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Engine Performance Characteristics Powertrain Technology (ACHA4029)

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1. Introduction

The engine dynamometer is a machine that allows engineers to measure power and torque by measuring an engine's performance under controlled and repeatable conditions. An engine dynamometer allows engineers to gather essential data that wouldn't be available through only doing road tests. Engine dynamometers play a very important role in the design and development of modern engines, ensuring both performance and reliability.

2. Testing equipment and Method used

2.1. Equipment

The dynamometer setup consists of multiple mechanical, electrical and monitoring systems designed for accurate engine testing. The dynamometer used for this test is the Schneck WS230 which is capable of operating up to 10,000 rpm and a maximum load of 230 kW. The engine is connected to the dynamometer via a driveshaft which has been directly bolted to the crankshaft. This allows power to be transmitted efficiently into the system. Load is applied to the engine via the outer casing which creates an electromagnetic field when a current is fed into it. A string gauge system measures the torque of the engine which is calibrated using a pivot arm with a distance of 815.776mm from the centre.

A dyno monitor and sensory recorder modules are used to collect and transmit data in real-time to a computer system for engineer analysis. The setup used includes several different sensors such as a coolant temperature sensor, airflow meter and a lambda sensor. The lambda sensor monitors the air-fuel ratio of the engine. The throttle is controlled remotely by a computer and recorded using a throttle actuator box. This allows both precise and repeatable control of the engine.

The fuel supply board delivers fuel from the main tank via a lift pump. This is passed through an FIA-approved filter and a fuel flow meter into a secondary swirl pot. The return system includes a cooling plate which leads back into the secondary swirl pot. Clean air is supplied through a custom air filter whilst the exhaust gasses are removed via an extraction system which includes an extraction pipe and an alternative silencer. Engine cooling is maintained via a roof-mounted coolant tank.

(Workshops, Engine Dynamometer Overview, 2020) (Workshops, Engine Dynamometer testing, 2020)

2.2. Method

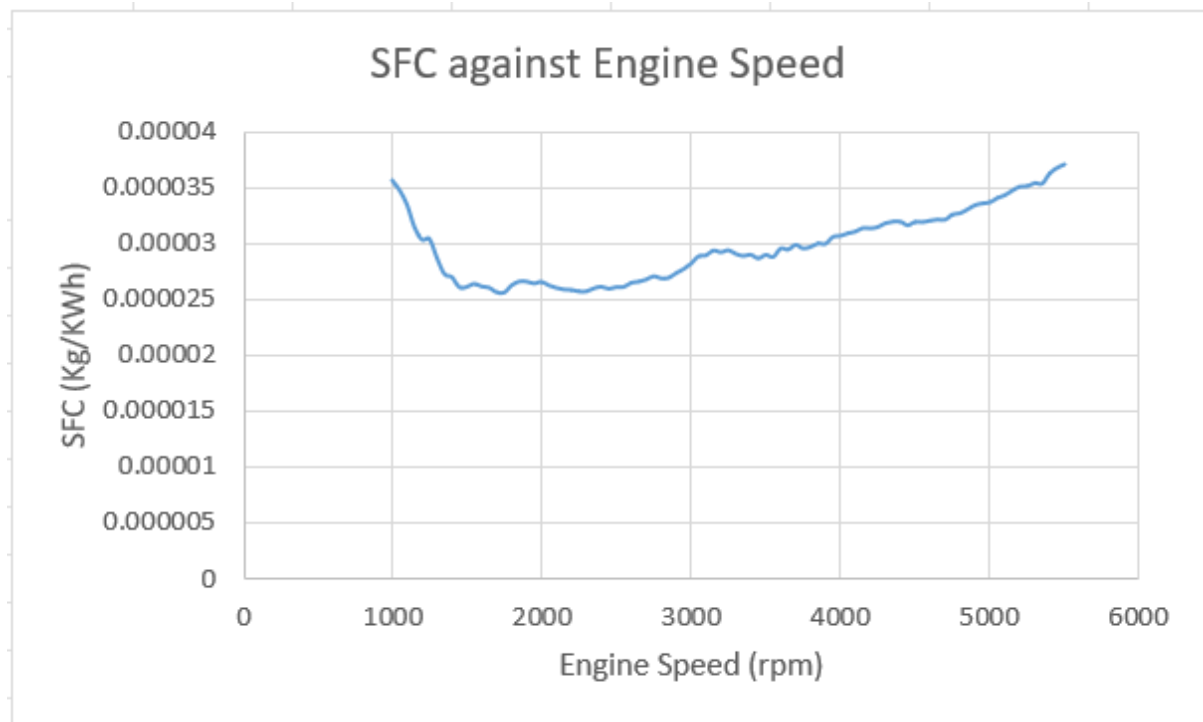
The testing method involves operating the engine under controlled and repeatable conditions in order to measure its performance. To begin, the engine is prepared and securely connected to the dynamometer via the driveshaft. Once the engine is secured the sensors and systems are checked and the engine is started.

