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Engine Characteristics Performance

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1 Introduction

This report covers a 1.6 Litre inline 4 (I4) Honda VTEC (Variable Valve Timing Electronic Control) D16 being assessed on the SCHENCK W230 dynamometer (dyno). The experimental procedure describes what equipment is used during the test and how it is carried out. This test aims to gather data that is then placed into an Excel spreadsheet. This raw data is then used to calculate Specific Fuel Consumption (SFC), Torque, Brake Power, Brake Mean Effective Pressure (BMEP) and Mechanical and Thermal Efficiency. These variables are then placed into graphs. Analysis is carried out and a conclusion is met. An evaluation is conducted, which will outline methods where the test can be improved.

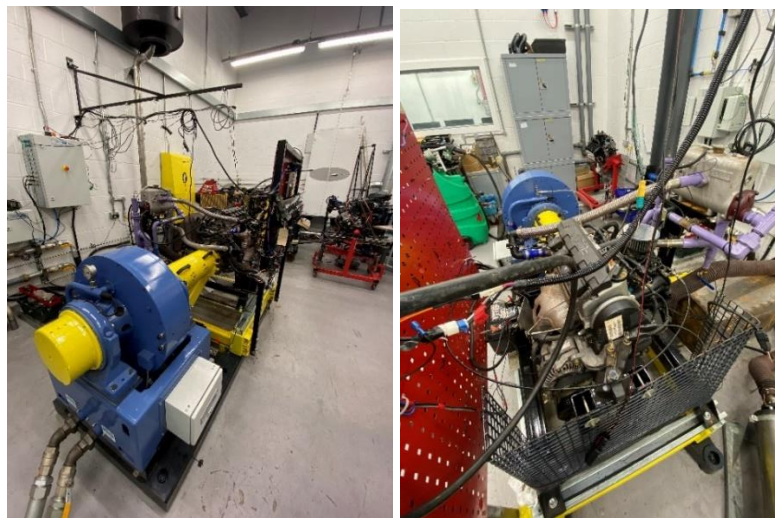


Figure 1 Shows the engine and dyno that was used to conduct the tests.

1.1 Aims

- Conduct a test on a 1.6L I4 Honda VTEC D16 engine using the SCHENCK W230 dyno.
- Gather data on the test to analyse the engine's performance.
- Analyse the data and graphs produced to show an understanding of the engine operations.

1.2 Objectives

- Explain the equipment and the experimental procedures used to complete the test.
- Using the equipment, gather the following variables; Load, Dyno speed, Fuel Flow rate and Lambda.
- Calculate Power, Torque, SFC, BMEP, Corrected Power, Engine Efficiency using the data collected in the test.
- Produce graphs plotting the variables listed against engine speed.

2 Experimental Procedure

The SCHENCK W230 is an Eddie current dyno, this means a current is supplied to the outer casing of the dyno which then produces an electromagnetic field. The core of the dyno is attached to the engine, this rotates when the engine is in use. As current is passed through the outer case of the dyno which then applies a load to the core, this load will slow the engine down. When the load is applied the outer casing it produces a reaction force, this force is measured using a strain gauge. The sensor will send signals to the control cell between 0-10 volts. To ensure the data being collected is correct, the system needs to be calibrated using the calibration arms.

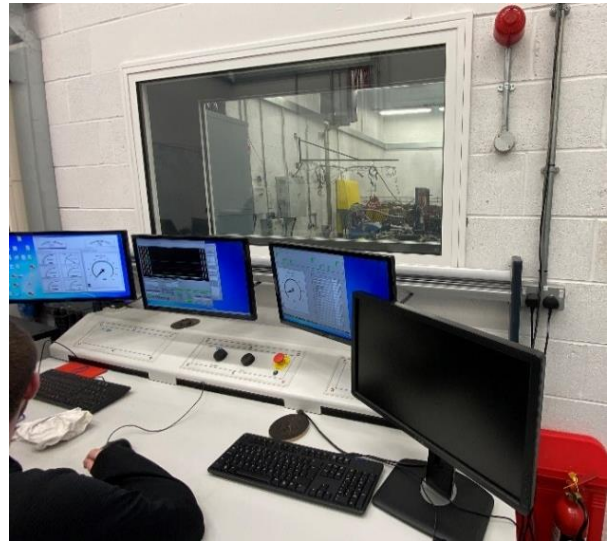


Figure 2 Shows the engine during testing from the control room.

2.1 Calibrating the Dynamometer

1. Place the calibration arms on both sides of the dyno, these arms are manufactured to precisely 815.776mm.
2. A weight is then placed on the arm, this will move the outer casing causing the strain gauge to send a signal.
3. Torque is calculated using data plotted by placing weights on the calibration arms.

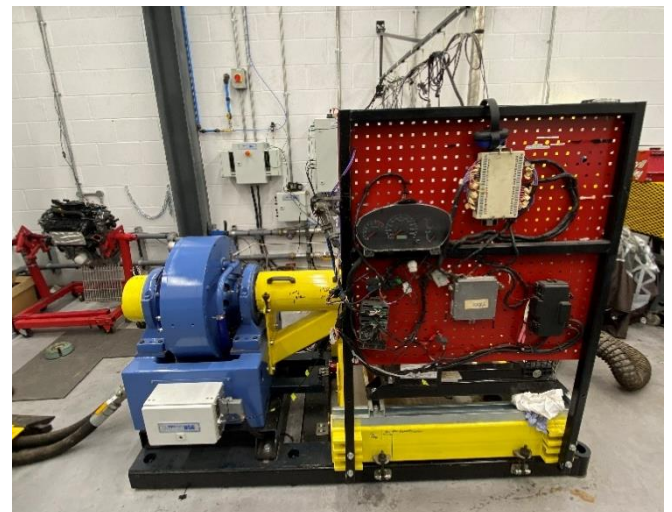


Figure 3 Shows the dyno set up with the engine instruments.

