



**AN INVESTIGATION OF THE EFFECTS OF THE USE OF
MAGNO-FLO MAGNETS ON DIESEL ENGINES**

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SUMMARY

This report describes an investigation undertaken by the School of Engineering, Bolton Institute for Magno-Flo Limited, on the effects of the use of the permanent magnets they supply on the performance and fuel consumption of diesel engines.

The magnets used are N410A. The study is based on bench engine testing. The diesel engine used in the investigation is the Perkins T4.236 which has turbocharged injection. During the tests, both the fuel consumption rate, the brake load and the engine speed were measured. The results show that the use of the magnets improves both the fuel consumption rate and engine thermal efficiency at various brake loads and speed.

1. INTRODUCTION

Since the 1970's people are more conscious of the energy economy, and the use of energy in an economical and efficient way has suddenly become important. This importance dates from the 1973 October War in the Middle East and the subsequent very large increase in the price of crude oil imposed by the OPEC countries.

Among different sectors, transport is one of the major energy consumers. In Western Europe roughly one quarter of crude oil is used in the transport sector, and of that 60% is used in private cars. The fraction of oil used for transport is likely to continue to increase rather than to diminish as other fuels (notably coal and gas) replace oil in the industrial and domestic sectors, so that the fuel economy of engines will grow in importance.

Ways of reducing fuel consumption in combustion engines have been investigated and proposed over the years. The power of magnetism has long been recognised. Its applications range from a simple compass to complex electrical machine and medical equipment. In recent years, claims have been made that the use of magnetism will help cut down the fuel consumption of engines. While different and sometimes contradictory conclusions have been made on such claims, this investigation sets out to study such claims and provide evidence of the improvement if such claims are true.

The main aim of the project is to investigate whether the permanent magnets N410A provided by Magno-Flo Limited will have effects on the performance of a diesel engine. In particular, the objectives are two fold ; firstly to assess the effect on fuel consumption, secondly to evaluate the effect on power output and hence the efficiency of the engine.

The method adopted in this study is bench engine testing. In this testing method, the operating conditions of the engine are well defined and controlled. Compared with the uncontrolled road testing, bench testing offers very good repeatability .

2. THE DEVICES

Each set of devices provided by Magno-Flo Ltd consists of a pair of magnets. The magnets are produced from iron, neodymium and baron by using the powder metallurgical process. The magnets are manufactured by uniaxial pressing to final shape. The typical tolerances of such sintered uniaxially pressed magnets are +1%. The typical physical and mechanical properties of the magnets are listed in Table 1.

Table 1 : Physical and Mechanical Properties of the Magnets

Curie temperature ($^{\circ}\text{C}$)	310
Hardness (HVS)	500 – 600
Tensile strength (N/mm^2)	80 – 100
Density (g/cm^3)	7.5
Electrical resistivity ($\mu\Omega\text{cm}$)	~140
Specific heat (J/kgK)	500
Magnetising field (kA/m)	2500

The particular magnets provided in this investigation are N410A. Their nominal values of remanence, coercivity and energy product are 1.15T, 870 Ka/M and 250 kJ/m^3 respectively. Each magnet is of cylindrical shape of approximately 27mm diameter and 15mm height, and is housed in a plastic case as shown, which has a flange of 15mm x 27mm in each side. There is a 10mm channel for clamping onto a pipe.

3. THE SET-UP

The set-up consists of a Perkins diesel engine T4.236 with turbocharged injection which has a maximum speed governed at 2800 rpm with 23% torque back-up over 1400rpm. The bore diameter and stroke of the engine are 98.4 and 127mm respectively. The number of cylinders is four in-line. The capacity is 3.86 litres. The engine is running on four stroke with the firing order 1-3-4-2. The compression ration 16:1. The engine is to drive a dynamometer (Dyno Mark I) manufactured by Heenan and Froude Ltd.

The set-up is controlled by a dedicated computer and fully instrumented to measure various temperatures, pressures, fuel consumption rate, brake load and speed.

4. PROCEDURE OF EXPERIMENT

The procedure of the experiment is as follows :

1. Without the magnet, the engine was started and allowed to run until thoroughly warm.
2. The Engine was then set to run at 1200rpm and drag load.
3. The fuel logging programme was run to record fuel consumption for the period 10-30 seconds.
4. The time elapse and fuel consumption and therefore the fuel consumption rate were noted.
5. Steps 3 and 4 were repeated for different loads 20 to 100 Nm with every 10 Nm increment.
6. Steps 2 to 5 were repeated for different speeds at 200rpm increment, up to 2800rpm.

The experiment was then repeated once without the magnets two days later.

When the engine was cold, four sets of magnets were mounted to the four fuel injection pipes. The locations where the magnets were mounted were chosen arbitrarily near the injectors. The experiment was then repeated twice a few days later with two days in between each run.

5. THE EXPERIMENTAL RESULTS AND ANALYSIS

Table 2 shows the experimental results. It is noted that the results between trials 1 and 2 for both with and without the magnets show significant consistence throughout, though the experiments took place with a long time gap between each run. The average between trials 1 and 2 for both cases are then taken as shown in Table 2.

Figure 6 shows the plot of average fuel consumption rate against the load for different engine speed where the dotted and solid lines are for the cases without and with the magnets respectively. It is noted first of all from Figure 6 that the fuel consumption rate increases as the load increases for a particular speed, and as the speed increases for a particular load. Secondly, for the same conditions it shows that the case with the magnets consumes less fuel.

Employing curve fitting techniques the best fitted lines are obtained for Figure 6 and are tabulated in Table 3. From the best fitted lines, the derived fuel consumption rates are obtained and shown in Table 4 together with the brake powers, brake thermal efficiencies and brake specific fuel consumptions. Figures 7 to 15 show the plots of the brake thermal efficiency and brake specific fuel consumption against the brake power of the engine speed 1200, 1400, 1600, 1800, 2000, 2200, 2400, 2600 and 2800 rpm respectively (dotted lines are without magnets, solid lines are with magnets). It can be seen that the use of the magnets improves both the brake thermal efficiency and the brake specific fuel consumption in all speeds and loads.

TABLE 2 – Experimental Results

Speed RPM	Without Magnets						With Magnets					
	Trial 1		Trial 2		Average		Trial 1		Trial 2		Average	
	Load N-M	f.c.r. ml/sec	Load N-M	f.c.r. ml/sec	Load N-M	f.c.r. ml/sec	Load N-M	f.c.r. ml/sec	Load N-M	f.c.r. ml/sec	Load N-M	f.c.r. ml/sec
1200	10.3	0.53	10.6	0.6	10.45	0.565	11.1	0.53	11	0.6	11.05	0.565
	20.3	0.6	20	0.65	20.15	0.625	20	0.6	20	0.6	20	0.6
	30	0.7	30	0.75	30	0.725	30	0.7	30	0.7	30	0.7
	40.2	0.76	40	0.805	40.1	0.7825	40	0.73	40	0.8	40	0.765
	50	0.87	50	0.9	50	0.885	50	0.9	50	0.9	50	0.865
	60	0.95	60	0.915	60	0.9325	60	0.86	60	0.95	60	0.905
	70	1	70	1.05	70	1.025	70	0.96	70	1	70	0.98
	80	1.1	80	1.1	80	1.1	80	1.03	80	1.06	80	1.045
	90	1.16	90	1.175	90	1.1675	90	1.1	90	1.13	90	1.115
	100	1.23	100	1.3	100	1.265	100	1.16	100	1.2	100	1.18
1400	12	0.7	12.9	0.7	12.45	0.7	12.9	0.6	12.9	0.6	12.9	0.6
	20	0.8	20	0.8	20	0.8	20	0.7	20	0.73	20	0.715
	30	0.8	30	0.95	30	0.875	30	0.8	30	0.84	30	0.82
	40	1	40	0.95	40	0.975	40	1	40	1	40	1
	50	1.1	50	1.05	50	1.075	50	1	50	1	50	1
	60	1.1	60	1.2	60	1.15	60	1.1	60	1.1	60	1.1
	70	1.225	70	1.25	70	1.2375	70	1.2	70	1.2	70	1.2
	80	1.3	80	1.4	80	1.35	80	1.3	80	1.3	80	1.3
	90	1.4	90	1.4	90	1.4	90	1.4	90	1.4	90	1.4
	100	1.6	100	1.5	100	1.55	100	1.5	100	1.5	100	1.5
1600	14.1	0.81	14.9	0.85	14.5	0.83	14.8	0.8	14.9	0.83	14.85	0.815
	20	0.88	20	0.9	20	0.89	20	0.9	20	0.9	20	0.9
	30	1	30	1	30	1	30	1	30	1	30	1
	40	1.2	40	1.2	40	1.2	40	1.1	40	1.1	40	1.1
	50	1.3	50	1.25	50	1.275	50	1.2	50	1.2	50	1.2
	60	1.3	60	1.35	60	1.325	60	1.3	60	1.32	60	1.31
	70	1.4	70	1.4	70	1.4	70	1.4	70	1.4	70	1.4
	80	1.6	80	1.5	80	1.55	80	1.5	80	1.5	80	1.5
	90	1.6	90	1.6	90	1.6	90	1.6	90	1.57	90	1.585
	100	1.8	100	1.7	100	1.75	100	1.63	100	1.66	100	1.645
1800	16	1	16.9	1.1	16.45	1.05	16.9	1	17	0.97	16.95	0.985
	20.1	1.1	20.1	1.1	20.1	1.1	20	1.1	20	1.1	20	1.1
	30	1.3	30	1.2	30	1.25	30	1.1	30	1.1	30	1.1
	40	1.3	40	1.3	40	1.3	40	1.2	40	1.23	40.05	1.215
	50.1	1.4	50.1	1.4	50.1	1.4	50	1.36	50	1.35	50	1.355
	60	1.5	60	1.475	60	1.4875	60	1.5	60	1.5	60	1.5
	69.9	1.6	70.1	1.7	70	1.65	70	1.6	70.1	1.6	70.05	1.6
	80	1.8	80.1	1.8	80.05	1.8	80	1.7	80.1	1.73	80.05	1.715
	90	1.8	90	1.9	90	1.85	90	1.8	90	1.77	90	1.785
	100	2.1	100	2	100	2.05	100	2	100	2	100	2

