62	39.97	25.65	0.0718	**30.6238**
10	9.30	200	5	38	5.63	78.77	48.62	30.15	36.1	48.2	0.824	0.815	64.87	39.63	25.25	0.0707	**31.1054**
11	9.50	200	5	29	5.48	76.61	47.36	29.25	36.0	48.7	0.824	0.815	63.10	38.58	24.52	0.0687	**32.0317**
Mean		200			5.57			30.31							25.448	0.0713	**30.8885**
Std Dev		0			0.1981			0.9309							0.7785	0.0022	**0.9285**

SPECIFIC FUEL CONSUMPTION TRUCK TRIAL

Truck No: 34
Date: 30/07/2003

Engine Hrs 49141
Amb; Temp; Start deg; C 25.3
Amb; Temp; Finish deg; C 24.5

Fuel Sample	Density	Temp Deg C
	0.824	31.2
Corrected	0.835	15

TREATED

Run No	Time	Load Tonnes	Haul Time		Haul Time	Fuel (Lt)		Fuel (Lt)	Fuel Temp		Density		Fuel (kg)		Fuel (kg)	Fuel (kg)	**Tonne/km**
			Mins	Secs	Mins	In	Out	Consumed	In	Out	In	Out	In	Out	Consumed	Per Tonne	**Per kg Fuel**
1	1.00	200	5	13	5.22	71.49	43.13	28.36	25.1	41.8	0.828	0.817	59.22	35.22	24.01	0.0672	**32.7159**
2	1.20	200	5	29	5.48	75.55	45.93	29.62	25.8	43.4	0.828	0.815	62.55	37.45	25.10	0.0703	**31.2952**
3	1.35	200	5	19	5.32	72.72	44.56	28.16	26.2	43.8	0.828	0.815	60.18	36.32	23.86	0.0668	**32.9140**
4	1.50	200	5	23	5.38	74.33	45.60	28.73	26.9	44.2	0.827	0.815	61.48	37.15	24.32	0.0681	**32.2898**
5	2.05	200	5	22	5.37	73.38	44.83	28.55	27.3	44.1	0.827	0.815	60.67	36.53	24.14	0.0676	**32.5371**
6	2.20	200	5	16	5.27	71.61	43.95	27.66	27.7	44.4	0.827	0.815	59.19	35.81	23.38	0.0655	**33.5934**
7	2.40	200	5	21	5.35	73.49	44.99	28.50	28.4	44.6	0.826	0.815	60.70	36.65	24.05	0.0674	**32.6517**
8	2.50	200	5	25	5.42	74.44	45.72	28.72	29.3	44.9	0.825	0.814	61.44	37.23	24.21	0.0678	**32.4371**
9	3.05	200	5	28	5.47	75.44	46.64	28.80	29.8	45.3	0.825	0.814	62.24	37.97	24.27	0.0680	**32.3631**
10	3.30	200	5	16	5.27	71.99	44.17	27.82	30.6	46.0	0.825	0.814	59.36	35.94	23.42	0.0656	**33.5368**
11	3.45	200	5	26	5.43	74.94	45.82	29.12	31.4	46.6	0.824	0.813	61.74	37.26	24.49	0.0686	**32.0744**
Mean		200			5.36			28.55							24.113	0.0675	**32.5826**
Std Dev		0			0.0870			0.5576							0.4778	0.0013	**0.6432**

% CHANGE: Treated-Baseline	Load Tonnes			Haul Time Mins		Fuel (Lt) Consumed		Fuel (kg) Consumed	Fuel (kg) Per Tonne	**Tonne/km Per kg Fuel**
Baseline	0.00%			-3.78%		-5.82%		-5.24%	**-5.2%**	**5.5%**

Test Truck 35-Table 4

SPECIFIC FUEL CONSUMPTION TRUCK TRIAL

Customer:	Hamersley Iron Marandoo	Engine Hrs	49415
Date:	14/05/2003	Amb; Temp; Start deg; C	27.3
Truck No;	35	Amb; Temp; Finish deg; C	20.4
Make/Model	Unit Rig Series 4000	Circuit Distance Km	2.2
		Unit Tare weight	157