Using the computer-controlled throttle the engine is set to specific speeds while the dynamometer applies load using the electromagnetic fields. Throughout the testing, data is continuously collected by the sensor modules and uploaded to the computer. The strain gauge within the dynamometer measures the torque which can be used to calculate the power output of the engine.

All data is recorded by the computer allowing engineers to analyse the engines performance in detail and use the results for further calculations. These tests can be repeated using the same circumstances allowing results to be compared with one another for more accurate results.

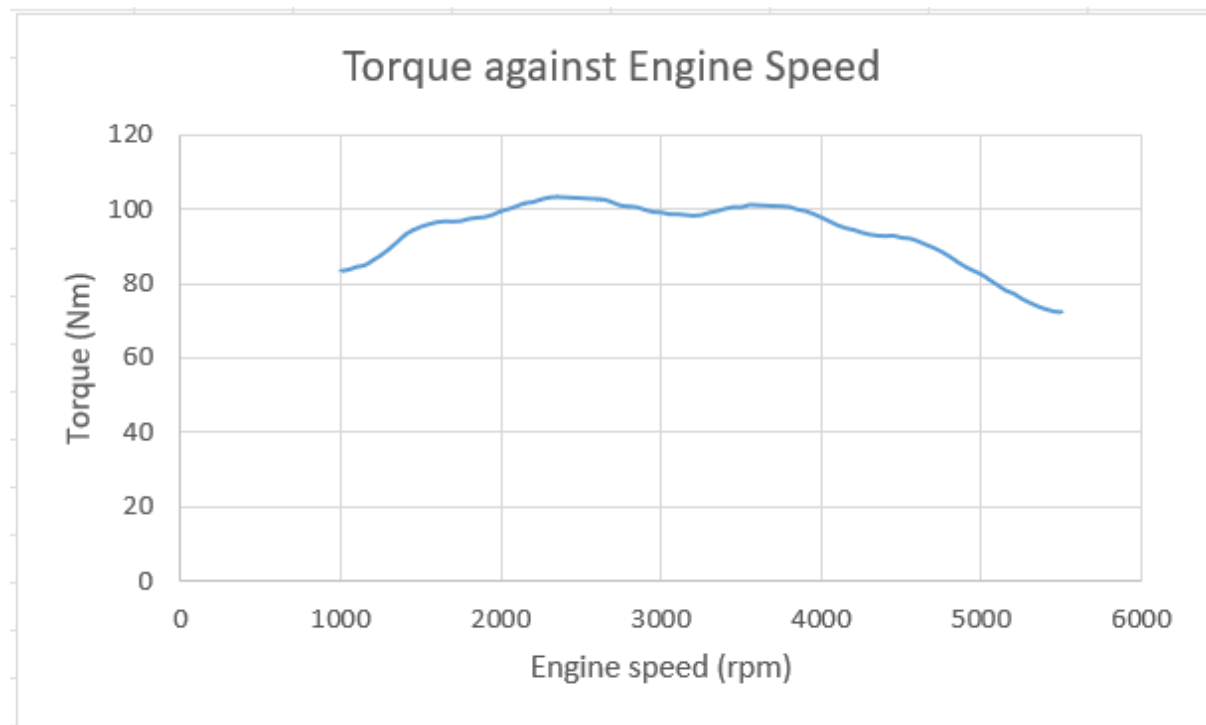
(Workshops, Engine Dynamometer Overview, 2020) (Workshops, Engine Dynamometer testing, 2020)

3. Results Conclusions



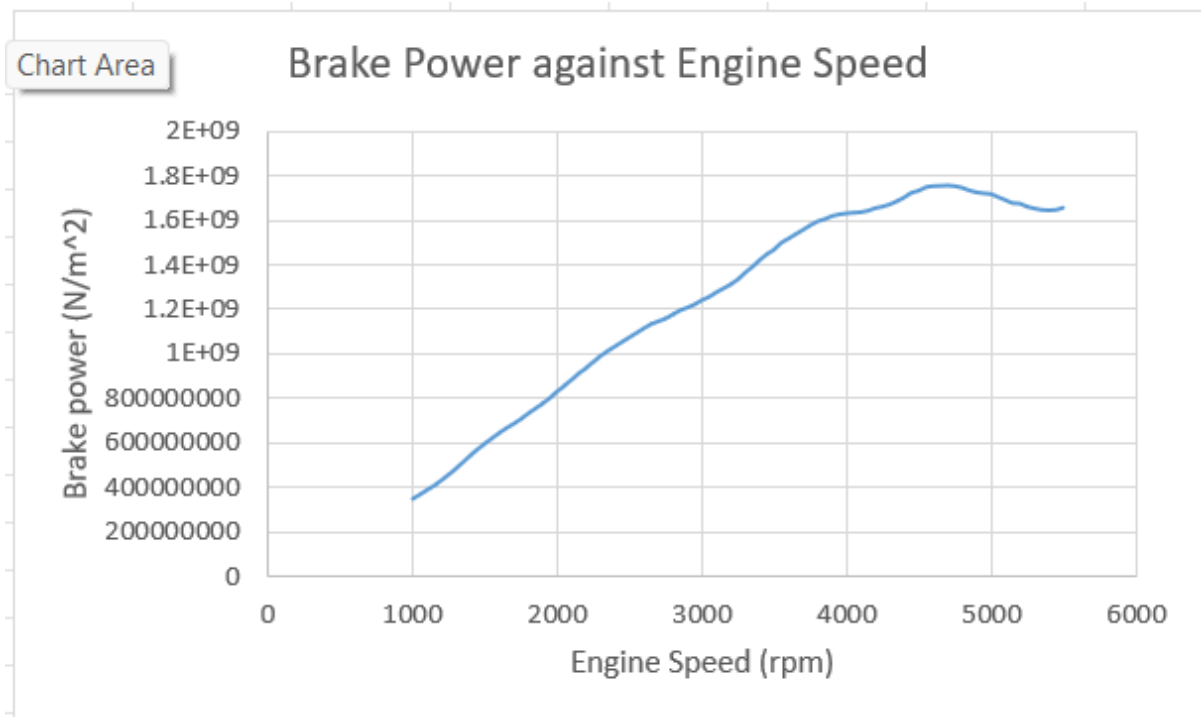
[Figure 1 – SFC against engine speed]