2000	18.7	1.3	19	1.3	18.85	1.3	19.1	1.2	18.9	1.2	19	1.2
	20.1	1.3	20	1.3	20.05	1.3	20	1.2	20	1.2	20	1.2
	30	1.4	30	1.4	30	1.4	30	1.3	29.9	1.33	29.95	1.315
	40.1	1.5	40	1.052	40.05	1.51	40	1.4	40.1	1.43	40.05	1.415
	50	1.7	50	1.7	50	1.7	50	1.7	50	1.7	50	1.7
	60	1.8	60	1.81	60	1.805	60	1.8	60	1.76	60	1.78
	70	2	70	1.9	70	1.95	70	1.8	70	1.84	70	1.82
	80	2.1	80	2.1	80	2.1	80	1.9	80	1.9	80	1.9
	90	2.2	90	2.15	90	2.175	90	2.1	90	2.1	90	2.1
	100	2.3	100	2.3	100	2.3	100	2.2	100.1	2.23	100.05	2.215
2200	20.9	1.6	21.2	1.6	21.05	1.6	21.3	1.5	21.1	1.58	21.2	1.5
	30	1.6	30	1.7	30	1.65	30	1.6	30	1.58	30	1.59
	40	1.8	40	1.8	40	1.8	40	1.7	40.1	1.73	40.05	1.715
	50	1.935	50	1.9	50	1.9175	50	1.9	50	1.9	50	1.9
	60	2.1	60	2.1	60	2.1	60	2	60	2.04	60	2.02
	70	2.2	70	2.3	70	2.25	70	2.2	70	2.23	70	2.215
	80	2.3	80	2.3	80	2.3	80	2.3	80	2.36	80	2.33
	90	2.5	90	2.55	90	2.525	90	2.4	90	2.4	90	2.4
	100	2.7	100	2.7	100	2.7	100	2.6	100.1	2.6	100.05	2.6
2400	23.2	1.9	23.3	1.8525	23.25	1.8763	23.6	1.9	23.3	1.9	23.45	1.9
	30	2	30	2	30	2	30	2	30	2	30	2
	40	2.1	40	2.2	40	2.15	40	2.1	40	2.1	40	2.1
	50	2.4	50	2.4	50	2.4	50	2.3	50	2.3	50	2.3
	60	2.5	60	2.5	60	2.5	60	2.4	60.1	2.4	60.05	2.4
	70	2.6	70	2.6	70	2.6	70	2.5	70	2.5	70	2.5
	80	2.8	80	2.75	80	2.775	80	2.7	80	2.7	80	2.7
	90	3	90	2.9	90	2.95	90	2.9	90	2.9	90	2.9
	100	3.1	100	3.05	100	3.075	100	3	100	3	100	3
2600	25.4	2.3	25.4	2.3	25.4	2.3	25.7	2.2	25.7	2.2	25.7	2.2
	30	2.4	30	2.4	30	2.4	30	2.2	30	2.2	30	2.2
	40	2.63	40	2.6	40	2.615	40	2.4	40	2.4	40	2.4
	50	2.8	50	2.8	50	2.8	50	2.6	50	2.6	50	2.6
	60	2.9	60	2.9	60	2.9	60	2.8	60	2.8	60	2.8
	70	3.1	70.1	3.05	70.05	3.075	70	2.9	70	2.9	70	2.9
	80	3.2	80	3.25	80	3.225	80	3.1	80	3.1	80	3.1
	90	3.5	90	3.4	90	3.45	90	3.2	90	3.2	90	3.2
	100	3.6	100	3.55	100	3.575	100	3.4	100	3.4	100	3.4
2800	27.7	2.7	27.6	2.65	27.65	2.675	27.8	2.5	27.9	2.5	27.85	2.5
	30.1	2.7	30.1	2.7	30.1	2.7	30	2.6	30	2.6	30	2.6
	40	2.9	40	2.9	40	2.9	40	2.8	40.1	2.8	40.05	2.8
	50	3.1	50	3.1	50	3.1	50	3	50	3	50	3
	60	3.4	60	3.3	60	3.35	60	3.2	60	3.2	60	3.2
	70	3.5	70	3.5	70	3.5	70	3.3	70	3.3	70	3.3
	80	3.6	80	3.6	80	3.6	80	3.4	80	3.4	80	3.4
	90	3.9	90	3.85	90	3.875	90	3.6	90	3.6	90	3.6
	100	4	100	4	100	4	100	3.9	100	3.9	100	3.9

Table 3 : Best Fitted Line Equations

Speed	Without Magnets	With Magnets
1200	$fcr = 0.00788L + 0.4804$	$fcr = 0.007L + 0.4840$
1400	$fcr = 0.0093L + 0.5995$	$fcr = 0.0098L + 0.5198$
1600	$fcr = 0.0103L + 0.7093$	$fcr = 0.0098L + 0.7017$
1800	$fcr = 0.0114L + 0.8591$	$fcr = 0.0115L + 0.7934$
2000	$fcr = 0.0128L + 1.0389$	$fcr = 0.0125L + 0.9646$
2200	$fcr = 0.014L + 1.2498$	$fcr = 0.0141L + 1.1834$
2400	$fcr = 0.0155L + 1.5465$	$fcr = 0.0146L + 1.5313$
2600	$fcr = 0.0168L + 1.9076$	$fcr = 0.016L + 1.8072$
2800	$fcr = 0.0187L + 2.1642$	$fcr = 0.0185L + 2.0114$

