



Engine Performance Characteristics
Motorsport Technology ACHA4012

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1 Introduction

In this test, a Honda D16 1.6L Civic CRX engine undergoes a dynamometer test to analyse its performance characteristics. The experiment focuses on key parameters such as specific fuel consumption (SFC), torque and power, which are essential in evaluating the engine efficiency. By varying the engine speed under controlled conditions, the test provides a valuable insight into how these parameters differ and impact the performance. The collected data will be put up to discussion and the peak power, torque and SFC ranges will be identified. The analysis that will follow will include comparisons between all three data points, and how getting the best of each different aspect effects the fuel efficiency and/or performance of the engine.

2 Method

To begin the test the equipment used are as listed below:

- Honda D16 1.6L Civic CRX engine
- W230 Schenck Dynamometer
- Specific sensors including load, dyno speed, fuel flow rate, lambda, temperature
- Exhaust extraction system
- Data logging and analysis software

Ensure the engine is securely mounted to the dynamometer test rig, next the fuel and cooling systems are connected and fuelled. The fuel is pumped from the lift pump from the main tank via the filter which is pumped through the fuel flow meter to the secondary fuel swirl pot. This feeds the main fuel pump feeding the engine via a regulator.

All sensors must now be calibrated to ensure accurate data collection. The environmental conditions must also be noted before and during the test to create consistency between multiple tests.

The W230 Dynamometer can be run up to a maximum of 10,000 rpm and is driven by the D16 engine it absorbs the power of the engine and turns it into heat energy. For torque via the shaft and flange the D16 is connected to the dynamometer with the rotor. The bedding with support flectures in the dynamometer only takes up the weight of the pendulum body and the countervailing force to the load cell via the lever arm. The complete torque acts on the load cell via the level arm. The measured force is proportional with the breaking moment due to this. (Schenck, 2001)

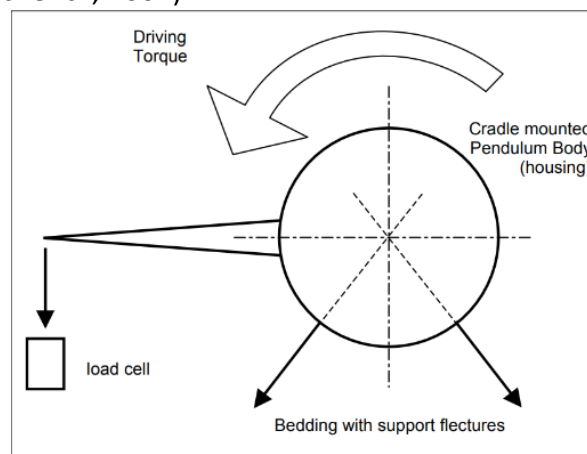


Figure 2-1: Diagram of dynamometer measuring torque

3 Raw Data

Table 3-1: Partial extract of table of initial data (10 data points from 90)

Load	Dyno Speed	Fuel Flow Rate	Lambda
Newtons	rpm	l/min	λ
102.275	1000	0.0704	1.2658
102.756	1050	0.0724	1.26783
103.689	1100	0.0737	1.27344
104.209	1150	0.0728	1.28476
105.811	1200	0.0744	1.29181
107.51	1250	0.07895	1.29729
109.488	1300	0.079	1.29895
111.797	1350	0.0796	1.29469
114.268	1400	0.0835	1.2855
115.783	1450	0.0847	1.27818

Table 3-2: Environmental Conditions

Baro	Humidity	Ambient temp
mBar	%	Deg °C
1018.9	46	27

4 Calculated Data

Table 4-1: Calculated Data (10 data points from 90)

Engine Speed	Torque	Power	Corrected Power	BMEP	SFC	Thermal Efficiency
Rad/s	Nm	KW	KW	Bar	kg/kWh	%
104.7197551	83.4334904	8.737135	8.791862712	6.594063912	0.360333197	21.81387136
109.9557429	83.8258787	9.217137	9.274871445	6.625075838	0.351271715	22.37658676
115.1917306	84.5869977	9.743723	9.804755786	6.685229948	0.338254218	23.23773539
120.4277184	85.0112012	10.2377	10.30183236	6.718756355	0.31800168	24.71767445
125.6637061	86.3180743	10.84705	10.91499333	6.822043477	0.30673404	25.62565931
130.8996939	87.7040778	11.48044	11.55234857	6.931584563	0.307534869	25.55892945
136.1356817	89.3176827	12.15932	12.23548769	7.059113856	0.290548288	27.05320368
141.3716694	91.2013095	12.89328	12.97404285	7.207983996	0.276089731	28.46995424
146.6076572	93.217092	13.66634	13.75194325	7.367298901	0.273234112	28.76749888
151.8436449	94.4529926	14.34209	14.43192323	7.464976797	0.264102015	29.76221905