2.2 Testing

When testing all operations are carried out in the control room. When beginning the test throttle was increased before torque to prevent the engine from stalling. When throttle was being applied so was torque, this provided a force for the engine to overcome. As the throttle is opening it increases the amount of fuel and air entering the engine. This allowed the engine to complete more revolutions per minute (RPM). The data collected allowed for analysis into what the engine was doing at certain RPM's. Fuel flow rate was collected using a fuel flow metre at each specific RPM as well as Lambda using an oxygen sensor in the exhaust. Additionally, the atmospheric pressure, humidity and the ambient temperature was noted for later calculations.

3 Data

3.1 Raw Data

Table 1 Shows the data collected from the engine dynamometer test.

Load (Newtons)	Dyno Speed (rpm)	Fuel Flow Rate (l/min)	Lambda (Lambda)
102.275	1000	0.0704	1.27
102.756	1050	0.0724	1.27
103.689	1100	0.0737	1.27
104.209	1150	0.0728	1.28
105.811	1200	0.0744	1.29
107.51	1250	0.07895	1.30
109.488	1300	0.079	1.30
111.797	1350	0.0796	1.29
114.268	1400	0.0835	1.29
115.783	1450	0.0847	1.28
116.985	1500	0.08865	1.28
117.788	1550	0.0932	1.28
118.471	1600	0.0959	1.28
118.772	1650	0.09875	1.29
118.656	1700	0.10005	1.30
118.861	1750	0.10305	1.31
119.584	1800	0.1093	1.31
119.934	1850	0.11415	1.32
120.176	1900	0.11745	1.32
120.948	1950	0.12055	1.31
122.157	2000	0.12555	1.32
122.845	2050	0.12785	1.32
123.796	2100	0.1309	1.32
124.794	2150	0.13435	1.32
125.137	2200	0.1377	1.32
126.028	2250	0.14105	1.30
126.66	2300	0.14495	1.30
126.822	2350	0.14985	1.28
126.69	2400	0.1537	1.27
126.552	2450	0.15565	1.27
126.438	2500	0.1596	1.27
126.239	2550	0.1626	1.28
126.161	2600	0.16805	1.28
125.847	2650	0.17145	1.28
124.911	2700	0.17465	1.28
123.927	2750	0.1784	1.28
123.689	2800	0.18005	1.27
123.389	2850	0.1831	1.26
122.519	2900	0.1879	1.25

121.837	2950	0.19255	1.24
121.709	3000	0.199	1.23
121.123	3050	0.20605	1.22
121.124	3100	0.21005	1.21
120.851	3150	0.21605	1.19
120.596	3200	0.21795	1.18
120.84	3250	0.22305	1.17
121.633	3300	0.2255	1.16
122.181	3350	0.2285	1.15
122.933	3400	0.2342	1.14
123.475	3450	0.23605	1.13
123.428	3500	0.24195	1.12
124.205	3550	0.24545	1.11
124.066	3600	0.25505	1.10
123.967	3650	0.25755	1.09
123.815	3700	0.26445	1.10
123.767	3750	0.2651	1.10
123.509	3800	0.2693	1.10
122.672	3850	0.27375	1.11
122.157	3900	0.2759	1.12
121.184	3950	0.28285	1.12
120.004	4000	0.28455	1.12
118.734	4050	0.2871	1.12
117.442	4100	0.28895	1.12
116.5	4150	0.29305	1.12
115.931	4200	0.2949	1.12
115.034	4250	0.29715	1.12
114.391	4300	0.3022	1.12
114.016	4350	0.30605	1.12
113.871	4400	0.3092	1.12
113.985	4450	0.3099	1.12
113.306	4500	0.31445	1.12
113.074	4550	0.3171	1.11
112.195	4600	0.3194	1.11
111.061	4650	0.32055	1.10
109.973	4700	0.3207	1.10
108.654	4750	0.32485	1.09
107.076	4800	0.32455	1.08
105.24	4850	0.3257	1.08
103.632	4900	0.3277	1.08
102.335	4950	0.32845	1.09
101.106	5000	0.3287	1.09
99.3149	5050	0.32985	1.09
97.5815	5100	0.3297	1.09
95.8486	5150	0.33095	1.09
94.8033	5200	0.3338	1.09

93.0976	5250	0.3313	1.09
91.7886	5300	0.3324	1.08
90.5938	5350	0.3308	1.08
89.6374	5400	0.3388	1.08
88.9256	5450	0.3438	1.08
88.6474	5500	0.3488	1.08

3.2 Results

Table 2 Shows the data calculated from the raw data.