Where fcr and L stand for fuel consumption rate and load respectively

TABLE 4 – Derived Results

Speed	Without Magnets						With Magnets					
	Ave Load N-M	f.c.r. ml/sec	error	Brake power kW	μ %	Bsfc kg/kWh	Ave Load N-R	f.c.r. ml/sec	error	Brake power Kw	μ %	Bsfc kg/kWh
1200	10.45	0.5614	-3.6x10 ⁻³	1.3132	7.2961	1.1466	11.05	0.5618	-3.18x10 ⁻³	1.389	7.7092	1.0851
	20.15	0.6358	-3.6x10 ⁻³	2.5321	12.4070	0.6743	20	0.6248	-3.18x10 ⁻³	2.513	12.5462	0.6668
	30	0.7129	-3.6x10 ⁻³	3.77	16.4937	0.5072	30	0.6952	-3.18x10 ⁻³	3.77	16.9134	0.4946
	40.1	0.7912	-3.6x10 ⁻³	5.039	19.8653	0.4211	40	0.7656	-3.18x10 ⁻³	5.03	20.4475	0.4085
	50	0.868	-3.6x10 ⁻³	6.283	22.5798	0.3705	50	0.8361	-3.18x10 ⁻³	6.283	23.4412	0.3569
	60	0.9455	-3.6x10 ⁻³	7.54	24.8744	0.3363	60	0.9064	-3.18x10 ⁻³	7.54	25.9446	0.3224
	70	1.023	-3.6x10 ⁻³	8.796	26.8213	0.3119	70	0.9769	-3.18x10 ⁻³	8.796	28.0871	0.2978
	80	1.1005	-3.6x10 ⁻³	10.053	28.4940	0.2936	80	1.0472	-3.18x10 ⁻³	10.053	29.9415	0.2794
	90	1.178	-3.6x10 ⁻³	11.31	29.9465	0.2794	90	1.1177	-3.18x10 ⁻³	11.31	31.5623	0.2650
	100	1.2556	-3.6x10 ⁻³	12.57	31.2197	0.2680	100	1.1880	-3.18x10 ⁻³	12.57	32.9910	0.2536
1400	12.45	0.715	-3.6x10 ⁻³	1.825	7.9646	1.0503	12.9	0.6467	-3.18x10 ⁻³	1.89	9.1221	0.9171
	20	0.785	-3.6x10 ⁻³	2.923	11.6542	0.7178	20	0.7165	-3.18x10 ⁻³	2.932	12.7648	0.6554
	30	0.877	-3.6x10 ⁻³	4.398	15.6357	0.5350	30	0.815	-3.18x10 ⁻³	4.398	16.8365	0.4969
	40	0.97	-3.6x10 ⁻³	5.864	18.8568	0.4436	40	0.913	-3.18x10 ⁻³	5.864	20.0313	0.4175
	50	1.063	-3.6x10 ⁻³	7.33	21.5163	0.3888	50	1.011	-3.18x10 ⁻³	7.33	22.6050	0.3701
	60	1.155	-3.6x10 ⁻³	8.796	23.7493	0.3522	60	1.11	-3.18x10 ⁻³	8.796	24.7226	0.3384
	70	1.248	-3.6x10 ⁻³	10.26	25.6508	0.3264	70	1.206	-3.18x10 ⁻³	10.26	26.4955	0.3157
	80	1.34	-3.6x10 ⁻³	11.73	27.2896	0.3065	80	1.306	-3.18x10 ⁻³	11.73	28.0015	0.2988
	90	1.433	-3.6x10 ⁻³	13.19	28.7164	0.2913	90	1.405	-3.18x10 ⁻³	13.19	29.2967	0.2855
	100	1.526	-3.6x10 ⁻³	14.66	29.9700	0.2791	100	1.503	-3.18x10 ⁻³	14.65	30.4225	0.2750
1600	14.5	0.859	-3.6x10 ⁻³	2.43	8.8214	0.9483	14.85	0.847	-3.18x10 ⁻³	2.488	9.1602	0.9133
	20	0.916	-3.6x10 ⁻³	3.35	11.4127	0.7330	20	0.898	-3.18x10 ⁻³	3.35	11.6433	0.7185
	30	1.019	-3.6x10 ⁻³	5.03	15.3842	0.5438	30	0.996	-3.18x10 ⁻³	5.03	15.7459	0.5313
	40	1.122	-3.6x10 ⁻³	6.702	18.6247	0.4492	40	1.094	-3.18x10 ⁻³	6.702	19.1132	0.4377
	50	1.226	-3.6x10 ⁻³	8.38	21.3190	0.3924	50	1.192	-3.18x10 ⁻³	8.38	21.9265	0.3815
	60	1.329	-3.6x10 ⁻³	10.05	23.5946	0.3546	60	1.290	-3.18x10 ⁻³	10.05	24.3125	0.3441
	70	1.432	-3.6x10 ⁻³	11.73	25.5420	0.3275	70	1.388	-3.18x10 ⁻³	11.73	26.3614	0.3173
	80	1.536	-3.6x10 ⁻³	13.4	27.2274	0.3072	80	1.486	-3.18x10 ⁻³	13.4	28.1400	0.2973
	90	1.639	-3.6x10 ⁻³	15.08	28.7004	0.2915	90	1.584	-3.18x10 ⁻³	15.08	29.6954	0.2817
	100	1.742	-3.6x10 ⁻³	16.76	29.9987	0.2789	100	1.682	-3.18x10 ⁻³	16.76	31.0752	0.2692
1800	16.45	1.047	-3.6x10 ⁻³	3.1	9.2407	0.9053	16.95	0.988	-3.18x10 ⁻³	3.195	10.0789	0.8330
	20.1	1.088	-3.6x10 ⁻³	3.789	10.8593	0.7704	20	1.024	-3.18x10 ⁻³	3.770	11.4843	0.7284
	30	1.2011	-3.6x10 ⁻³	5.65	14.6850	0.5697	30	1.139	-3.18x10 ⁻³	5.65	15.4835	0.5403
	40	1.315	-3.6x10 ⁻³	7.54	17.8827	0.4678	40.05	1.255	-3.18x10 ⁻³	7.549	18.7626	0.4459
	50.1	1.430	-3.6x10 ⁻³	9.44	20.5950	0.4062	50	1.37	-3.18x10 ⁻³	9.425	21.4628	0.3898
	60	1.534	-3.6x10 ⁻³	11.31	22.8608	0.3659	60	1.485	-3.18x10 ⁻³	11.31	23.7563	0.3521
	70	1.657	-3.6x10 ⁻³	13.19	24.8362	0.3368	70.05	1.6	-3.18x10 ⁻³	13.24	25.7285	0.3251
	80.05	1.772	-3.6x10 ⁻³	15.09	26.5653	0.3149	80.05	1.716	-3.18x10 ⁻³	15.09	27.4266	0.3050
	90	1.885	-3.6x10 ⁻³	16.96	28.0701	0.2980	90	1.831	-3.18x10 ⁻³	16.96	28.9041	0.2894
	100	1.999	-3.6x10 ⁻³	18.85	29.4105	0.2844	100	1.946	-3.18x10 ⁻³	18.85	30.2135	0.2769