Table 4-2: Post test data

Radius (m)	CV Petrol (Kj)	Engine Displacement (m ³)
0.815776	4580	0.00159

Table 4-3: Environmental Conditions transposed into correct units

Ambient Pr	Baro	Humidity	Ambient temp	Ambient temp
Bar	mBar	%	Deg °C	Kelvin
1.0189	1018.9	46	27	300

5 Graphical Analysis

5.1 Specific Fuel Consumption

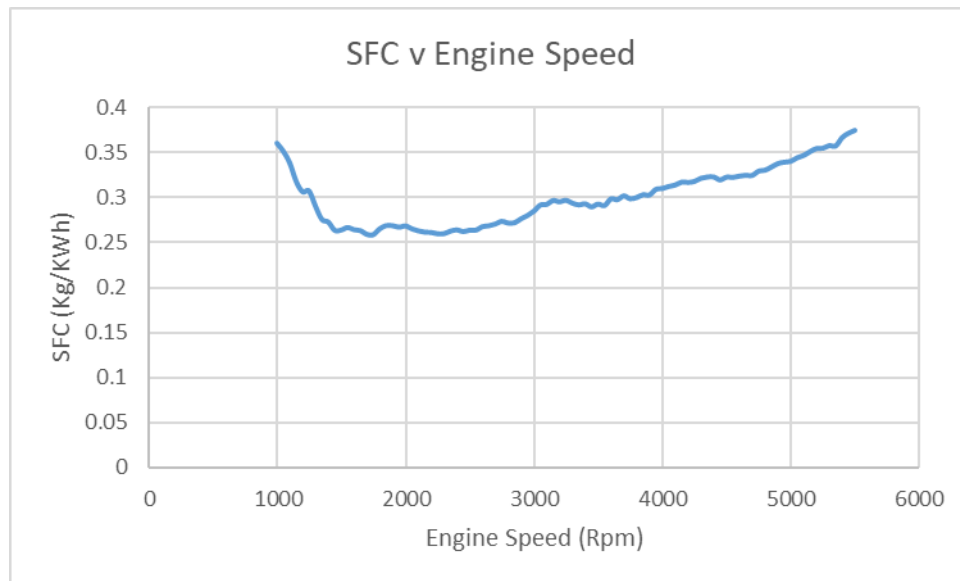


Figure 5-1: Graph displaying SFC v Engine Speed

The specific fuel consumption (SFC) is the amount of fuel used to produce a certain power output, when compared against the engine speed there are multiple talking points to be highlighted (Hall, 2021). Firstly, between 1000-1750rpm the engine operates inefficiently at lower speeds where any frictional loss becomes more significant to the power output. However, more importantly the engine is burning more fuel to produce the same amount of work due to engines being designed to work best at certain rpm ranges and the low end is never optimal for the driver this has an effect in incomplete combustion as the engine cannot burn the fuel as efficient at a lower speed (Saranya et al. 2022). The mid-range rpm (1800-3000) is where SFC is at its lowest due to the engine reaching its optimal operating range, frictional & mechanical losses are lower, and combustion is at peak performance. The high range rpm (3000+) the SFC begins to increase again as the engine starts to require more fuel to sustain higher speeds as well as frictional and thermal losses increasing. The SFC will continue to increase until 5500 rpm is reached peaking at its highest value of 0.37kg/kWh. Overall, SFC is at its highest when the engine speed is at its minimum and maximum.