Torque (N/m)	Power (Kw)	Power (Watts)	SFC (kg/kWh)	BMEP (KPa)	Thermal Efficiency (%)	Corrected Power (Watts)	Corrected Power (Kw)	Fuel Flow kg/sec	Engine Efficiency (%)
83.43	8.74	8737.13	0.36	659.76	21.81	8791.86	8.79	0.00088	21.81
83.83	9.22	9217.14	0.35	662.86	22.38	9274.87	9.27	0.00091	22.38
84.59	9.74	9743.72	0.34	668.88	23.24	9804.76	9.80	0.00092	23.24
85.01	10.24	10237.70	0.32	672.23	24.72	10301.83	10.30	0.00091	24.72
86.32	10.85	10847.05	0.31	682.57	25.63	10914.99	10.91	0.00093	25.63
87.70	11.48	11480.44	0.31	693.53	25.56	11552.35	11.55	0.00099	25.56
89.32	12.16	12159.32	0.29	706.29	27.05	12235.49	12.24	0.00099	27.05
91.20	12.89	12893.28	0.28	721.18	28.47	12974.04	12.97	0.00100	28.47
93.22	13.67	13666.34	0.27	737.12	28.77	13751.94	13.75	0.00104	28.77
94.45	14.34	14342.09	0.26	746.89	29.76	14431.92	14.43	0.00106	29.76
95.43	14.99	14990.67	0.26	754.65	29.72	15084.57	15.08	0.00111	29.72
96.09	15.60	15596.68	0.27	759.83	29.41	15694.38	15.69	0.00117	29.41
96.65	16.19	16193.16	0.26	764.23	29.68	16294.59	16.29	0.00120	29.68
96.89	16.74	16741.62	0.26	766.17	29.80	16846.49	16.85	0.00123	29.80
96.80	17.23	17232.10	0.26	765.43	30.27	17340.04	17.34	0.00125	30.27
96.96	17.77	17769.57	0.26	766.75	30.31	17880.88	17.88	0.00129	30.31
97.55	18.39	18388.45	0.27	771.41	29.57	18503.63	18.50	0.00137	29.57
97.84	18.95	18954.55	0.27	773.67	29.19	19073.28	19.07	0.00143	29.19
98.04	19.51	19506.12	0.27	775.23	29.19	19628.30	19.63	0.00147	29.19
98.67	20.15	20148.04	0.27	780.21	29.38	20274.25	20.27	0.00151	29.38
99.65	20.87	20871.22	0.27	788.01	29.22	21001.96	21.00	0.00157	29.22
100.21	21.51	21513.49	0.27	792.45	29.58	21648.25	21.65	0.00160	29.58
100.99	22.21	22208.82	0.26	798.58	29.82	22347.93	22.35	0.00164	29.82
101.80	22.92	22920.90	0.26	805.02	29.99	23064.48	23.06	0.00168	29.99
102.08	23.52	23518.41	0.26	807.23	30.02	23665.73	23.67	0.00172	30.02
102.81	24.22	24224.18	0.26	812.98	30.19	24375.92	24.38	0.00176	30.19
103.33	24.89	24886.67	0.26	817.06	30.18	25042.56	25.04	0.00181	30.18
103.46	25.46	25460.21	0.26	818.10	29.86	25619.69	25.62	0.00187	29.86
103.35	25.97	25974.85	0.26	817.25	29.70	26137.56	26.14	0.00192	29.70
103.24	26.49	26487.11	0.26	816.36	29.91	26653.03	26.65	0.00195	29.91
103.15	27.00	27003.32	0.26	815.63	29.74	27172.46	27.17	0.00200	29.74
102.98	27.50	27500.04	0.26	814.34	29.73	27672.29	27.67	0.00203	29.73
102.92	28.02	28021.93	0.27	813.84	29.31	28197.45	28.20	0.00210	29.31

