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Engine Performance Characteristics

Powertrain technology (ACHA4029)

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1.Introduction

The aim of this assignment is to evaluate the performance characteristics of a Honda 1.6 litre VTEC petrol engine using an engine dynamometer. Engine dynamometer testing is a globally used method for assessing the brake performance of the ICE (internal combustion engine). It allows important data to be recorded such as torque, brake power, fuel consumption and efficiency all under controlled conditions (Stone, 2012).

The main purpose of this test was to determine how the ICE responds across a range of revolutions. To achieve this raw dynamometer data was used to calculate torque, brake power, brake mean effective pressure (BMEP), brake specific fuel consumption (BSFC) and overall thermal efficiency. Parameters like these are commonly used in ICE analysis because they provide how effectively an engine converts the chemical energy of fuel into useful mechanical output (Heywood, 2018).

Torque and brake power are the two of the most important factors of engine output. Torque shows the turning force produced by the engine, while brake power shows the rate at which work is delivered at the crankshaft. BMEP relates engine torque to engine size this makes it useful for comparing performance independently of displacement (Stone, 2012). BSFC and thermal efficiency are equally just as important as they show how economically an engine and efficiently an engine can run how the fuel is burnt (Heywood, 2018).

All data was processed in a excel spreadsheet and used to plot graphs of torque against engine speed, brake power against engine speed, and specific fuel consumption against engine speed. These graphs allow main operating characteristics of the ICE to be identified this includes at what revolutions most torque is generated, point of maximum brake power, and the region where the engine operates efficiently.

The overall objective was therefore to use the dynamometer test data to assess the brake performance and fuel use characteristics of the Honda engine, and to explain the trends shown by using accepted engine theory.



1 *Figure 1 Image of Honda D16 VTEC Engine connected to Dynamometer (UWTSD, 2020)*

2. Equipment and Method

2.1 Equipment

The engine under test was a Honda motor company 1.6 4-cylinder VTEC petrol engine as seen in figure 1 above, the engine code of D16 commonly found in civics and across other cars in Hondas line up. The engine was produced from 1986 to 2007 (MotorReviewer, 2026).

Testing was carried out using a Schenck WS230 engine dynamometer which can take a maximum output of 230 kW (SCHENCK, 2001), the engine was directly connected to the dynamometer from the crankshaft, which means engine speed and dynamometer speed is equal throughout the test, this simplified the analysis as there is no gearbox or final drive ratio conversion was needed.

The test data available from the dynamometer consisted of load (N), dyno speed (rpm), fuel flow rate (L/min) and lambda. In addition to this ambient test conditions recorded were 1018.9 mbar barometric pressure, 46% humidity and an ambient temperature of 27°C these values are important as they can influence engine behaviour.

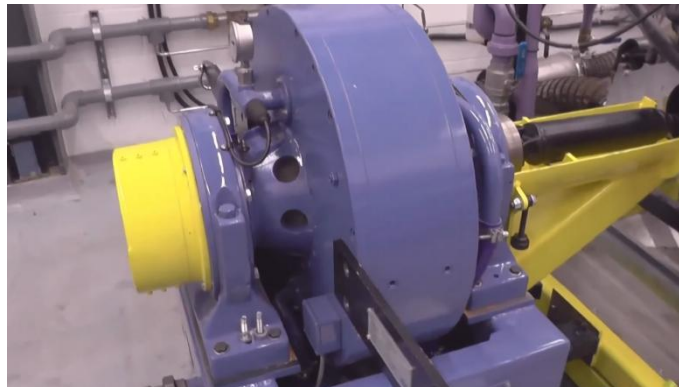


Figure 2 Schenck WS230 connected to D16 Honda Engine (UWTSD, 2020)

The distance from the dynamometer pivot centre to the hook eye was given as 815.776mm, which is the same as 0.815776m. This value was used as the effective moment arm in torque calculation.