The SFC against engine speed graph shows that the SFC (specific fuel consumption) is relatively high at low engine speed which then, decreases to a minimum at moderate speeds and then rises again at higher speeds. At the lower RPM the combustion is less efficient due to the poorer air-fuel mixing, greater relative heat losses and other losses which equates to higher fuel use per unit power. As the speed of the engine increases, the combustion improves, the volumetric efficiency increases. This is because the engine is working near to its optimal load and torque conditions. This results in the lowest SFC on the graph. However, as the engine reaches higher speeds the SFC begins to rise again. This is due to the fact that the engine has less time for complete combustion and the airflow both in and out of the engine becomes less efficient. Due to this the engine requires more fuel to maintain its power output.



[Figure 2 – Torque against engine speed]

The torque against engine speed shows that the torque increases from the low engine speeds to a peak during its medium rpm range and then decreases at the higher rpm. At low rpm the torque is relatively low because the airflow into the cylinders is rather limited and the fuel-air mixing isn't at its most efficient, this causes the combustion to produce less force on the piston. The torque increases as the engine speed rises because the cylinders are beginning to fill more effectively with the air-fuel mixture meaning the combustion is more efficient. The engine begins to operate at its optimal timings which is shown by the peak in the graph meaning it has reached its highest torque. After the peak, the graph begins to falter as the rpm increases. This is due to the fact that the pistons have less time for air to enter the cylinders meaning complete combustion cannot occur.



[Figure 3 – Brake power against engine speed]

The brake power against engine speed graph shows that the brake power increases with engine speed at first before reaching its peak and then decreasing slightly. This is because it is closely related to both torque and rotational speed. At low engine speeds, the brake power is low due to the fact that the engine is rotating slowly, the torque may be at a reasonable level however due to the slow rotation the rate of doing work is small. As the engine speed increases, the brake power rises almost in unison. This is due to the fact that the torque is also rising or nearing its peak giving a combined affect with speed. At the higher speeds, despite the torque beginning to lower as seen in the previous graph, the brake power still increases for an amount of time. This is due to the fact that the speed outweighs the drop in torque. However, at a certain point the brake power reaches its peak. Once the brake power has peaked it begins to fall due to the fact that the speed no longer outweighs the drop in torque. This causes the brake power to decrease slightly at very high speeds.

4. Conclusion

The results collected and calculated in the excel document demonstrate how engine performance varies with speed. This was demonstrated by the torque, brake power and SFC graphs created from the gathered data. Together, the results gathered highlight the fact that an engine performs most efficiently at moderate speeds where the torque is near it maximum and the fuel consumption is at its lowest. It also shows that both very low and very high speeds lead to reduced efficiency and performance.

5. Evaluation

Unfortunately, it wasn't possible to do the engine performance testing myself due to the fact that the dynamometer was not functioning correctly at the time. Despite this I was able to use provided data in order to calculate results and generate graphs needed for the assignment. Despite not being able to gather my own results I believe I was able to do the correct calculations needed with the given data. The obvious improvement for the investigation would be a working dynamometer. With access to a working dynamometer I would've been able to have the experience of gathering my own data which would've helped with my own understanding. Along with this, I would've been able to repeat the test multiple times in order to cross reference the data in order to attain more accurate results and negate any results that would be outliers.

6. Bibliography

Workshops, U. W. (2020, October 16). Engine Dynamometer Overview.

Workshops, U. W. (2020, October 16). Engine Dynamometer testing.

7. Appendices

7.2. [Appendix A](#)

“Engine Dynamometer Results – Owain Holgate .xlsx”