

ENGINE PERFORMANCE CHARACTERISTICS

**Motorsport Technology
(ACHA4004)**

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17.03.2024

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1. Introduction

This report consists of an engine dynamometer test on a 1.6 litre Honda CRX engine as well as an explanation of how it was completed and the equipment used. The aims of this sweep test were to record data such as the engine load and fuel flow rate within a range of 1000rpm to 5500rpm. The results of the dynamometer test were then used to calculate many more parameters such as brake power, specific fuel consumption and energy per hour from fuel. These new parameters were then analysed and compared to researched results to be validated. This was then followed by an individual evaluation as well as how the investigation itself could have been improved.

2. Methodology

2.1 Equipment Used

The dynamometer test was conducted using an eddy-current dynamometer. This type of dynamometer has an inner core that is attached to the engine's crankshaft through a driveshaft and spins freely. The outer casing then creates a variable electromagnetic field due to currents being fed through it which then puts a load onto the spinning inner core and by extension, the engine. A strain gauge then stops the outer casing from rotating with the inner casing. This strain gauge is what sends a signal of 0V to 10V to the computers in the test room. The system is calibrated with radius arms of a specific length (815.776mm) and a weight suspended at this length by a hook eye. This length can then be used to calculate the torque of the engine by using $T=WR$ (Torque = Load x Radius).

2.2 Test Conducted

The session began by ensuring the system was on its manual mode so changes could be made to the engine speed and load values. The engine was then taken off its idle mode in order to begin increasing the throttle and load. The aim was to find the highest amount of load the engine could take whilst sustaining 2000rpm. This figure was about 150N of load. Anything beyond this figure would make the RPM begin to drop as the engine was overpowered by the load. After this was complete, the dials were turned back at an even rate to ensure the RPM did not spike and that the engine did not stall. Finally, the idle mode was set back to on as no more adjustments needed to be made to the throttle or load.

2.3 Data Gathered

The data for the analysis within this report was gathered using the sweep test method. This involves starting the test at a chosen low RPM and increasing until a pre-determined high RPM is reached. Measurements will then be taken in increments as the engine RPM increases. The chosen increments for this test were every 50rpm. This does mean that the sensors attached to the engine can struggle to keep up with the changes in the engine's output and lead to slightly inaccurate readings. However, a major advantage of sweep testing is that it *"provides a broader representation of the power/torque curve, and it is quicker"* (SuperFlow, 2021) than other methods such as step testing. Step testing requires the engine to hold its RPM for longer periods of time in order for sensors to fully record the observed characteristics. While this does bring greater sensor accuracy, it also means that the engine's temperature rises noticeably which itself brings inconsistencies.