2.2 Method

The D16 was run on the dynamometer over a measured speed range from approximately 1000rpm to 5500rpm. The load, engine speed, fuel flow rate and lambda values were recorded and given in a excel spreadsheet for analysis, because the engine was directly coupled to the dynamometer, the recorded dyno speed was used directly as engine speed for all calculation and graphs.

3.Raw Data

Table 1 Excel Table containing data gathered and processed

							Baro	Humidity	Ambient temp	
							mBar	%	Deg C	
							1018.9	46	27	
Load	Dyno Speed	Fuel Flow Rate	Lambda	Torque	Brake Power (kW)		BMEP	Fuel Mass Flow	BSFC	Thermal efficiency
Newtons	rpm	l/min								
102.28	1000	0.0704	1.2658	83.4334904	8.737126985		6.552851013	3.12576	357.7560456	22.86982507
102.76	1050	0.0724	1.26783	83.82587866	9.217128638		6.583669114	3.21456	348.7593725	23.45978009
103.89	1100	0.0737	1.27344	84.59699766	9.743714064		6.643447261	3.27228	335.8349782	24.36261472
104.21	1150	0.0728	1.28476	85.01120118	10.23769597		6.678764128	3.23232	315.7272894	25.91419385
105.81	1200	0.0744	1.29181	86.31807434	10.84703957		6.779405705	3.30338	304.5402369	26.86613193
107.51	1250	0.07895	1.29729	87.70407776	11.48042682		6.88826216	3.50538	305.3353378	26.79617184
109.49	1300	0.079	1.29895	89.31768269	12.1593129		7.014994394	3.5076	288.4702473	28.36278007
111.8	1350	0.0796	1.29469	91.20130947	12.89327001		7.162934096	3.53424	274.1151001	29.8481119
114.27	1400	0.0835	1.2855	93.21709197	13.66632742		7.321253283	3.7074	271.2799047	30.16005992
115.78	1450	0.0847	1.27818	94.45299261	14.34207403		7.418320692	3.76068	262.2131214	31.20293194
116.99	1500	0.08865	1.2795	95.43355536	14.99065461		7.495333911	3.93606	262.5675864	31.16080813
117.79	1550	0.0932	1.27766	96.08862349	15.5966708		7.546782841	4.13808	265.3181602	30.83776164
118.47	1600	0.0959	1.28235	96.6457985	16.19314469		7.590543284	4.25796	262.9483081	31.11569054
118.77	1650	0.09875	1.29028	96.89134707	16.74100818		7.609828604	4.3845	261.8924033	31.24114361
118.86	1700	0.10005	1.29942	96.79671706	17.23208328		7.60239638	4.44222	257.7877514	31.73858392
118.86	1750	0.10305	1.31053	96.96395114	17.76956647		7.615530914	4.57542	257.4864492	31.77572337
119.58	1800	0.1093	1.3149	97.55375718	18.38843381		7.661854172	4.85292	263.9115462	31.00212286
119.93	1850	0.11415	1.31849	97.83927878	18.95453813		7.684278987	5.06826	267.3903191	30.59878237
120.18	1900	0.11745	1.31892	98.06696958	19.50610264		7.699784144	5.21478	267.3409494	30.60443303
120.95	1950	0.12055	1.31484	98.66647565	20.14802412		7.749246876	5.35242	265.6548338	30.79867787
122.16	2000	0.12555	1.31653	99.65274883	20.87120452		7.826708591	5.57442	267.0866544	30.6357275
122.85	2050	0.12785	1.32098	100.2140027	21.51347198		7.870789368	5.67654	263.8597807	31.00820504
123.8	2100	0.1309	1.32287	100.9698057	22.20879865		7.931720792	5.81196	261.6962805	31.26455663