2000	18.85	1.28	-3.6x10 ³	3.95	9.6202	0.8696	19	1.2025	-3.18x10 ³	3.98	10.3223	0.8104
	20.05	1.2954	-3.6x10 ³	4.2	10.1113	0.8273	20	1.215	-3.18x10 ³	4.19	10.7536	0.7779
	30	1.4227	-3.6x10 ³	6.28	13.7754	0.6073	29.95	1.339	-3.18x10 ³	6.27	14.6060	0.5727
	40.05	1.5513	-3.6x10 ³	8.39	16.8659	0.4960	40.05	1.466	-3.18x10 ³	8.39	17.8469	0.4687
	50	1.679	-3.6x10 ³	10.47	19.4591	0.4299	50	1.59	-3.18x10 ³	10.47	20.5358	0.4074
	60	1.8065	-3.6x10 ³	12.57	21.6972	0.3865	60	1.716	-3.18x10 ³	12.57	22.8448	0.3662
	70	1.9344	-3.6x10 ³	14.66	23.6392	0.3539	70	1.84	-3.18x10 ³	14.66	24.8398	0.3358
	80	2.062	-3.6x10 ³	16.76	25.3403	0.3301	80	1.966	-3.18x10 ³	16.76	26.5807	0.3147
	90	2.1903	-3.6x10 ³	18.85	26.8426	0.3117	90	2.09	-3.18x10 ³	18.85	28.1131	0.2976
	100	2.3183	-3.6x10 ³	20.94	28.1791	0.2969	100.5	2.217	-3.18x10 ³	20.95	29.4789	0.2838
2200	21.05	1.545	-3.6x10 ³	4.85	9.782	0.8546	21.2	1.4817	-3.18x10 ³	4.88	10.2812	0.8137
	30	1.671	-3.6x10 ³	6.91	12.9023	0.6484	30.05	1.506	-3.18x10 ³	6.932	13.4430	0.6223
	40	1.811	-3.6x10 ³	9.21	15.8699	0.5271	40.05	1.747	-3.18x10 ³	9.23	16.4731	0.5078
	50	1.952	-3.6x10 ³	11.52	18.4105	0.4544	50	1.887	-3.18x10 ³	11.52	19.0395	0.4394
	60	2.092	-3.6x10 ³	13.82	20.6102	0.4059	60	2.028	-3.18x10 ³	13.82	21.2616	0.3935
	70	2.232	-3.6x10 ³	16.13	22.533	0.3713	70	2.169	-3.18x10 ³	16.13	23.1952	0.3607
	80	2.373	-3.6x10 ³	18.43	24.2288	0.3453	80	2.309	-3.18x10 ³	18.43	24.8931	0.3361
	90	2.513	-3.6x10 ³	20.73	25.7350	0.3251	90	2.45	-3.18x10 ³	20.73	26.3960	0.3169
	100	2.653	-3.6x10 ³	23.04	27.8017	0.3089	100.05	2.591	-3.18x10 ³	23.05	27.7418	0.3016
2400	23.25	1.906	-3.6x10 ³	5.84	9.56	0.875	23.45	1.874	-3.18x10 ³	5.89	9.81	0.8528
	30	2.0108	-3.6x10 ³	7.54	11.69	0.7152	30	1.97	-3.18x10 ³	7.54	11.94	0.7007
	40	2.17	-3.6x10 ³	10.05	14.47	0.577	40	2.116	-3.18x10 ³	10.05	14.82	0.5645
	50	2.32	-3.6x10 ³	12.57	16.89	0.496	50	2.26	-3.18x10 ³	12.57	17.32	0.483
	60	2.475	-3.6x10 ³	15.08	19.00	0.44	60.05	2.409	-3.18x10 ³	15.09	19.54	0.428
	70	2.63	-3.6x10 ³	17.59	20.86	0.401	70	2.554	-3.18x10 ³	17.59	21.48	0.39
	80	2.785	-3.6x10 ³	20.11	22.52	0.37	80	2.701	-3.18x10 ³	20.11	23.22	0.36
	90	2.939	-3.6x10 ³	22.6	24.00	0.348	90	2.847	-3.18x10 ³	22.6	24.78	0.33
	100	3.094	-3.6x10 ³	25.13	25.33	0.33	100	2.99	-3.18x10 ³	25.13	26.19	0.319
2600	25.4	2.335	-3.6x10 ³	6.916	9.23	0.954	25.7	2.22	-3.18x10 ³	6.997	9.84	0.8504
	30	2.412	-3.6x10 ³	8.168	10.56	0.7920	30	2.28	-3.18x10 ³	8.168	11.14	0.7511
	40	2.508	-3.6x10 ³	10.89	13.17	0.6534	40	2.44	-3.18x10 ³	10.89	13.88	0.6027
	50	2.748	-3.6x10 ³	13.61	15.45	0.5414	50	2.607	-3.18x10 ³	13.61	16.28	0.4137
	60	2.9165	-3.6x10 ³	16.33	17.47	0.4788	60	2.767	-3.18x10 ³	16.33	18.41	0.4544
	70.05	3.085	-3.6x10 ³	19.07	19.29	0.4339	70	2.927	-3.18x10 ³	19.07	20.31	0.4120
	80	3.253	-3.6x10 ³	21.78	20.89	0.4005	80	3.087	-3.18x10 ³	21.78	22.00	0.3802
	90	3.42	-3.6x10 ³	24.50	22.34	0.3744	90	3.247	-3.18x10 ³	24.50	23.53	0.3555
	100	3.589	-3.6x10 ³	27.22	23.66	0.3535	100	3.407	-3.18x10 ³	27.22	24.92	0.3357
2800	27.65	2.6802	-3.6x10 ³	8.107	9.43	0.866	27.85	2.52	-3.18x10 ³	8.166	10.08	0.830
	30.1	2.726	-3.6x10 ³	8.826	10.09	0.828	30	2.567	-3.18x10 ³	8.79	10.69	0.7827
	40	2.911	-3.6x10 ³	11.73	12.56	0.665	40.05	2.573	-3.18x10 ³	11.74	13.30	0.6288
	50	3.097	-3.6x10 ³	14.66	14.76	0.567	50	2.937	-3.18x10 ³	14.66	15.57	0.5374
	60	3.284	-3.6x10 ³	17.59	16.71	0.5006	60	3.122	-3.18x10 ³	17.59	17.57	0.4760
	70	3.471	-3.6x10 ³	20.52	18.44	0.463	70	3.308	-3.18x10 ³	20.52	19.35	0.4322
	80	3.657	-3.6x10 ³	23.46	20.00	0.418	80	3.493	-3.18x10 ³	23.46	20.94	0.3994
	90	3.844	-3.6x10 ³	26.39	21.41	0.3907	90	3.678	-3.18x10 ³	26.39	22.37	0.3738
	100	4.03	-3.6x10 ³	29.32	22.69	0.3687	100	3.863	-3.18x10 ³	29.32	23.67	0.3534