Fuel Sample	Density	Temp Deg C
	0.829	28.5
Corrected	0.838	15

UNTREATED

Run No	Time	Load Tonne	Haul Time		Haul Time	Fuel (Lt)		Fuel (Lt)	Fuel Temp		Density		Fuel (kg)		Fuel (kg)	Fuel (kg)	**Tonne.km**
			Mins	Secs	Mins	In	Out	Consumed	In	Out	In	Out	In	Out	Consumed	Per Tonne	**Per kg Fuel**
1	3.40	200	5	15	5.25	78.83	52.85	25.98	38.9	58.8	0.822	0.808	64.77	42.68	22.09	0.0619	**35.5540**
2	4.00	200	5	39	5.65	85.22	56.53	28.69	39.6	58.2	0.821	0.808	69.97	45.67	24.30	0.0681	**32.3163**
3	4.25	200	5	26	5.43	81.77	54.56	27.21	39.7	59.4	0.821	0.807	67.13	44.04	23.10	0.0647	**34.0032**
4	4.45	200	5	23	5.38	80.44	53.73	26.71	40.4	58.9	0.821	0.807	66.00	43.38	22.62	0.0634	**34.7224**
5	5.05	200	5	21	5.35	80.33	53.73	26.60	40.6	60.2	0.820	0.807	65.90	43.33	22.57	0.0632	**34.7992**
6	5.25	200	5	31	5.52	82.83	55.10	27.73	41.0	59.2	0.820	0.807	67.93	44.48	23.45	0.0657	**33.4894**
7	6.40	200	5	14	5.23	77.72	52.08	25.64	39.6	56.9	0.821	0.809	63.82	42.13	21.69	0.0608	**36.2129**
8	6.55	200	5	35	5.58	83.94	55.71	28.23	39.8	58.6	0.821	0.808	68.91	45.00	23.92	0.0670	**32.8375**
9	7.15	200	5	30	5.50	82.38	54.83	27.55	40.0	58.7	0.821	0.808	67.62	44.28	23.34	0.0654	**33.6550**
10	7.35	200	5	32	5.53	82.72	55.10	27.62	40.3	58.9	0.821	0.807	67.88	44.49	23.39	0.0655	**33.5752**
Mean		200			5.44			27.20							23.047	0.0646	**34.1165**
Std Dev		0			0.1386			0.9651							0.8082	0.0023	**1.2057**
C.V		0.0%			2.5%			3.5%							3.5%	3.5%	**3.5%**

SPECIFIC FUEL CONSUMPTION TRUCK TRIAL

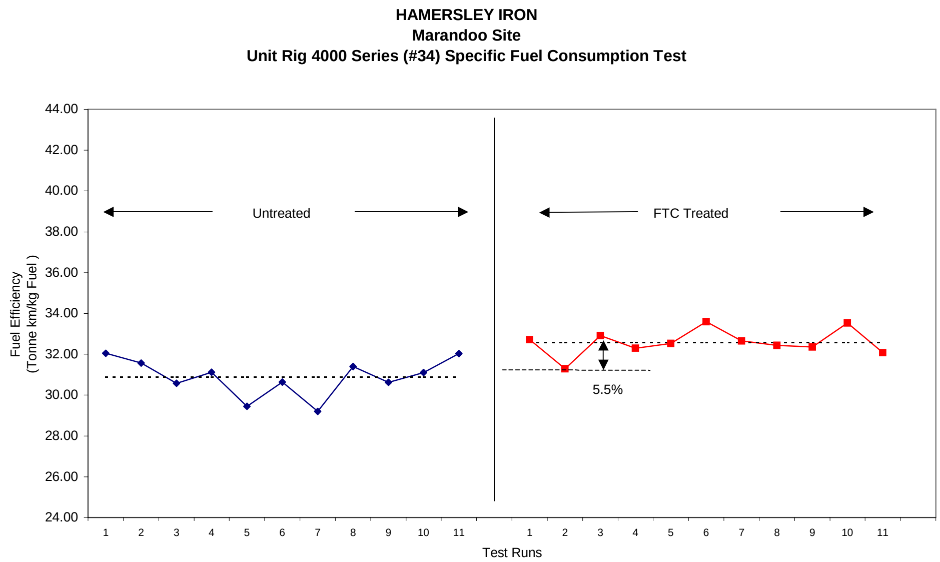
Truck No:	35	Engine Hrs	50677
Date:	31/07/2003	Amb; Temp; Start deg; C	
		Amb; Temp; Finish deg; C	24.9