124.79	2150	0.13435	1.32164	101.8039501	22.92088197		7.995663547	5.95514	260.2491478	31.43840528
125.14	2200	0.1377	1.31652	102.0837613	23.51838955		8.017639865	6.11388	259.9616776	31.47317042
126.03	2250	0.14105	1.30465	102.8106177	24.22415976		8.074727034	6.26262	258.5278525	31.64772423
126.66	2300	0.14495	1.29646	103.3261882	24.88665225		8.115219841	6.43578	258.6036858	31.6384438
126.82	2350	0.14985	1.28229	103.4583439	25.46018879		8.125599327	6.65334	261.3232783	31.30918239
126.69	2400	0.1537	1.27304	103.3506614	25.97483141		8.117141968	6.82428	262.726633	31.14194434
126.55	2450	0.15565	1.26984	103.2380844	26.4870906		8.108300184	6.91086	260.9142735	31.35826213
126.44	2500	0.1596	1.27446	103.1450859	27.00329655		8.100996102	7.08624	262.4212932	31.17817949
126.24	2550	0.1626	1.27876	102.9827465	27.50001215		8.088245993	7.21944	262.524975	31.16586596
126.16	2600	0.16805	1.27634	102.9191159	28.02190331		8.083248463	7.46142	266.2709922	30.72741087
125.85	2650	0.17145	1.28027	102.6629623	28.48970161		8.063130202	7.61238	267.1976037	30.82085164
124.91	2700	0.17465	1.28371	101.8993959	28.81135004		8.003159842	7.75446	269.1460132	30.39918029
123.93	2750	0.1784	1.2812	101.0966724	29.11372597		7.940114079	7.92096	272.0696076	30.07251804
123.69	2800	0.18005	1.27448	100.9025177	29.58613736		7.924865206	7.99422	270.2015441	30.28042719
123.39	2850	0.1831	1.26036	100.6577849	30.04142049		7.905643936	8.12964	270.6143674	30.23423428
122.52	2900	0.1879	1.2531	99.94805974	30.35292864		7.849902256	8.34276	274.8584856	29.76738435
121.84	2950	0.19255	1.23943	99.39170051	30.70438283		7.806205904	8.54922	278.436471	29.38486526
121.71	3000	0.199	1.22735	99.28728118	31.19199183		7.798004829	8.8356	283.2650139	28.88397006
121.12	3050	0.20605	1.2193	98.80923645	31.55917328		7.760459283	9.14862	289.8878218	28.22408382
121.12	3100	0.21005	1.20692	98.81005222	32.0768016		7.760523354	9.32622	290.7465687	28.14072138
120.85	3150	0.21605	1.19274	98.58734538	32.52070574		7.743031999	9.59262	294.9696134	27.73783403
120.6	3200	0.21795	1.18481	98.3793225	32.96719834		7.72669392	9.67698	293.5335581	27.87353315
120.84	3250	0.22305	1.17378	98.57837184	33.55005505		7.742327219	9.90342	295.1834202	27.71774301
121.63	3300	0.2255	1.16118	98.22528221	34.28976572		7.793135441	10.0122	291.9879967	28.02107715
122.18	3350	0.2285	1.15104	98.67232746	34.96613596		7.828246293	10.1454	290.1493036	28.19864835
122.93	3400	0.2342	1.14117	100.285791	35.70644036		7.876427607	10.39848	291.2214126	28.09483722
123.48	3450	0.23605	1.12669	100.7279416	36.39127649		7.911154034	10.48062	287.9981416	28.40827422
123.43	3500	0.24195	1.11975	100.6896001	36.90463342		7.908142701	10.74258	291.0902779	28.1074938
124.21	3550	0.24545	1.10622	101.3234581	37.66748221		7.957925789	10.89798	289.3206384	28.27941424
124.07	3600	0.25005	1.09697	101.2100652	38.15526206		7.949019934	11.32422	296.7931391	27.56741011