102.66	28.49	28489.73	0.27	811.81	29.21	28668.18	28.67	0.00214	29.21
101.90	28.81	28811.38	0.27	805.78	29.00	28991.85	28.99	0.00218	29.00
101.10	29.11	29113.75	0.27	799.43	28.68	29296.12	29.30	0.00223	28.68
100.90	29.59	29586.16	0.27	797.89	28.88	29771.49	29.77	0.00225	28.88
100.66	30.04	30041.45	0.27	795.96	28.84	30229.62	30.23	0.00229	28.84
99.95	30.35	30352.96	0.28	790.35	28.39	30543.08	30.54	0.00235	28.39
99.39	30.70	30704.41	0.28	785.95	28.03	30896.74	30.90	0.00241	28.03
99.29	31.19	31192.02	0.29	785.12	27.55	31387.40	31.39	0.00249	27.55
98.81	31.56	31559.20	0.29	781.34	26.92	31756.88	31.76	0.00258	26.92
98.81	32.08	32076.83	0.29	781.35	26.84	32277.75	32.28	0.00263	26.84
98.59	32.52	32520.73	0.30	779.59	26.46	32724.44	32.72	0.00270	26.46
98.38	32.97	32967.23	0.30	777.94	26.59	33173.73	33.17	0.00272	26.59
98.58	33.55	33550.08	0.30	779.51	26.44	33760.24	33.76	0.00279	26.44
99.23	34.29	34289.80	0.29	784.63	26.73	34504.58	34.50	0.00282	26.73
99.67	34.97	34966.17	0.29	788.17	26.90	35185.19	35.19	0.00286	26.90
100.29	35.71	35706.47	0.29	793.02	26.80	35930.13	35.93	0.00293	26.80
100.73	36.39	36391.31	0.29	796.51	27.10	36619.26	36.62	0.00295	27.10
100.69	36.90	36904.67	0.29	796.21	26.81	37135.83	37.14	0.00302	26.81
101.32	37.67	37667.52	0.29	801.22	26.97	37903.46	37.90	0.00307	26.97
101.21	38.16	38155.30	0.30	800.32	26.29	38394.29	38.39	0.00319	26.29
101.13	38.65	38654.36	0.30	799.69	26.38	38896.49	38.90	0.00322	26.38
101.01	39.14	39135.83	0.30	798.71	26.01	39380.97	39.38	0.00331	26.01
100.97	39.65	39649.31	0.30	798.40	26.29	39897.67	39.90	0.00331	26.29
100.76	40.09	40094.22	0.30	796.73	26.17	40345.36	40.35	0.00337	26.17
100.07	40.35	40346.49	0.30	791.33	25.91	40599.21	40.60	0.00342	25.91
99.65	40.70	40698.88	0.30	788.01	25.93	40953.82	40.95	0.00345	25.93
98.86	40.89	40892.34	0.31	781.73	25.41	41148.48	41.15	0.00354	25.41
97.90	41.01	41006.74	0.31	774.12	25.33	41263.60	41.26	0.00356	25.33
96.86	41.08	41079.93	0.31	765.93	25.15	41337.25	41.34	0.00359	25.15
95.81	41.13	41134.56	0.31	757.59	25.02	41392.22	41.39	0.00361	25.02
95.04	41.30	41302.24	0.32	751.52	24.77	41560.95	41.56	0.00366	24.77
94.57	41.60	41595.70	0.32	747.85	24.79	41856.25	41.86	0.00369	24.79
93.84	41.77	41765.21	0.32	742.06	24.70	42026.82	42.03	0.00371	24.70
93.32	42.02	42020.37	0.32	737.91	24.44	42283.58	42.28	0.00378	24.44
93.01	42.37	42369.62	0.32	735.49	24.33	42635.02	42.64	0.00383	24.33
92.89	42.80	42802.13	0.32	734.56	24.33	43070.23	43.07	0.00387	24.33
92.99	43.33	43331.85	0.32	735.29	24.58	43603.28	43.60	0.00387	24.58
92.43	43.56	43557.70	0.32	730.91	24.35	43830.54	43.83	0.00393	24.35
92.24	43.95	43951.50	0.32	729.42	24.36	44226.80	44.23	0.00396	24.36
91.53	44.09	44089.06	0.32	723.75	24.26	44365.23	44.37	0.00399	24.26
90.60	44.12	44117.82	0.32	716.43	24.19	44394.17	44.39	0.00401	24.19
89.71	44.16	44155.36	0.32	709.41	24.20	44431.95	44.43	0.00401	24.20
88.64	44.09	44089.88	0.33	700.91	23.86	44366.05	44.37	0.00406	23.86
87.35	43.91	43906.91	0.33	690.73	23.78	44181.94	44.18	0.00406	23.78
85.85	43.60	43603.58	0.33	678.88	23.53	43876.70	43.88	0.00407	23.53
84.54	43.38	43380.00	0.34	668.51	23.27	43651.72	43.65	0.00410	23.27

83.48	43.27	43274.19	0.34	660.14	23.16	43545.25	43.55	0.00411	23.16
82.48	43.19	43186.35	0.34	652.21	23.09	43456.86	43.46	0.00411	23.09
81.02	42.85	42845.51	0.34	640.66	22.83	43113.89	43.11	0.00412	22.83
79.60	42.51	42514.51	0.35	629.48	22.66	42780.82	42.78	0.00412	22.66
78.19	42.17	42168.93	0.35	618.30	22.40	42433.07	42.43	0.00414	22.40
77.34	42.11	42113.99	0.35	611.56	22.18	42377.78	42.38	0.00417	22.18
75.95	41.75	41753.93	0.35	600.55	22.15	42015.47	42.02	0.00414	22.15
74.88	41.56	41558.91	0.36	592.11	21.98	41819.23	41.82	0.00416	21.98
73.90	41.40	41404.91	0.36	584.40	22.00	41664.26	41.66	0.00414	22.00
73.12	41.35	41350.67	0.37	578.23	21.45	41609.68	41.61	0.00424	21.45
72.54	41.40	41402.15	0.37	573.64	21.17	41661.48	41.66	0.00430	21.17
72.32	41.65	41651.27	0.37	571.85	20.99	41912.17	41.91	0.00436	20.99

Table 3 Shows values used to calculate the variables in Table 2 (CRX_Workshop_Manual.VTec 1.6 2020-10-27 12_57_06.).