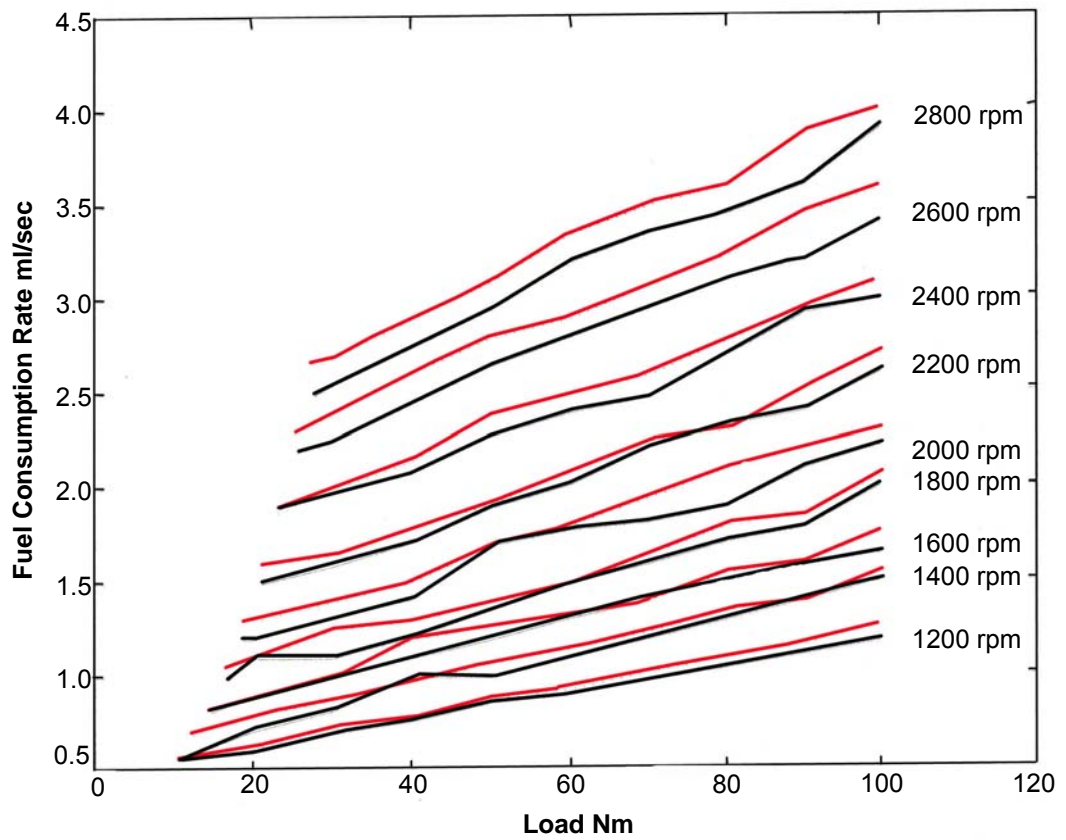


Figure 6: Average Fuel Consumption vs Load

FIGURE 7 - PERFORMANCE CURVES, 1200 rpm

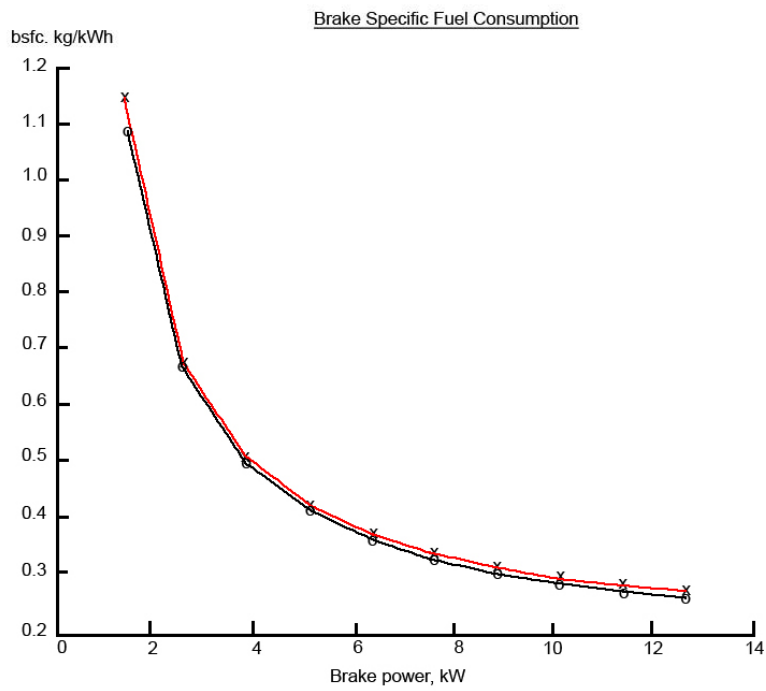
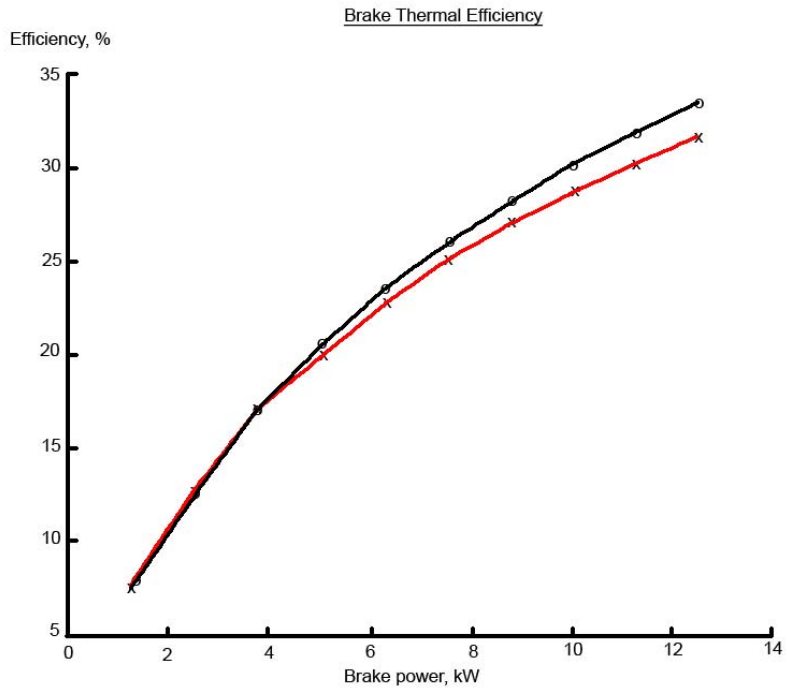


FIGURE 8 - PERFORMANCE CURVES, 1400 rpm

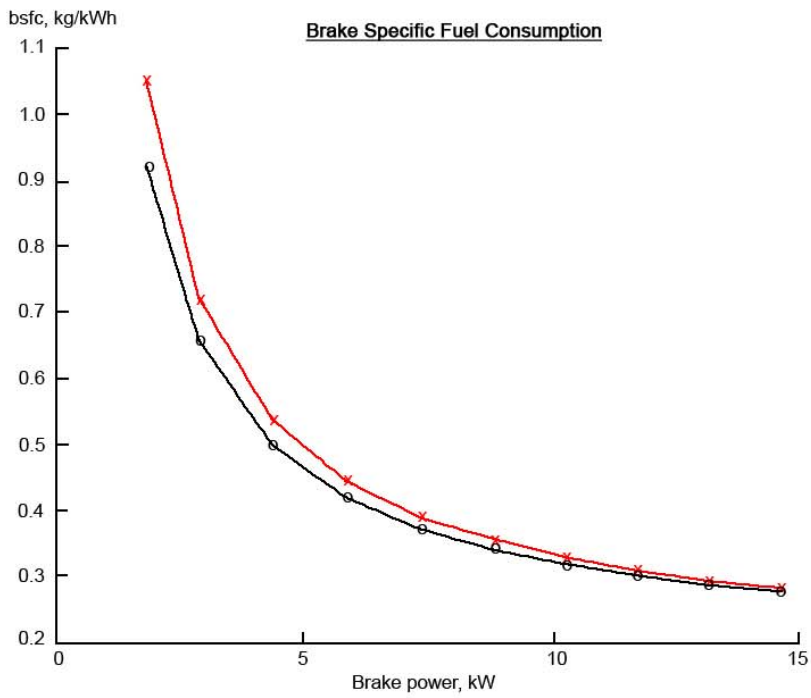
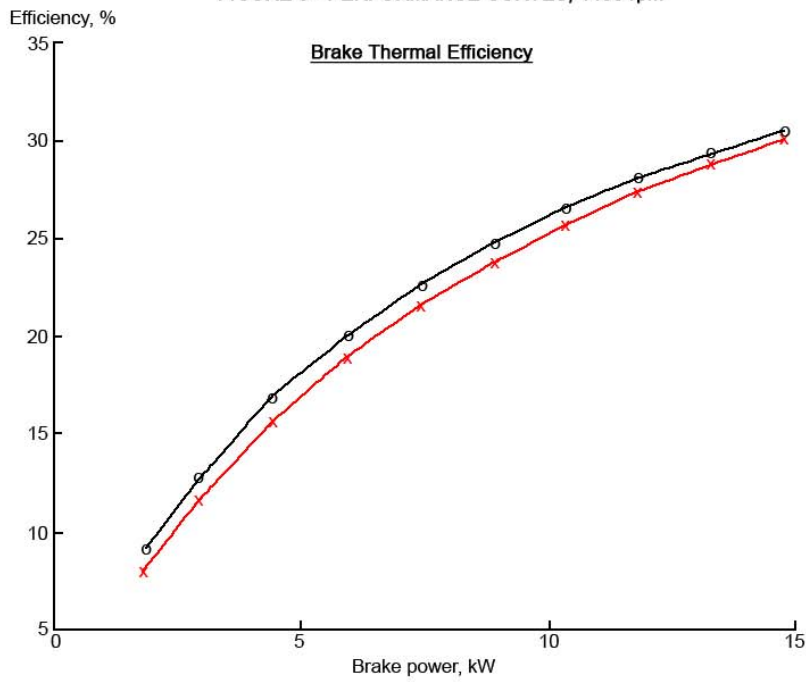


FIGURE 9 - PERFORMANCE CURVES, 1600 rpm

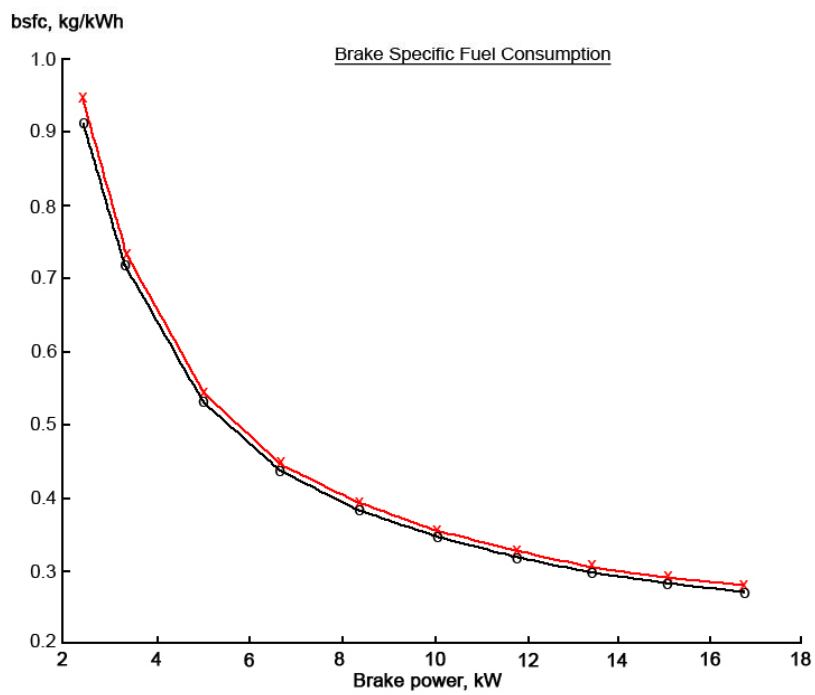
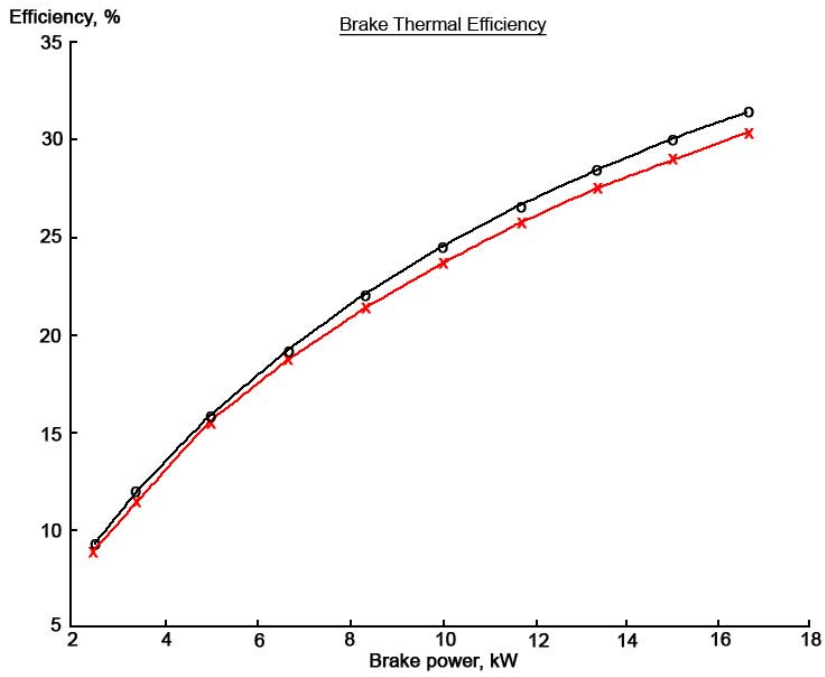