123.97	3650	0.25755	1.09401	101.1293034	38.65432693		7.942676915	11.43522	295.8328578	27.65689465
123.82	3700	0.26445	1.09659	101.0053054	39.13579367		7.932938139	11.74158	300.0215123	27.27077175
123.77	3750	0.2651	1.09808	100.9661482	39.64927874		7.928962736	11.77044	296.8639121	27.66083797
123.51	3800	0.2693	1.09907	100.755678	40.09418239		7.913332444	11.95692	298.2208213	27.43643575
122.67	3850	0.27375	1.10533	100.0728735	40.34645064		7.859705103	12.1545	301.2532663	27.15928804
122.16	3900	0.2759	1.11704	99.65274883	40.69884881		7.826708591	12.24996	300.9903316	27.18299335
121.18	3950	0.28285	1.12259	98.85899878	40.89230004		7.764367608	12.55854	307.1125857	26.6411035
120	4000	0.28455	1.12461	97.8963831	41.00670493		7.688763949	12.63402	308.0964448	26.55602919
118.73	4050	0.2871	1.1222	96.80034758	41.07989092		7.607393931	12.74724	310.3036477	26.36713503
117.44	4100	0.28895	1.12394	95.80636499	41.13452199		7.524614311	12.82938	311.888394	26.23316013
116.5	4150	0.29305	1.12233	95.037904	41.30219865		7.464259525	13.01142	315.0297106	25.97157636
115.93	4200	0.2949	1.12179	94.57372746	41.59506118		7.427803185	13.09356	314.7818697	25.99202485
115.03	4250	0.29715	1.12456	93.84197638	41.76517554		7.37033159	13.19346	315.8961941	25.90033794
114.39	4300	0.3022	1.12278	93.31743242	42.02033126		7.329134003	13.41768	319.3139987	25.62311147
114.02	4350	0.30605	1.11943	93.01151642	42.36958568		7.305107417	13.58862	320.7163766	25.51107077
113.87	4400	0.3092	1.11986	92.8932289	42.80208949		7.295817137	13.72848	320.7432199	25.50893573
113.99	4450	0.3099	1.11873	92.98622736	43.33181438		7.303121219	13.75956	317.5394383	25.76630552
113.31	4500	0.31445	1.11563	92.43231546	43.5576641		7.25961708	13.96158	320.5309626	25.52582788
113.07	4550	0.3171	1.10953	92.24305542	43.95146057		7.244752632	14.07924	320.3361121	25.54135445
112.2	4600	0.3194	1.10569	91.52598832	44.08902494		7.188434313	14.18136	321.6528381	25.43679773
111.06	4650	0.32055	1.09782	90.60089834	44.1177842		7.115777916	14.23242	322.6005172	25.36207938
109.97	4700	0.3207	1.09558	89.71333405	44.15532544		7.040608779	14.23908	322.4770706	25.37178276
108.85	4750	0.32485	1.08827	88.6373255	44.0898365		6.961559266	14.23334	327.1352571	25.01050561
107.08	4800	0.32455	1.08396	87.35003098	43.90687581		6.86045539	14.41002	328.1950659	24.92974158
105.24	4850	0.3257	1.08221	85.85226624	43.60353882		6.742821223	14.46108	331.6492283	24.67008564
103.83	4900	0.3277	1.0846	84.54049843	43.37995721		6.639795522	14.64988	335.4055867	24.39380412
102.34	4950	0.32845	1.08823	83.48243696	43.27415063		6.556695266	14.68318	336.9951758	24.27873978
101.11	5000	0.3287	1.08687	82.47984826	43.1863095		6.477952134	14.69428	337.9376512	24.21102873
99.315	5050	0.32985	1.0891	81.01871186	42.84547356		6.36319475	14.64534	341.8167713	23.96205996
97.582	5100	0.3297	1.09185	79.60464574	42.51447548		6.252134257	14.63868	344.32	