3. Results Analysis

3.1 SFC against engine speed

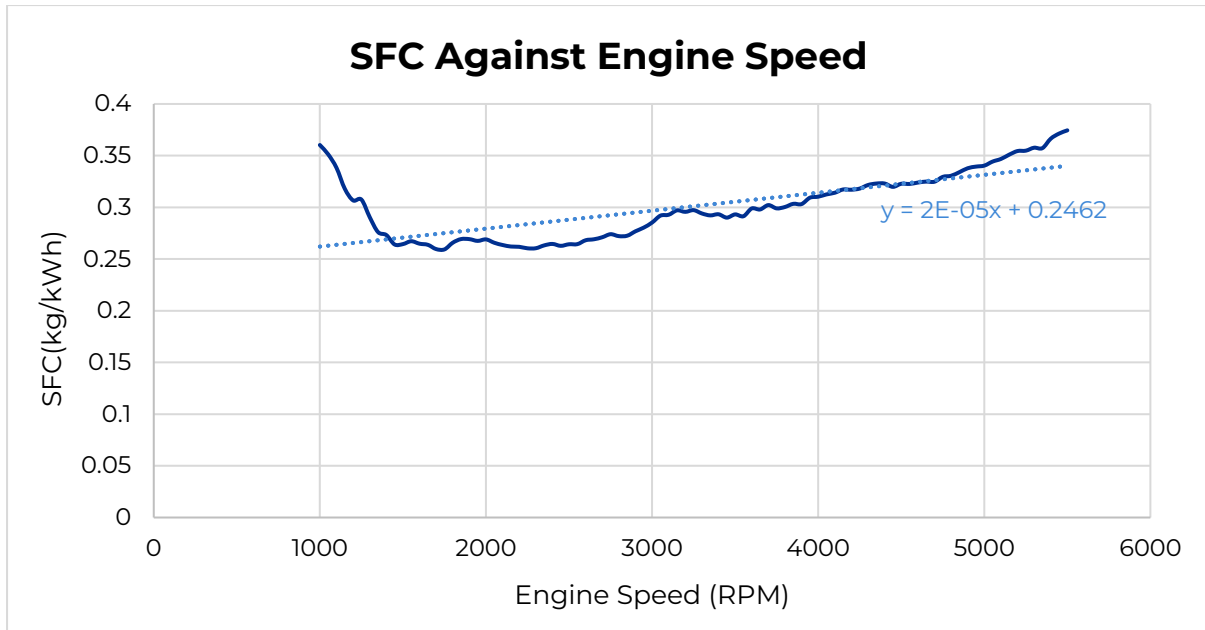


Figure 1: SFC against engine speed graph

The SFC (Specific Fuel Consumption) for this engine starts at 0.36kg/kWh at 1000rpm before dropping to it's lowest at 0.26kg/kWh at 1750rpm and increasing back up to 0.37kg/kWh at 5500rpm. This general trend of a high SFC to at low RPM followed by a decrease and another increase towards the higher RPM may be because *"the power produced does not increase significantly with the fuel being entered, due to incomplete combustion"* (Irawan, et al., 2021). This inefficiency at higher RPM could also be exaggerated by frictional losses meaning the engine has to work exponentially harder to generate the same amount of power as the RPM increases.

3.2 Torque against engine speed

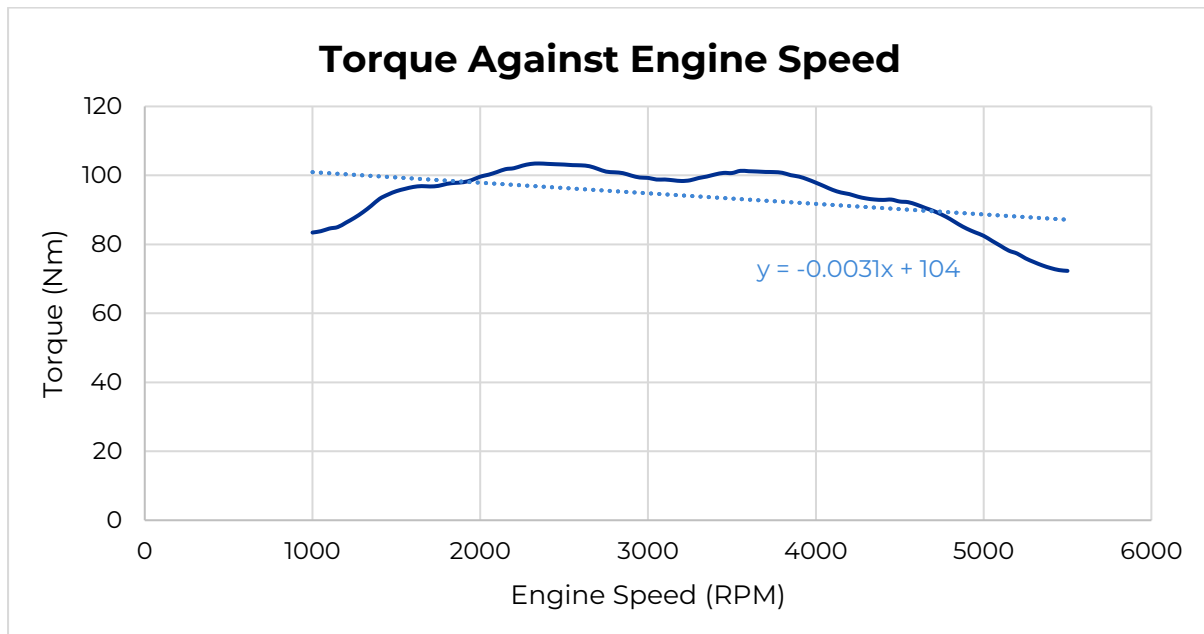


Figure 2: Torque against engine speed graph

Figure 2 displays the torque being lower at low RPM due to the simple fact that less revolutions per minute means a smaller load on the engine which then leads to a smaller amount of torque being generated. Torque then increases with higher RPM because *“torque is a measure of the twisting force that an engine can produce, and a higher load requires a higher twisting force to maintain the same RPM”* (Chughtai, 2023). However, this increase is not exponential. There is a limit to how much air an engine can take in on every stroke and torque suffers from this deprivation of air in the higher RPM as it drops off significantly; far below even the torque produced at low RPM. One thing to note with this particular engine is the custom air filter which was much less efficient than a stock air filter. This could have contributed to the extent of the drop in torque at high RPM.