CV Petrol kJ/Kg	Bar (Bar)	Humidity (%)	Ambient Temp (Deg C)	Calibration Arm Length (m)	Stroke (m)	Area (m^2)
45800	1.0189	46	27	0.815776	0.09	0.004414

4 Results

4.1 Specific Fuel Consumption vs Engine Speed

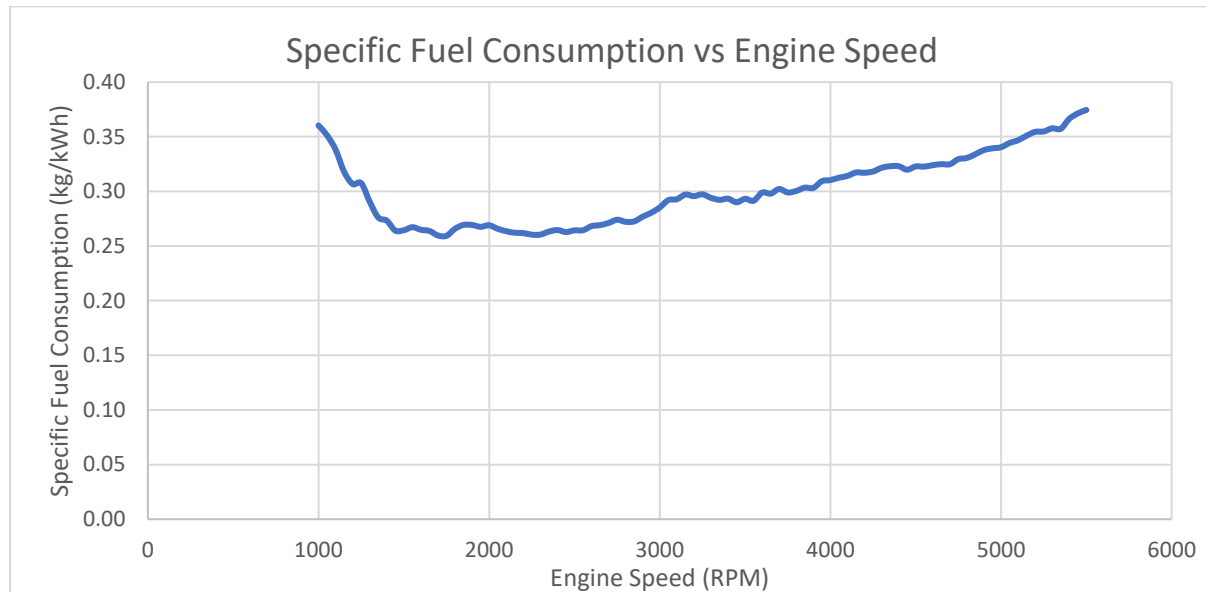


Figure 4 Shows SFC plotted against Engine speed. The plotted data shows that fuel consumption is high when idling and at 5500RPM. The graph shows that as the engine speed increases so does SFC.

Equation 1 Was used to calculate the SFC in Table 2. Fuel rate was converted to kg using 0.75 which is the weight for 1 litre of fuel. Then multiplied by 60 to convert to hours giving kg per hour.

$$S.F.C = \frac{\text{Fuel Flow Rate } (l/min) \times 0.75 \times 60}{\text{Corrected Power (Kw)}}$$

In Figure 4 SFC is decreasing in the low RPM range before slowly increasing towards the higher RPM range, this shows that as RPM increase so does the fuel consumption. engine idles at 1000RPM, the SFC at this point is high, this could be due to engine attempting to get to operating temperature. Figure 4 displays a steady increase from 2000-5500RPM, this shows that the engine requires more fuel to complete larger RPM's. Power is being produced from 2000-4700RPM before decreasing, the SFC is constantly increasing regardless of if power is being produced towards the latter stages of the test. This indicates that mechanical limitations have disallowed the engine to produce more power.

Comparing SFC to other sources shows that the results calculated for this engine are standard.

Typical petrol engines SFC values can range from 298 (g/kWh) at 2500RPM from 304 (g/kWh) at 5000RPM (John Fenton 1986).

Equation 2 Was used to calculate the percentage difference between values from (John Fenton 1986) to check the accuracy of the SFC results provided in this assignment (Díez, Czernia 2024).

$$\text{Percentage Difference (\%)} = 100 \times \frac{(A - B)}{\frac{A + B}{2}}$$

Table 1 Shows the percentage difference between values gathered from research and values calculated from the engine dyno test. The percentage difference is small, this difference can be put down to different engines with different fuelling characteristics. Figures provided by (John Fenton 1986).

Engine Speed (RPM)	SFC Results (1.6l Honda VTEC D16) (g/kWh)	SFC Results - Gasoline Engine Analysis (g/kWh)	Percentage Difference (%)
2500	260	298	13.62
5000	340	304	11.18