4. Calculations

The raw data supplied was processed in Excel as seen in figure 3 above, the calculated values were torque, brake power, brake mean effective pressure (BMEP), fuel mass flow rate, brake specific fuel consumption (BSFC) and overall thermal efficiency.

4.1 Torque

Torque was calculated from the measured dynamometer load and dynamometer arm length:

$$T = F \times r$$

Where:

T = torque

F = load (N)

r = dynamometer arm length (m)

The arm length was 0,815776m, therefore:

$$T = F \times 0.815776$$

This produced torque in newton metres (Nm). Torque is one of the main indicators of engine output as it represents the turning force produced at the crankshaft (Pulkrabek, 2017).

4.2 Brake Power

Brake power was calculated using torque and engine speed:

$$Pb = \frac{T \times N}{9549.305}$$

Where:

Pb = brake power (kW)

T = torque (Nm)

N = engine speed (rpm)

This equation gives brake power in kW. Brake power is an important performance parameter because it represents the rate of useful output from the engine (Heywood, 2018).

4.3 Brake Mean Effective Pressure (BMEP)

For a four-stroke engine, BMEP was calculated using:

$$BMEP = \frac{4\pi T}{Vd}$$

Where:

T = torque (Nm)

Vd = engine displacement (m³)

For the Honda D16 the displacement was 1.6 litres, which is:

$$Vd = 0.0016\text{m}^3$$

To express BMEP in bar:

$$BMEP(\text{bar}) = \frac{4\pi T}{0.0016 \times 100000}$$

BMEP allows torque output to be related to engine size, making performance easier to compare independent of displacement (Stone, 2012).

4.4 Fuel Mass flow rate (kg/hr)

Fuel flow was measured in litres per minute and converted into kilograms per hour using an assumed petrol density of 0.74 kg/L:

$$mf' = Fuel\ flow \times 60 \times 0.74$$

Where:

mf' = fuel mass flow rate (kg/hr)

This conversion is needed because BSFC and thermal efficiency require fuel flow mass terms rather than volume terms (Heywood, 2018).

4.5 Brake Specific Fuel consumption (BSFC)

Brake specific fuel consumption was calculated using:

$$BSFC = \frac{mf'}{P_b}$$

To express BSFC in g/kWh:

$$BSFC(g/kWh) = \frac{mf'(kg/hr) \times 1000}{P_b(kW)}$$

BSFC show much fuel is required to produce a unit of brake power, lower BSFC values indicate better fuel efficiency (Heywood, 2018).

4.6 Overall Thermal Efficiency

Overall thermal efficiency was calculated by comparing the brake power with the rate of fuel energy input:

$$\eta_{th}(\%) = \frac{P_b(W)}{m_f(kg/s) \times 44 \times 10^6} \times 100$$

Where:

η_{th} = Thermal Efficiency (%)

P_b = Brake Power

m_f = fuel mass flow rate (kg/s)

44×10^6 = assumed calorific value of petrol (J/kg)

This value shows how the engine converts the energy from the fuel into useful brake output. Higher thermal efficiency means a greater proportion of fuel energy was converted into mechanical work. (Heywood, 2018; Stone, 2012)

5.Results

The data from the dynamometer was given in a excel spreadsheet as seen in Table 1, which then was processed in excel to calculate torque, brake power, brake mean effective pressure (BMEP), fuel mass flow rate, brake specific fuel consumption (BSFC), and overall thermal efficiency across the recorded range of revolutions.

The main calculated results obtained from the dataset were as follows:

- Maximum measured torque: 103.46Nm at 2350 rpm
- Maximum measured brake power: 44.16 kW at 4700rpm
- Maximum measured BMEP: 8.13 bar at 2350 rpm
- Minimum BSFC: 257.49 g/kWh at 1750 rpm
- Maximum thermal efficiency: 31.78% at 1750 rpm

The values show that the engine achieved its highest measured torque in the low to mid revolution range, while maximum brake power occurred later at a higher engine revolution. This difference is expected as torque and power do not peak at the same point. BSFC and thermal efficiency results also show that the engines most efficient operating region occurred below the speed at which maximum power was developed.