3.3 Brake Power against engine speed

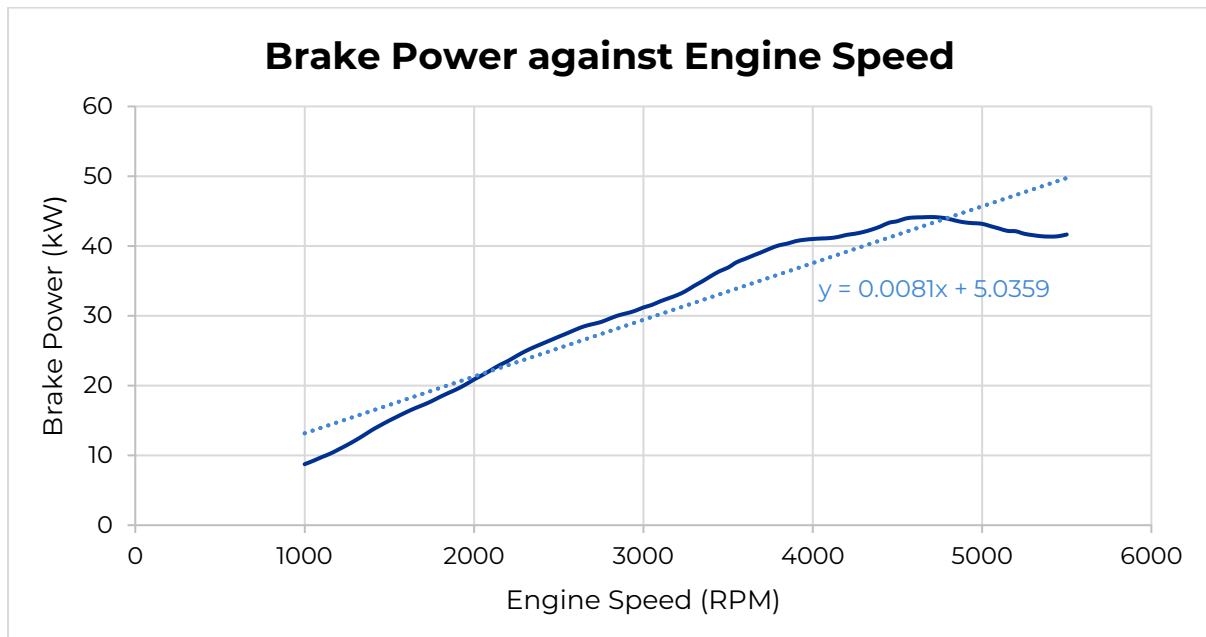


Figure 3: Brake power against engine speed graph

As seen above in figure 3, the engine's power has a relatively linear increase from 1000 to 4700rpm where the power plateaus. This is most likely due to the *"increasing friction and inertia of moving parts due to high speed"* (Maawa, et al., 2015) becoming too strong for the engine to continue generating more break power. This would also explain the gradual decrease in the brake power at the highest RPM rather than a flatline due to the friction restricting the engine further as the RPM rises. The air filter may also be contributing to the engine's lack of power. A base 1990 1.6 litre Honda CRX would have had 108 horsepower (edmunds, 2024) which means that the 59.58 peak horsepower (44.1kw) produced in the dynamometer test is a 44.83% reduction in horsepower. It must also be said that age could be another factor as the engine is at least two decades old.

4. Test Conclusion

To conclude, it is clear that the engine is no longer running in an optimal state as seen by the reduction in all the parameters analysed. The power is just over half what it was when the engine was new and the torque follows a similar trend. The SFC is also lower than usual most likely due to the engine not running to capacity due to its weakened state. Despite this, the engine does not display any signs of leaks or failures. This is because while all values are lower than expected, the gradients themselves are still normal. This also means that there was no major error in the excel calculations.

5. Evaluation

A small mistake occurred in the dynamometer session as a result of increasing the load and engine speed whilst the idle setting was still enabled meaning that the engine's rpm skyrocketed when this setting was turned off. This was a simple misunderstanding of the way the dynamometer worked and is very unlikely to happen again.

While the excel data was eventually completed correctly, there were many alterations that had to be made to get there. A few of these were down to a misunderstanding of how to input equations into excel and others due to the incorrect equations being used to calculate certain parameters such as SFC. This process would have been far less time consuming had there been a better understanding of both excel and the necessary equations from the beginning.

The investigation as a whole could have been improved if I knew how to find references that would allow for a more in depth analysis of the parameters analysed.

6. Reference List

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