FIGURE 10 - PERFORMANCE CURVES, 1800 rpm

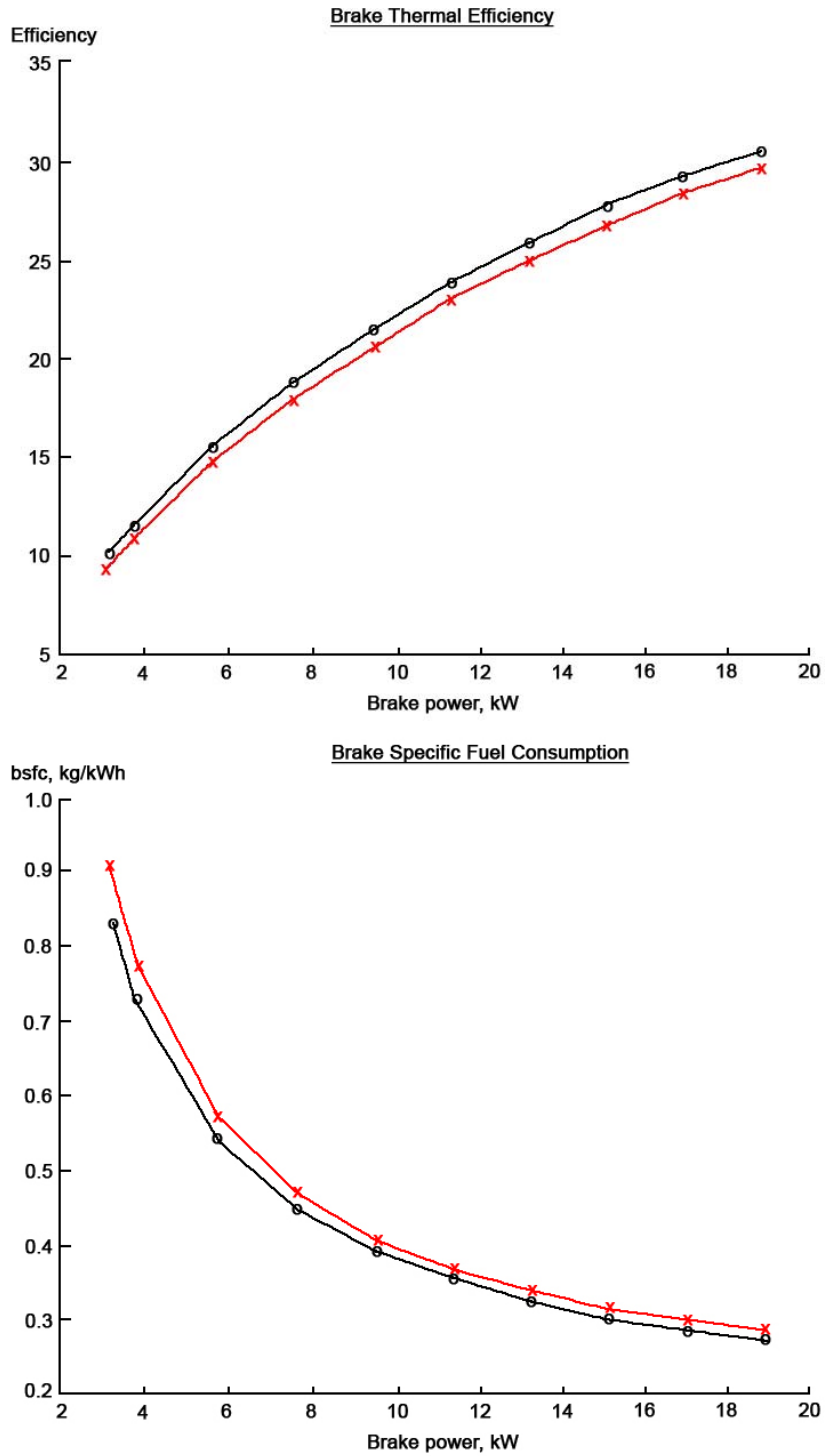


FIGURE 11 - PERFORMANCE CURVES, 2000 rpm

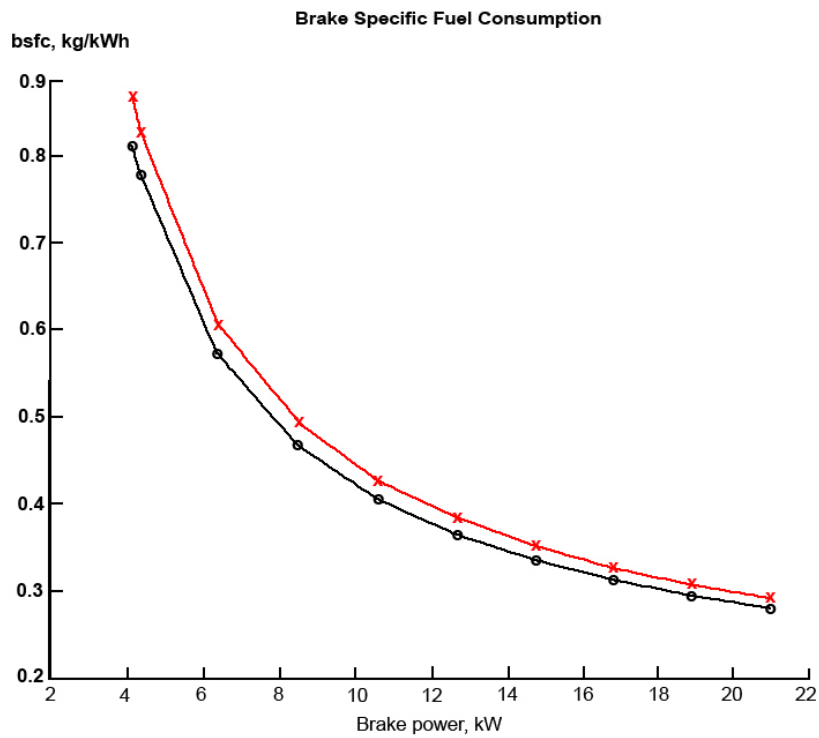
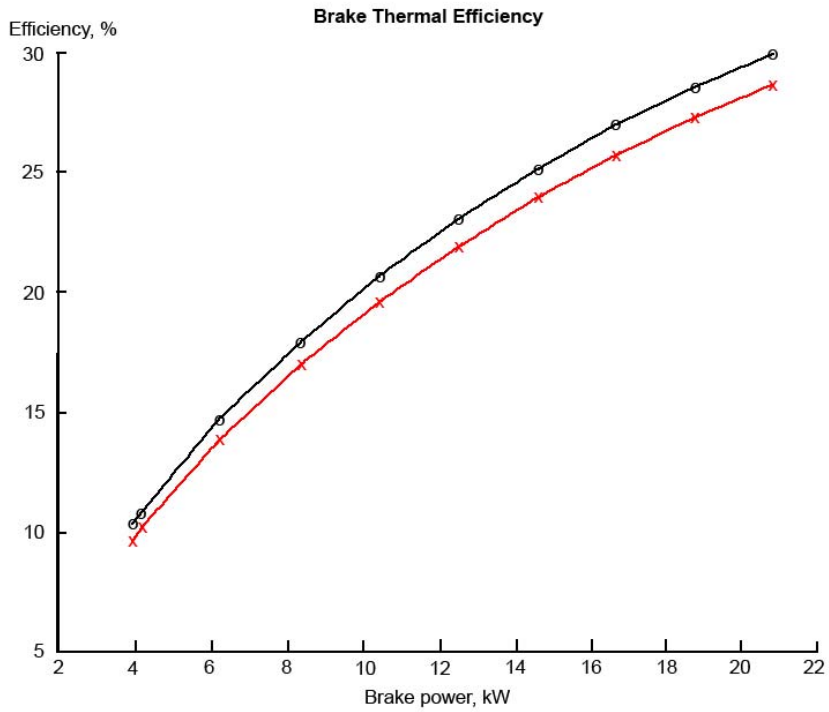