4.2 Torque vs Engine Speed

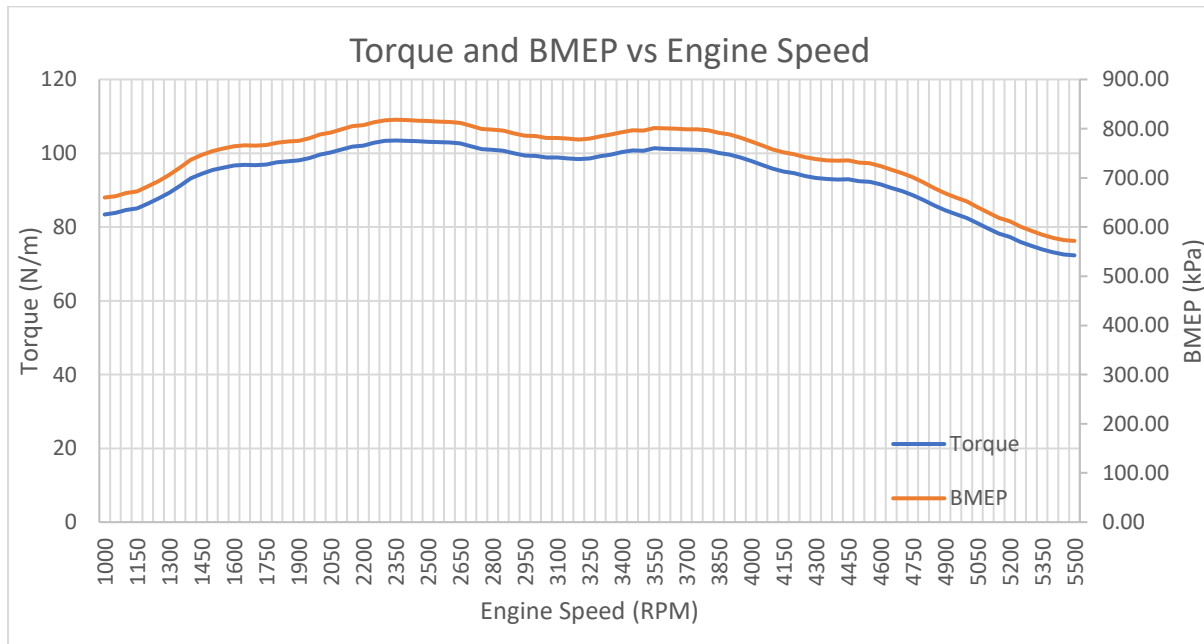


Figure 5 Shows a graph of torque and BMEP plotted against engine speed. BMEP and Torque have been overlayed with one another to show that both variables are proportional with one another. The curve shows that in the low RPM region there is gentle increase in torque before gradually decreasing as the engine goes through the RPM range.

Equation 3 Was used to calculate the torque using the engine load and the calibration arm length.

$$\text{Torque} = \text{Load (N)} \times 0.815776 \text{ (Calibration arm length)}$$

Equation 4 Was used to calculate BMEP. This equation was rearranged for BMEP. Equation 3

$$\text{BMEP} = \frac{4\pi \times \text{Torque}}{\text{Stroke (m)} \times \text{Bore Area (m}^2\text{)} \times \text{Number of cylinders}}$$

Torque is the force acting on the crankshaft. BMEP is the pressure in the combustion chamber acting on the piston to produce a revolution which produces torque (Sundar 2018). In Figure 5 torque is not consistent, this means that the brake power will increase in response to engine speed shown in Figure 7. Towards the end of the test torque begins to decrease. This is because the engine is unable to allow more air into the combustion chamber (Ran When Parked 2024).

If volumetric efficiency were to be increased this would lead to a larger BMEP and torque (John Fenton 1986). Volumetric efficiency indicates the amount of air and fuel enters the combustion chamber. VTEC was produced by Honda to increase volumetric efficiency. When the engine is running the Electronic Control Unit (ECU) can calculate what camshaft lobes are needed to adjust the amount of air is entering the combustion chamber. At low RPM it adjusts the cam so that there is a lower lift for a shorter duration, this improves fuel consumption. This is shown in Figure 4 between 1000-3000RPM. This allows the engine to optimise power in the low and high RPM's whilst improving fuel efficiency (howstuffworks 2000).

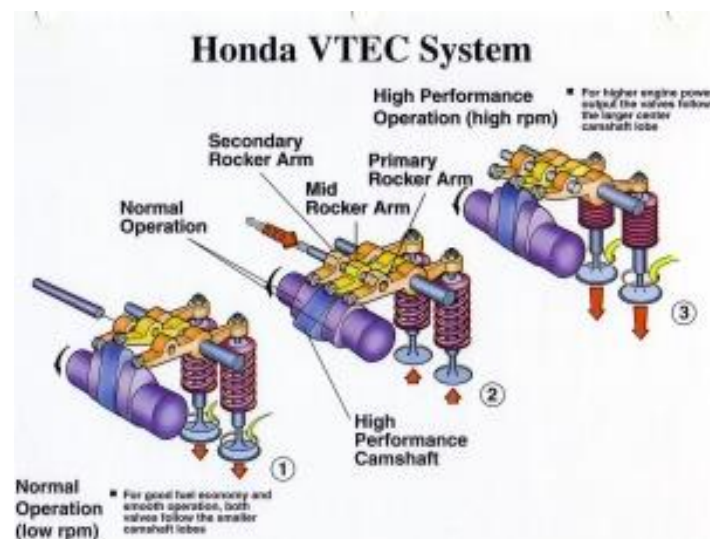


Figure 6 Shows an annotated diagram of how VTEC works (Isabella Mason 2014).

