EVALUATION OF FUEL PERFORMANCE FOR RESEARCH AND DEVELOPMENT

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In the mid 1970s, fuel shortages spurred interest in diversifying fuel resources, and thus biodiesel as fatty esters was developed as an alternative to petroleum diesel. As an alternative and renewable energy source, biodiesel has received increasing interest in recent years because it can reduce global dependence on non-renewable petroleum. Moreover, increased environmental awareness prompts the development of biodiesels with less emissions in an effort to reduce environmental pollution from burning fuel.

Malaysia has also conducted research on renewable fuel, especially from its abundant palm oil resource. Methyl ester, derived from palm oil through an esterification process, has proven to be suitable for unmodified diesel engines. Hence, a test on this fuel or its derivative is a prerequisite before it can be fully used in the engine. Fuel testings are normally required to meet increasing stringent quality and safety standards.

With this development, MPOB has acquired a testing facility for fuel performance. MPOB is extending its services on evaluating fuel performance to the industry and the scientific community for research and development (R&D) purposes.

OBJECTIVE

To provide services on the evaluation of diesel and biodiesel fuel performance to the industry and the scientific community for R&D purposes.

ENGINE DYNAMOMETER

A dynamometer, or 'dyno' in short, is a device used to measure the power and torque produced by an engine. There are two types of dynos: one that is bolted directly to an engine, and is known as an engine dyno, or a dyno that can measure power and torque without removing the engine from the frame of the vehicle; this latter is known as a chassis dyno. There are several kinds of dynamometers in use for evaluating engines. Among the popular ones are the eddy current or electromagnetic brake, the electric motor/generator [alternate current (AC) or direct current (DC)], the hysteresis brake, the hydraulic brake, the water brake, the fan brake and the mechanical friction brake.

Eddy current (EC) dynamometers are currently the most common absorbers used in modern engines and chassis dynos. They produce a braking torque using the principle of eddy currents induced on a rotating metallic disk which is immersed in a magnetic field. By varying the voltage of the electromagnets, the magnetic field strength is changed to control the amount of braking. The EC absorbers provide a quick load change rate for rapid load settling. They are fitted with high accuracy strain gauge load cells to provide torque measurement capabilities for precise test and development applications. Most are air-cooled, but some are designed to require external water cooling systems.

The engine test bed houses several sensors (or transducers), data acquisition features and actuators to control the engine state. The sensors measure several physical variables of interest which typically include:

- crankshaft torque and angular velocity.
- intake air and fuel consumption rates, often detected using volumetric and/or gravimetric measurement methods.
- air-fuel ratio for the intake mixture, often detected using an exhaust gas oxygen sensor.
- temperatures and gas pressures at several locations on the engine body such as engine oil temperature, exhaust gas temperature and intake manifold pressure.
- atmospheric conditions such as temperature, pressure, and humidity.

Information gathered through the sensors is processed and logged through data acquisition

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systems and displayed on a monitor(s). The operation of the dyno is normally computerised and can be customised according to client needs.

Why Dyno Testing?

- To evaluate the performance and power of engines.
- To evaluate the performance of fuels.
- So that operating data can be compared to the manufacturer's specifications and original data.
- To know positively the engine and oil temperatures, pressures, fuel consumption and air/fuel ratio over a range of loads.
- For continuous duty power verification with minimum load capability.
- To tune for fuel economy, maximum power and emissions control, and to set electronically commutated motors (ECM) parameters.
- For engine break-in before installation.
- Dyno testing gives you the confidence of knowing exactly what you have got.

MPOB Engine Dynamometer Testing Facility

The engine testing facility at MPOB is equipped with an EC dynamometer and supported by a DataqPro control system (*Table 1*). This data control system provides an excellent solution for data acquisition and control in the engine and dynamometer, and is a highly efficient engine qualification tool.