FIGURE 12 - PERFORMANCE CURVE, 2200 rpm

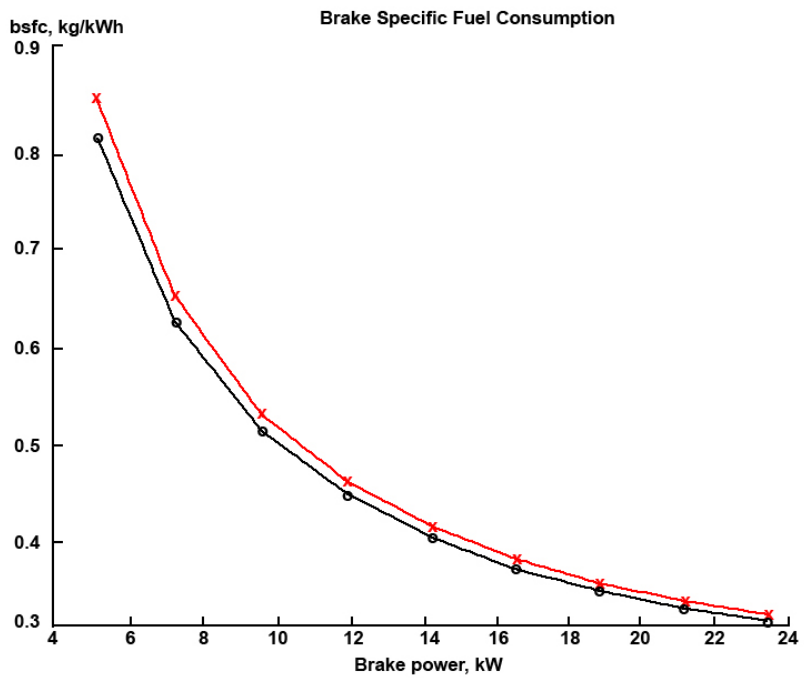
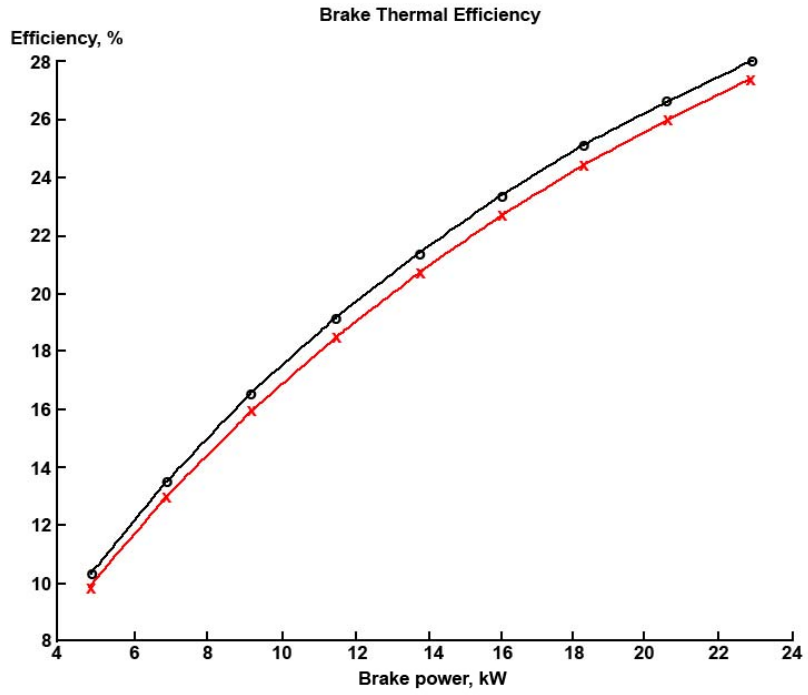


FIGURE 13 - PERFORMANCE CURVE, 2400 rpm

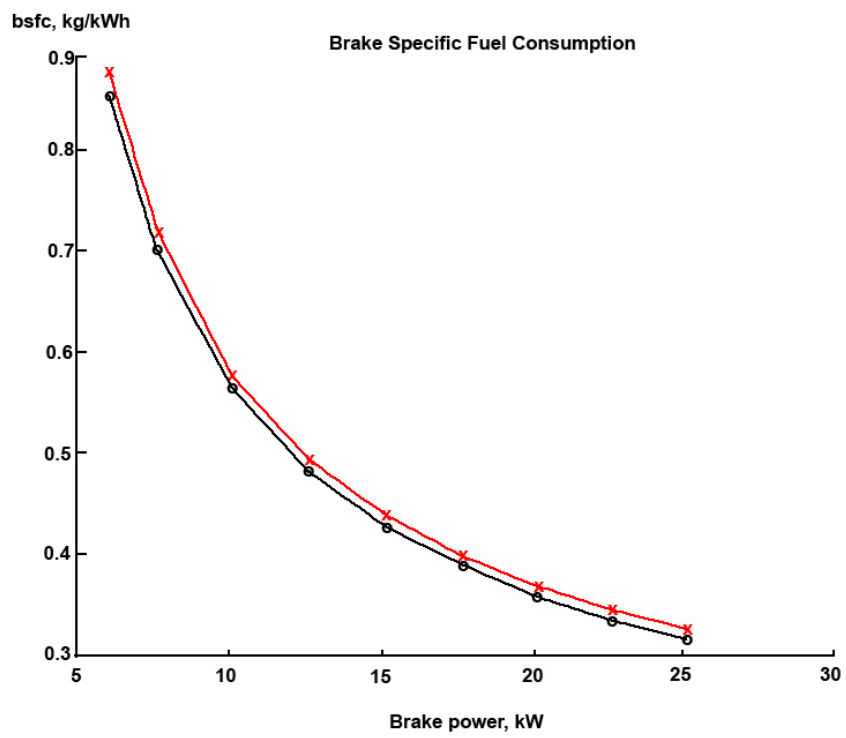
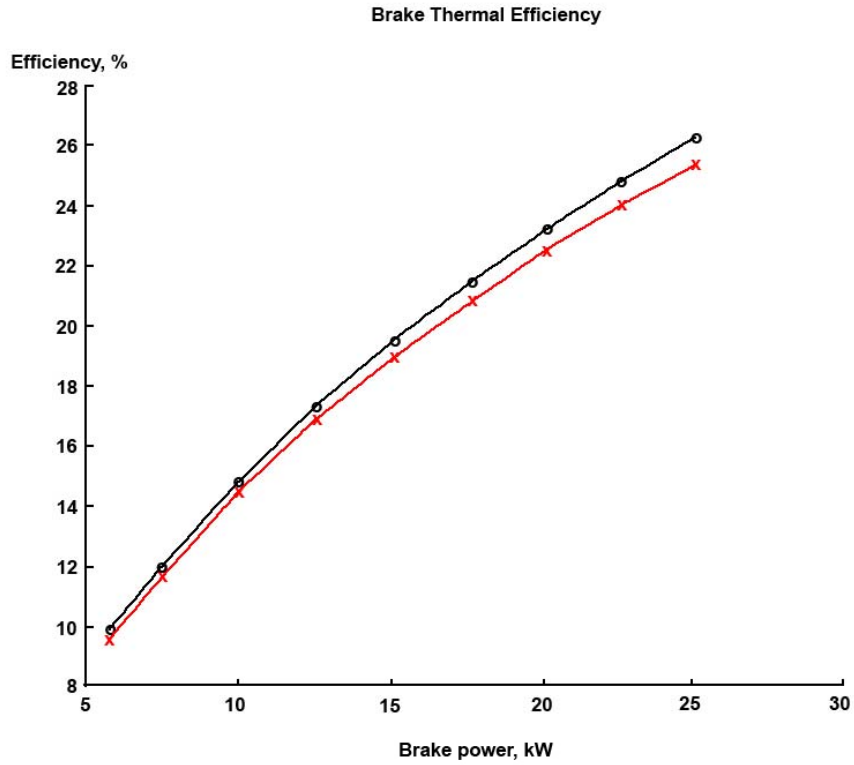