5.2 Torque

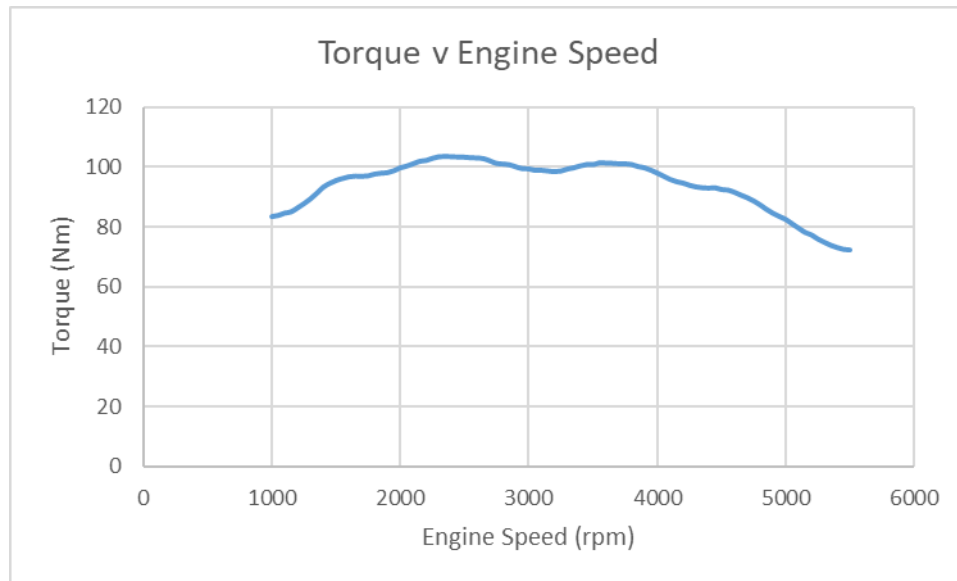


Figure 5-2: Graph displaying Torque v Engine Speed

Torque is the twisting/rotational force produced by the engine that turns the wheels and propels the car, it affects acceleration and the pulling force of the car under different loads (Arnold, 2025). At lower engine speeds the torque builds up from the first value of 83Nm as the engine begins to improve its combustion efficiency & fuel-air mixture. The initial low torque ranges from 1000-2000rpm. The peak engine torque is reached between 2000-4000rpm, peaking at 103Nm this where the mechanical performance and engine efficiency reaches its peak before declining. After 4000rpm the torque begins to decrease as the engine reaches the max rpm recorded of 5500 and the lowest torque value of 72Nm. This is due to the frictional and thermal losses increasing and reduced volumetric efficiency. However, different to SFC the torque reaches its highest when the engine speed is closer to its mid-point rather than the start or end.

5.3 Brake Power

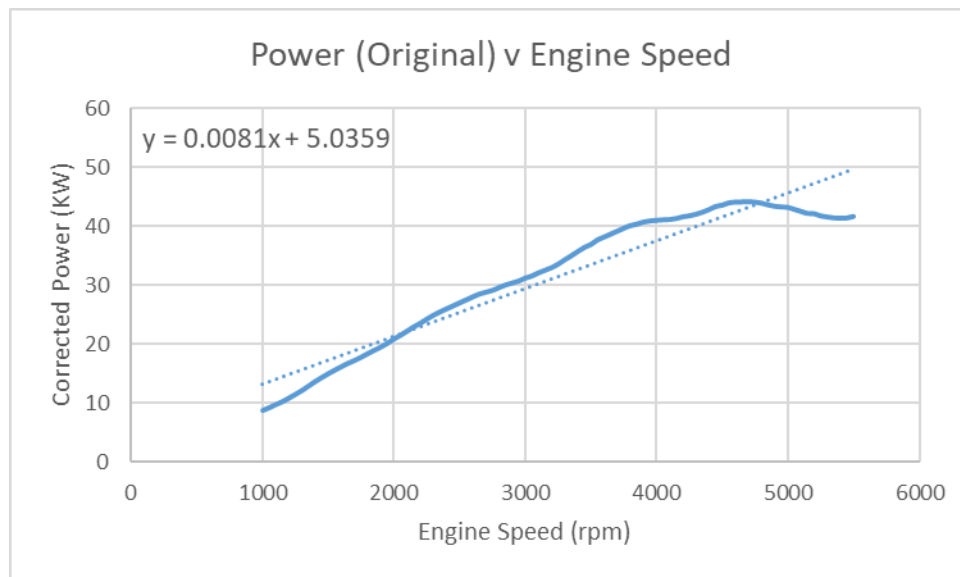


Figure 5-3: Graph of Original Power v Engine Speed

For the power of the engine to be compared with engine speed other variables must be taken into consideration other than the Torque and Engine Speed to calculate the power. This includes considering the temperature and pressure at the time of the test this gives the equation below.

$$\text{Original Power (W)} = \text{Torque (Nm)} * \text{Engine Speed (rad/s)}$$

$$\text{Corrected Power} = \frac{1.01325}{\text{Ambient Pressure}} * \sqrt{\frac{\text{Ambient Temperature}}{293}} * \text{Original Power}$$

$$\text{Corrected Power} = \frac{1.01325}{1.0189} * \sqrt{\frac{300}{293}} * \text{Original Power}$$

Using this equation gives a more accurate power value that can be more compared with other tests as conditions for each test can and will vary.