The processed data showed that torque increased steadily from low revolutions to a broad peak before gradually falling away at higher engine revolutions. Brake power increased steadily over the range of revolutions, reaching a maximum near the upper middle part of the revolution range before decreasing slightly. BSFC initially reduced as engine revolutions increased, reaching its lowest in the lower mid-range and then rose progressively toward higher engine revolutions. Thermal efficiency showed opposite general trend to BSFC.

Below are graphs obtained from excel presenting the data gathered more clearly.

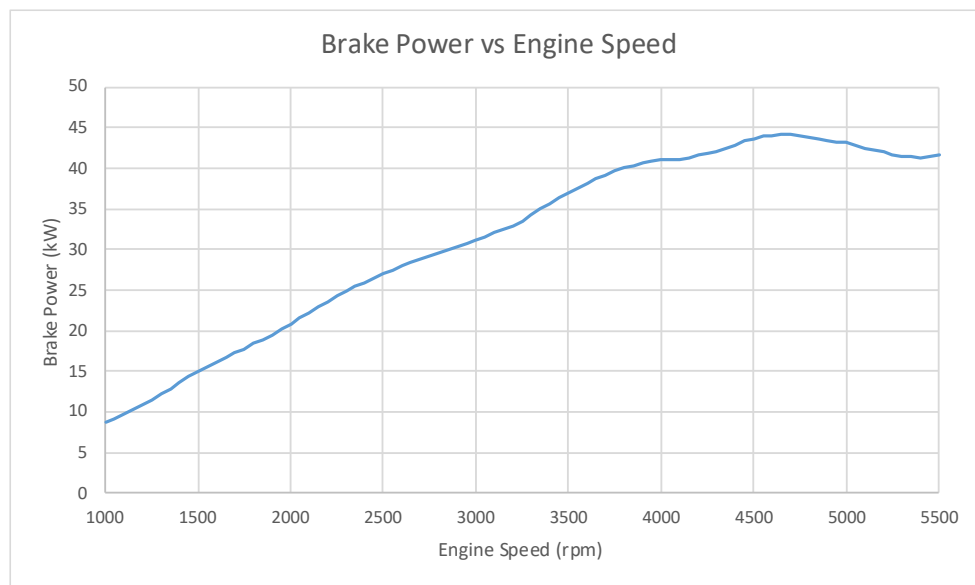


Figure 3 Brake Power vs Engine Speed

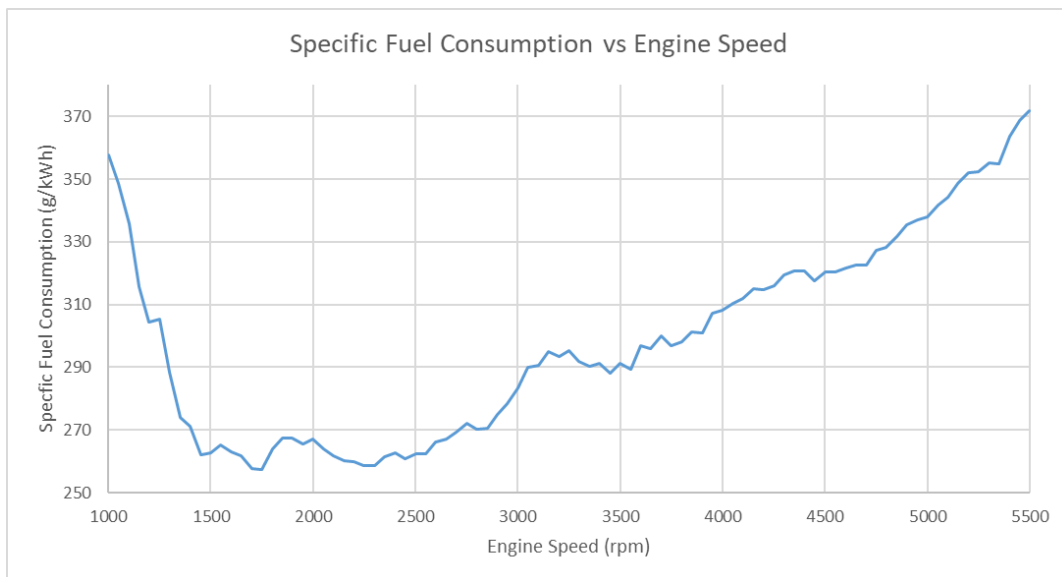


Figure 4 Specific Fuel Consumption vs Engine Speed

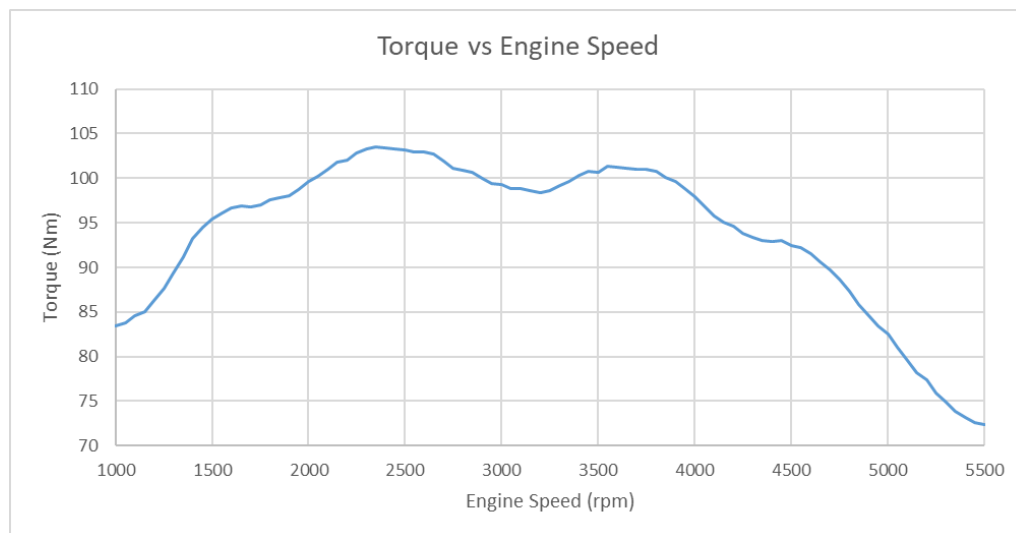


Figure 5 Torque vs Engine Speed

6.Disscusion

6.1 Torque against Engine Speed

The torque graph showed that torque increased from about 83 Nm at 1000 rpm to a maximum measured value of 103.46 Nm at 2350 rpm, which before gradually decreasing to about 72 Nm at 5500 rpm. This is a typical behaviour of a naturally aspirated petrol engine and is mainly due to changes in volumetric efficiency and cylinder filling with engine speed (Heywood, 2018; Stone, 2012).

In the low to mid-range, airflow and combustion conditions improve which means the cylinders can fill more effectively and increasing brake torque. After the peak, torque falls because there is less time for cylinder filling at higher rpm and mechanical losses increase. Although the graph contains some small dips, this is normal in real dynamometer data and does not change the overall trend of a rise to a mid-range peak followed by a gradual decline (Martyr and Plint, 2012).

6.2 Brake Power against Engine Speed

The brake power graph showed that power increased from 8.74 kW at 1000 rpm to a maximum measured value of 44.16 kW at 4700 rpm, before decreasing slightly at higher speed. This is expected because brake power depends on both torque and engine speed:

$$Pb = \frac{T \times N}{9549.305}$$

Even after torque begins to fall, power can continue increasing while engine speed is still rising. This is why maximum measured brake power occurred at a higher speed than maximum measured torque. After 4700 rpm, the drop in torque became large enough that brake power also started to fall (Heywood, 2018).