FIGURE 14 - PERFORMANCE CURVE, 2600 rpm

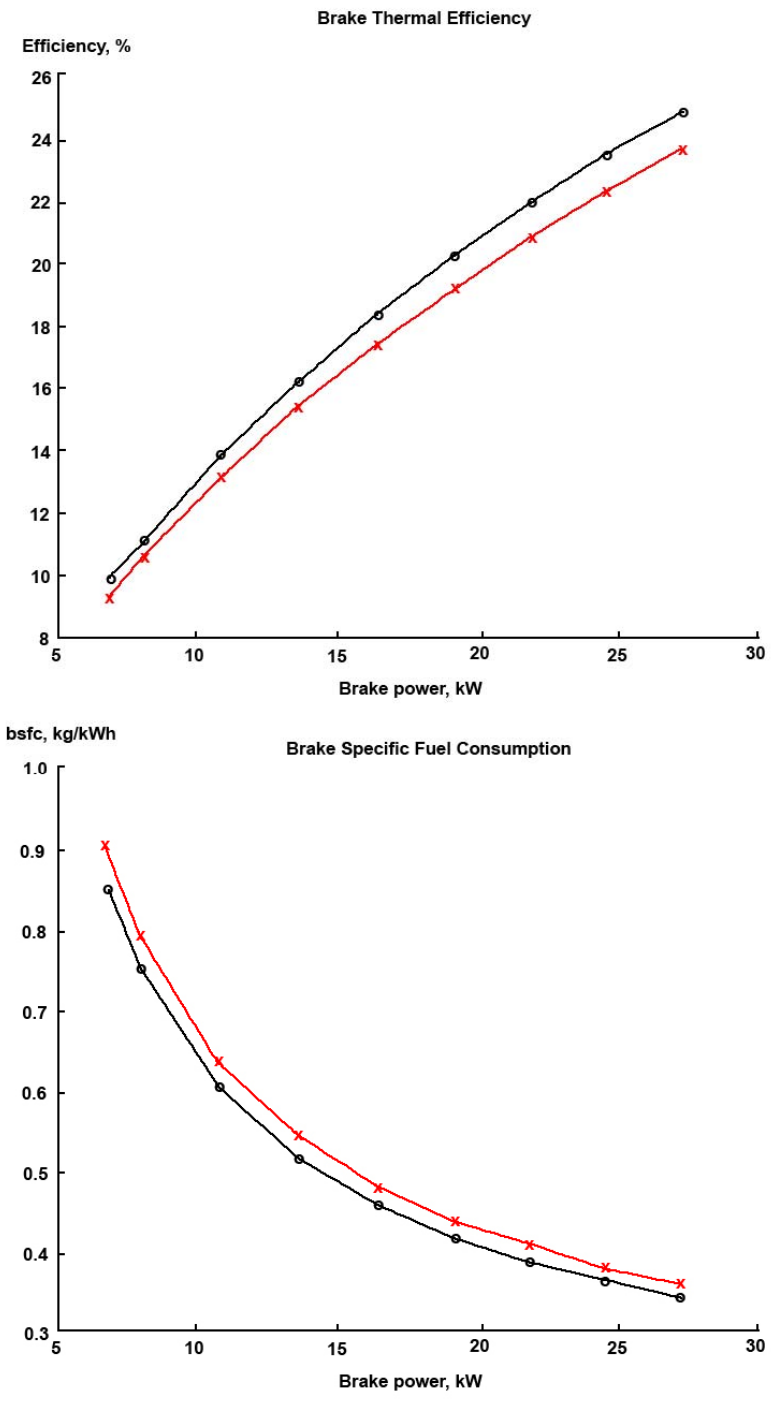
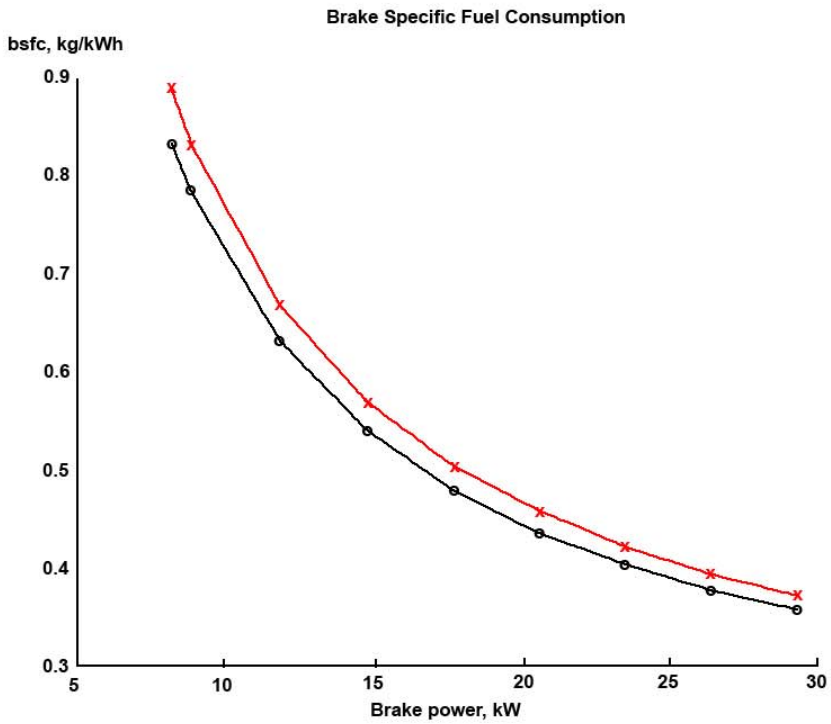
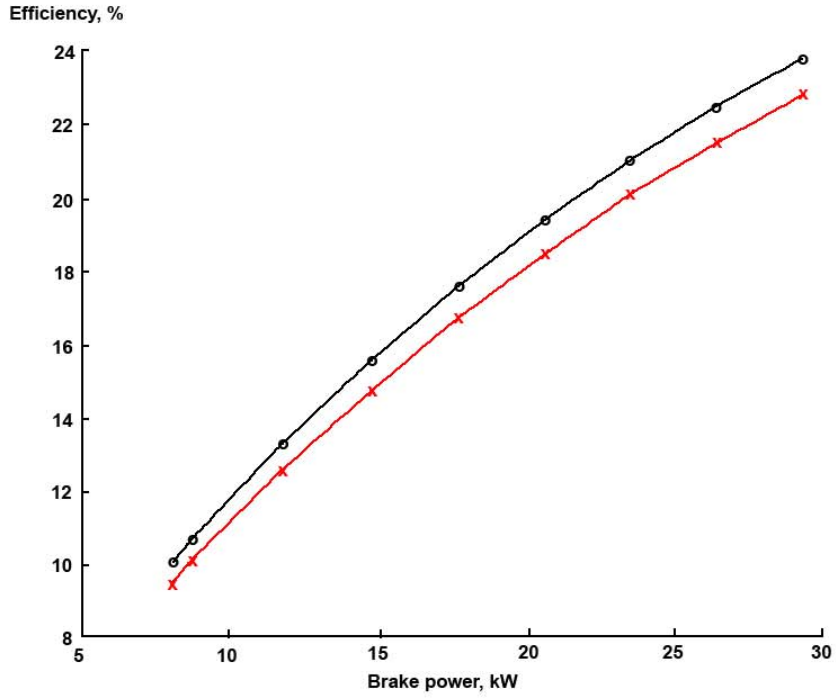


FIGURE 15 - PERFORMANCE CURVES, 2800 rpm
 Brake Thermal Efficiency



CONCLUSIONS

An investigation of the use of the permanent magnets N410A supplied by Magno-Flo Ltd in diesel engines has been carried out. The approach taken is bench engine testing based on the Perkins T4.236 diesel engine. It has been shown that the use of the magnets improves the engine performance and saves fuel at all speeds and loads. The improvements are particularly more apparent at high speed and load. The results obtained in this study are conservative since factors such as the exact locations where the magnets are mounted, are not considered. To obtain the maximum benefit of the devices, the company should be fully consulted, since there are various designs of diesel engines available.