Fuel Sample	Density	Temp Deg C
	0.816	41.3
Corrected	0.835	15

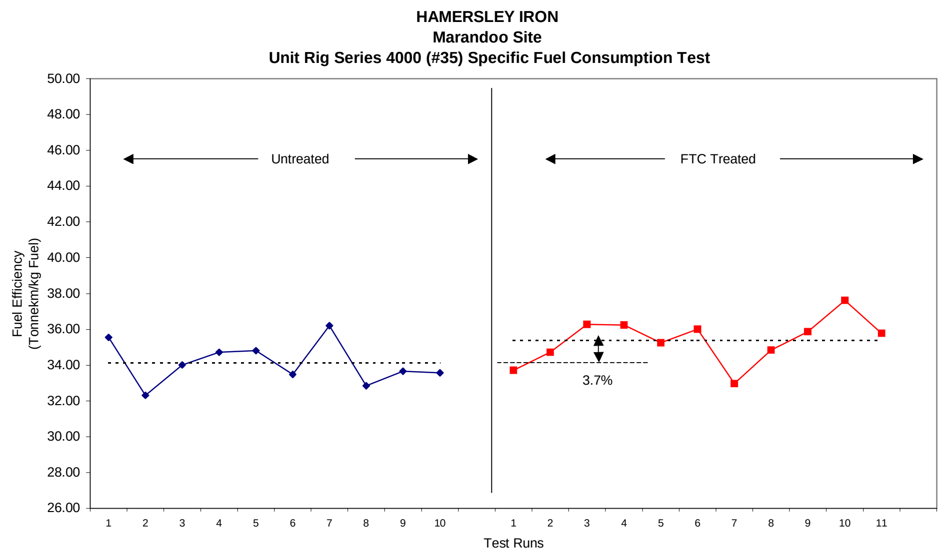
TREATED

Run No	Time	Load Tonnes	Haul Time		Haul Time	Fuel (Lt)		Fuel (Lt)	Fuel Temp		Density		Fuel (kg)		Fuel (kg)	Fuel (kg)	**Tonne.km**
			Mins	Secs	Mins	In	Out	Consumed	In	Out	In	Out	In	Out	Consumed	Per Tonne	**Per kg Fuel**
1	10.54	200	5	17	5.28	79.66	52.30	27.36	29.0	48.8	0.825	0.811	65.70	42.40	23.30	0.0653	**33.7140**
2	11.14	200	5	13	5.22	77.27	50.71	26.56	30.2	50.9	0.824	0.809	63.66	41.03	22.62	0.0634	**34.7207**
3	11.30	200	5	06	5.10	75.16	49.83	25.33	31.4	54.1	0.823	0.807	61.86	40.21	21.65	0.0606	**36.2791**
4	11.47	200	5	04	5.07	75.27	49.72	25.55	33.8	53.4	0.821	0.807	61.82	40.14	21.68	0.0607	**36.2348**
5	12.04	200	5	10	5.17	76.40	50.15	26.25	32.9	52.8	0.822	0.808	62.79	40.51	22.28	0.0624	**35.2482**
6	12.19	200	5	07	5.12	75.60	49.95	25.65	33.8	55.0	0.821	0.806	62.09	40.27	21.82	0.0611	**36.0018**
7	12.35	200	5	26	5.43	81.94	53.90	28.04	34.5	55.5	0.821	0.806	67.26	43.44	23.82	0.0667	**32.9746**
8	12.53	200	5	13	5.22	77.72	51.09	26.63	34.9	54.2	0.821	0.807	63.77	41.22	22.54	0.0632	**34.8374**
9	1.08	200	5	08	5.13	75.99	50.16	25.83	35.5	55.7	0.820	0.806	62.32	40.42	21.90	0.0613	**35.8622**
10	1.22	200	4	58	4.97	73.49	48.84	24.65	36.1	55.5	0.820	0.806	60.24	39.36	20.88	0.0585	**37.6157**
11	1.39	200	5	09	5.15	76.65	50.76	25.89	36.5	56.8	0.819	0.805	62.81	40.86	21.95	0.0615	**35.7891**
Mean		200			5.17			26.16							22.221	0.0622	**35.3889**
Std Dev		0			0.1217			0.9564							0.8211	0.0023	**1.2896**
C.V		0.0%			2.4%			3.7%							3.7%	3.7%	**3.6%**

%CHANGE:	Load Tonnes			Haul Time		Fuel (Lt)		Fuel (kg)	Fuel (kg)	**Tonne.km**
Treated-Baseline				Mins		Consumed		Consumed	Per Tonne	**Per kg Fuel**
Baseline	0.00%			-5.05%		-3.82%		-3.58%	**-3.6%**	**3.7%**



Graph # 1



Graph # 2

GREENHOUSE GAS REDUCTION

A gross reduction of **5.3%** of the current estimated annual fuel consumption of 50,000 KL translates to a **7,662 tonnes per annum** reduction in CO_2 emissions, based on the formula outlined in Worksheet 1 of the "Electricity Supply Business Greenhouse Change Workbook". Our estimate is based on the following calculations:-

(50,000 KL x 38.6 x 74.9) ÷ 1000 = 144,557 tonnes CO_2 per annum

- 5.3% (47,350 KL x 38.6 x 74.9) ÷ 1000 = 136,895 tonnes CO_2 per annum

CO_2 reduction by application FPC Catalyst
144,557 – 136,895 = 7,662 tonnes

CONCLUSION

These carefully controlled engineering standard test procedures conducted on a selection of Hamersley Iron Marandoo fleet provide clear evidence of average reduced fuel consumption of **5.3%**.

A fuel efficiency gain of **5.3%** as measured by the Australian Standards (AS2077) CMB test method and SAE Specific Fuel Consumption method, if applied to the total fuel currently consumed by Hamersley Iron mobile equipment of approximately 50ML p.a. at a cost of $0.48/L will result in a **net** saving of in excess of **$1,000,000 per annum.**

Additional to the fuel economy benefits measured, is a reduction in greenhouse gas emissions of 7,662 tonnes per annum due to more complete combustion of the fuel. Further, the more complete combustion will translate to significant reduction over time in engine maintenance costs. FTC/FPC also acts as an effective biocide.