5.3 Specific Fuel Consumption against Engine Speed

The BSFC graph showed that specific fuel consumption fell to a minimum of 257.49 g/kWh at 1750 rpm and then increased steadily as engine speed rose, reaching over 370 g/kWh near the top of the range. This indicates that the engine was most fuel-efficient in the lower to mid-speed range

At moderate speeds, the engine produced useful brake output with relatively low fuel use. At higher speeds, BSFC decreased because frictional losses, pumping losses and fuel demand increased. This pattern was supported by the thermal-efficiency results, which showed a maximum value of 31.78% at 1750 rpm, the same region as the lowest BSFC.

5.4 BMEP and Thermal Efficiency

BMEP followed the same overall trend as torque, reaching a maximum measured value of 8.13 bar at 2350 rpm. This is expected because BMEP is directly related to torque for a given engine size (Stone, 2017).

Overall, the results showed that the engine produced its highest torque in the lower to mid-range, its highest measured brake power at a higher engine speed, and its best fuel efficiency at a lower speed than both the torque and power peaks. This demonstrates why several performance parameters are needed to fully assess engine behaviour (Pulkrabek, 2017; Martyr and Plint, 2012).

7. Conclusion & Evaluation

The dynamometer investigation successfully identified the main performance characteristics of the Honda 1.6 litre VTEC petrol engine over the measured speed range. The maximum measured torque was 103.46 Nm at 2350 rpm, while the maximum measured brake power was 44.16 kW at 4700 rpm. This shows that torque peaked earlier in the speed range, while brake power continued to rise to a higher rpm because power depends on both torque and engine speed.

The lowest BSFC was 257.49 g/kWh at 1750 rpm, which also corresponded to the highest calculated thermal efficiency of 31.78%. This indicates that the engine operated most efficiently in the lower to mid-speed range rather than at maximum power. Overall, the results followed the expected behaviour of a naturally aspirated four-stroke petrol engine, with torque peaking in the mid-range, power peaking later, and fuel efficiency being best below the point of maximum power.

One strength of the investigation was that the engine was directly coupled to the dynamometer, which meant that dyno speed was equal to engine speed and no transmission correction was required. The spreadsheet method also made it possible to calculate torque, brake power, BMEP, BSFC and thermal efficiency consistently across the full dataset.

However, the investigation had some limitations. The accuracy of the results depended on the measured load and dynamometer arm length, so any error in these values would affect torque and power calculations. Small fluctuations in the graphs also suggest some measurement scatter, which is common in real dynamometer testing (Martyr and Plint, 2012). The investigation could be improved by repeating test points, averaging the results, and including more measured parameters such as airflow or exhaust temperature.

8. References

- Heywood, J.B. (2018). *Internal Combustion Engine Fundamentals*. 2nd ed. New York: McGraw-Hill Education.
- Martyr, A., Plint, M.A. and Firm, P. (2012). *Engine testing : the design, building, modification and use of powertrain test facilities*. Amsterdam: Butterworth Heinemann.
- MotorReviewer (2026). *D16A (B, V, W, Y, Z) Engine - In-Depth Look at Design and Reliability*. [online] MotorReviewer - In-Depth Engine Reviews. Available at: https://www.motorreviewer.com/engine.php?engine_id=82 [Accessed 12 Mar. 2026].
- Pulkrabek, W.W. (2017). *Engineering fundamentals of the internal combustion engine*. India: Pearson.
- SCHENCK (2001). *Eddy-Current Dynamometer W Series*.
- Stone, R. (2012). *Introduction to internal combustion engines*. Basingstoke: Palgrave Macmillan.
- UWTSD (2020). *Engine Dynamometer Overview*. [online] [www.youtube.com](https://www.youtube.com/watch?v=-WajOAp2LUE). Available at: <https://www.youtube.com/watch?v=-WajOAp2LUE>.