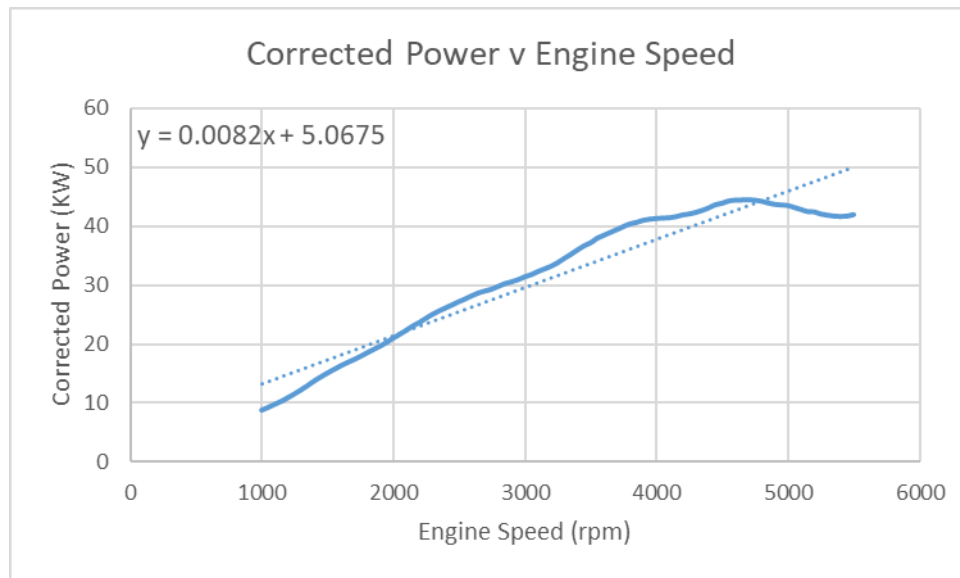


Figure 5-4: Graph of Corrected Power v Engine Speed

The difference in the gradients of both Figures 5-3 & 5-4 highlight the importance of ensuring that the power value is corrected to the conditions of the test to guarantee more accurate results.

Figure 5-4 demonstrates a steady increase in power as the engine speed rises. At 1000 rpm, power output is relatively low at 8.79 kW, but as the engine speed increases the power output also increases. By 4000 rpm, the engine is producing 41 kW, close to its peak power output. The peak engine speed range for maximum power is between 4000 and 5000 rpm however, after the peak of 4700 rpm power does begin to decline, indicating a higher internal friction and reduced volumetric efficiency at higher engine speeds.

Figure 5-4 suggests that the optimal shifting point for engine performance should be near peak power being 4000-5000 rpm to maximize acceleration. The data indicates that the engine is designed for mid-range performance and efficiency, making it well-suited for daily driving and vigorous acceleration while maintaining efficiency. (OpenAI, 2025)

6 Conclusion

Overall, all three graphs show that the peak operating condition of the engine is slightly different depending on what use the engine is needed. If fuel economy is the main objective keeping rpm between 1500-2500 is the main focus as this directly corresponds with the lowest range of specific fuel consumption. If a high torque output is the priority, then the rpm is to be kept between 2000-4000. If maximum power is needed the engine speed must need to reach 5000 rpm to maximise the acceleration and power output.

Each different use of the engine doesn't go hand in hand with each other, it's inherently a trade-off, to have the best fuel economy power is sacrificed, to maximise torque neither power nor fuel economy will be at its peak. However, the peak torque is well suited for both low SFC and high-power output across its range, as torque begins to reach its peak SFC is at its lowest but as torque starts to reach the end of its peak the power output is reaching its maximum. This suggests that for an overall general performance, operating within the peak torque range offers a compromise between fuel efficiency and power output, making it the most versatile range for various driving conditions.

7 Evaluation

I think that I performed the tasks set at a good level, I believe that I have done everything that has been asked. I have shown my workings in coming to my conclusions from the data I have analysed as well as being able to then explain my findings.

For further work I think that having the dynamometer working would be crucial to supplying better data rather than data from a past test as being able to run the dynamometer test personally would give a better visual understanding of what is happening. I also think that being able to run two of the same D16 engines on the dynamometer would give more of an insight to the test and make it possible to identify outliers in the data. To add to this running the dynamometer three times on the same engine would also increase the reliability of the test results.

Another addition could be to upgrade the dynamometer from the W230 to one of the highest standards. Upgrading the dynamometer could mean an increase in accuracy when measuring the data. Having access to more accurate data is crucial to having an understanding in what the data is displaying for small inaccuracies can have huge effect on the conclusions being made.

8 Bibliography

Arnold, N. 2025. *Technology explained, simply: Torque in cars* | BMW.com.

Hall, N. 2021. *Specific Fuel Consumption*.

Saranya, P., Anantharaj, R., Gnana Prakash, D. and Vichitra, M. 2022. Experimental investigation of performance of bio diesel with different blends in diesel engine. In: *Biofuels and Bioenergy: A Techno-Economic Approach*. Elsevier, pp. 553–567. doi: 10.1016/B978-0-323-90040-9.00026-6.

Schenck. 2001. *Technical Specification Eddy-Current Dynamometer W Series*.

Open AI. 2025.