4.3 Brake Power vs Engine Speed

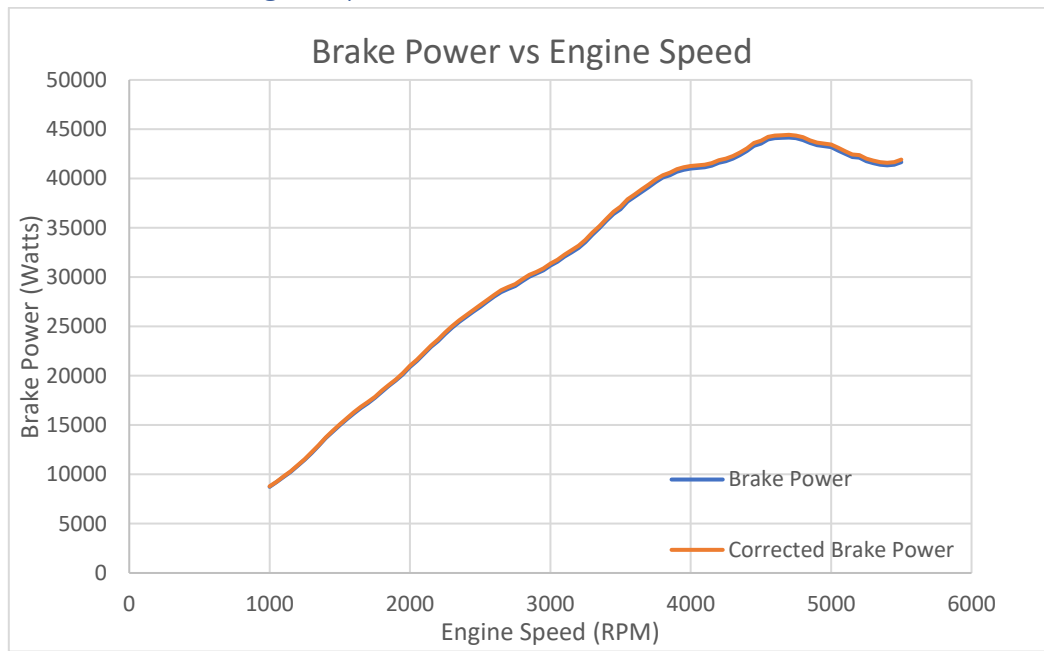


Figure 7 Shows the corrected power curve and calculated brake power curve of the engine. These two variables have been placed on the same graph to show accuracy of the data and calculations made. Corrected brake power is more accurate as the pressure and local temperatures were considered into the calculations for corrected power.

Equation 5 Was used to calculate the Power produced by the engine.

$$Power (Watts) = \frac{2\pi \times Dyno Speed (RPM) \times Torque(N/m)}{60}$$

Equation 6 Was used to calculate the corrected power. This equation accounts for the atmospheric pressure and temperature at the time of testing, this added information allows for more accurate results.

$$Corrected Power (Watts) = Power \left(\frac{1.01325}{1.0189} \right) \times \sqrt{\frac{27 + 273}{293}}$$

Figure 7 shows that the power increases steadily until it reaches 4700RPM, from there power decreases. In Figure 5 the torque curve had been steadily decreasing from 4000RPM. Figure 5 shows at high RPM the values for BMEP and torque decrease, this is related to the decrease in brake power in the high RPM. This means that BMEP was decreasing whilst frictional forces were increasing. As the engine reaches high RPM's, the engine temperature begins to increase. This causes the oil to become less viscous which hinders the lubrication of the pistons. VTEC allows the engine to reach high RPM's however this causes internal components to wear, therefore RPM limiters are used to protect the engine.

4.4 Efficiency vs Engine Speed

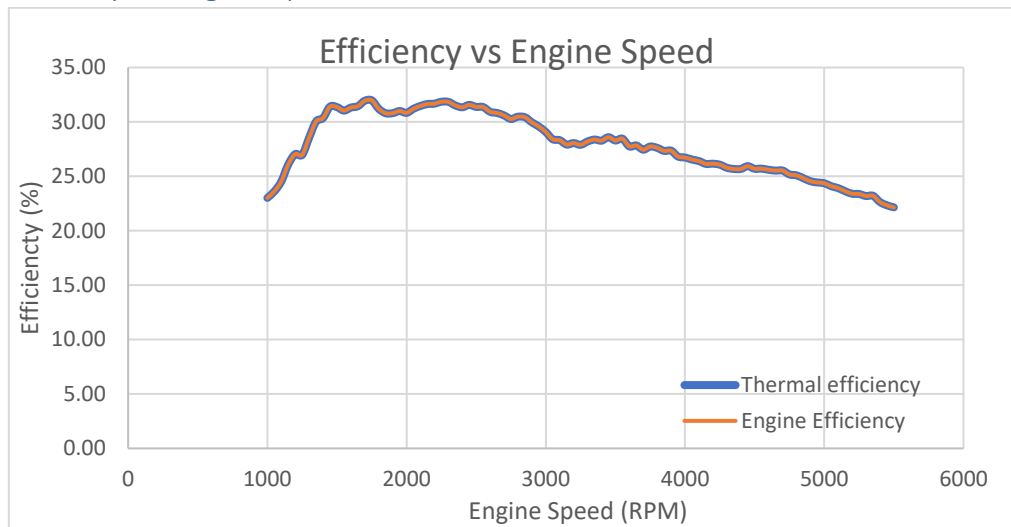


Figure 8 Shows the thermal and engine efficiency plotted against engine speed. This graph shows the relation between thermal and engine efficiency. This graph shows where the engine is most efficient when running through the RPM range.

Equation 7 Was used to calculate the thermal efficiency of the engine throughout testing.

$$\text{Thermal Efficiency (\%)} = \left(\frac{\text{Corrected Power (kw)}}{\text{BMEP}} \times \text{Calorific Value} \right) \times 100$$

Equation 8 Was used to calculate the engines efficiency throughout the test.

$$\text{Engine Efficiency (\%)} = \frac{\text{Corrected Power (kw)}}{\text{SFC (kg/sec)} \times \text{Calorific Value}} \times 100$$

The air and fuel charge are compressed prior to being ignited in the combustion chamber (known as compression ratio). The precompression determines the efficiency of the combustion process. The compression prior to ignition allows temperatures of air and fuel charge to increase, this results in an increase in internal energy. If temperatures increase this can cause the engine oil to thin leading to increased friction. This means as the engine speed rises friction increases causing a decline in efficiency (Hongyu Mu, Yinyan Wang et al. 2022).

Thermal and Mechanical efficiency is measured by the amount of useful work against the internal energy performed by the engine (M.J.Nunney 1975). The engines efficiency is standard for average automotive engines. Figure 8 shows that the engine is most efficient at 1750RPM. Between 1000-2000RPM the engine has high thermal efficiency but as the RPM increase the efficiency decreases.

To increase the thermal efficiency a high compression ratio can be used. Increasing Mechanical efficiency can include, using a synthetic oil which decreases engine wear whilst being longer lasting compared with other oils. One option is to use forced induction. It allows for increased volumetric efficiency thus increasing the BMEP, torque and power of the engine.

4.5 Corrected Power and Torque Graph

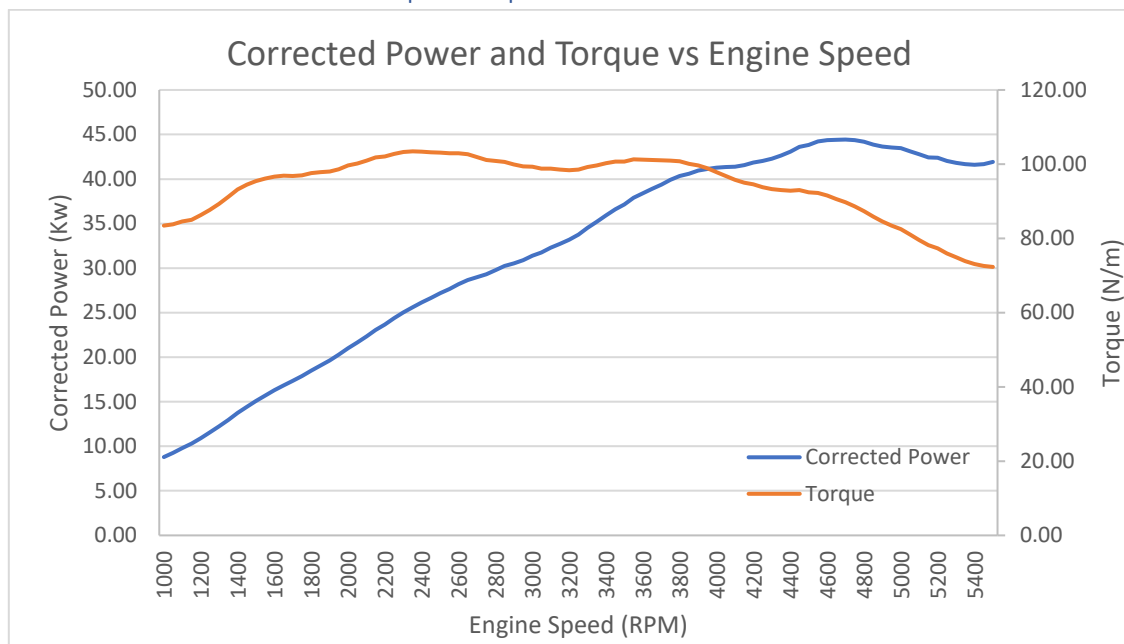


Figure 9 Shows a graph overlaying Torque and Power to show the relation between one another. The graph shows when torque is being produced in relation to power. Power increases sharply when there is a high torque value. When torque begins to decrease this leads to power peaking and then decreasing.

5 Conclusion

Overall, the testing was completed gathering the results required to calculate torque, SFC, BMEP, thermal and mechanical efficiency. Using these values made from the calculation's graphs were produced indicating what was occurring with variables listed at certain points during the test.

SFC has been calculated to show the amount of fuel used as the engine increases speed. SFC is steadily increasing with the RPM, this shows that fuel consumption increases with the rate of work the engine completes. SFC data shows that the engine performs as a typical petrol engine should.

Torque and BMEP were overlayed onto the same graph to show that they are proportional to one another. The torque curve produced shows that it is not consistent, it is undulating throughout the test before steadily decreasing at high RPM due to mechanical limitations. The reason the curve appears to undulate whilst being relatively smooth is due to VTEC as it provides an efficient operation when switching between the high and low range camshafts. This technology also allows for no spikes or sudden drops in torque which has been shown in Figure 5. Towards the latter stages of the test the engine is still able to deliver more power despite torque decreasing. The power curve shows that there is consistent delivery of power from 1000-4000RPM before reaching its peak output at 4700RPM.

The efficiency of this engine was standard, it was at its most efficient between 1500-2700RPM.

Finally, the test shows that at high RPM the engine reaches its mechanical limitations. It shows that when an engine is running at high RPM the overall efficiency drops. Due to VTEC it allows the engine to provide a smooth operation whilst increasing power.

6 Evaluation

When testing the group should have retained the same members on specific controls to ensure consistent results. When testing the engine, the group could use a program which will be able to carry out sequences to ensure there is consistency when torque and throttle is applied. This will provide consistent results which can produce accurate figures.

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