Testing is fully automated for precision control of engine throttle and dynamometer load, ensuring accurate and repeatable performance of each step under controlled testing environments for reliable certification tests. An integrated DigiC Real-Time Digital Control System enables the entire test to be viewed in Trend Display, which stores all of the monitored channels. The Trend Display is viewable whilst the test is running on a second monitor, and post-test analysis can be performed using the Trend Analyser. Power Curve generation is fully automatic with viewing in real-time as the Power Curve is plotted. Up to two channels can be viewed at any one time on the graph. Full logged data can be extracted and viewed in Microsoft Excel for separate analysis and storage. Alarm warnings sound when the sensors exceed the range of operation presets, and data are recorded so that conditions triggering the alarm can be diagnosed.

A common rail direct fuel injection diesel engine is coupled to the dynamometer (*Table 2*). This type of engine is a modern variant of the fuel injection system that features piezoelectric injectors for increased precision, with fuel pressures up to 1800 bar (26 000 psi) as opposed to its predecessor that uses a solenoid valve to feed the fuel at over 1000 bar (15 000 psi).

TABLE 1. EDDY CURRENT (EC) DYNAMOMETER SPECIFICATIONS

Maximum absorption power	250 kW
Maximum torque	1 200 Nm
Maximum speed	8 000 rpm

TABLE 2. DIESEL ENGINE SPECIFICATIONS

Engine type	1KD-FTV
Number of cylinders and arrangement	4 cylinders, in-line
Valve mechanism	16-valve DOHC
Bore x stroke (mm)	97.0 x 103.0
Displacement (cc)	2 982 (Intercooled Turbo)
Compression ratio to 1	16.0
Fuel system	Common-rail type
Maximum output (EEC) (kW @ rpm)	120 @ 3 400
Maximum torque (EEC) (Nm @ rpm)	343 @ 1 200-1 600

Figure 1. Engine dynamometer facility setup.

Figure 2. Fully computerised control of the dyno operation.

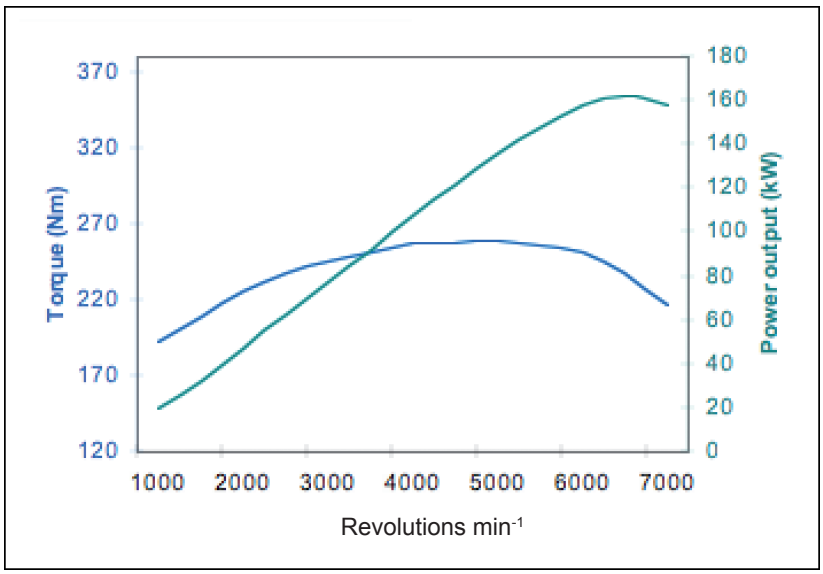

Figure 3. Power curves.

Among the evaluations offered by MPOB using the engine dynamometer testing facilities are:

(i) Power curve (power and torque) generation;
(ii) Fuel consumption; and
(iii) Exhaust emissions.

TERMS AND CONDITIONS OF SERVICES

(i) The starting date of the testing is subject to the availability of the testing facilities.
(ii) Fuel for testing is to be provided by the client.
(iii) Services provided to the client shall not in any way constitute an endorsement by MPOB of the end-product and/or its performance thereof, and none shall therein be inferred.
(iv) MPOB does not in any way warrant that the result of the testing conducted hereunder for the services shall be in any way suitable, capable and/or compatible for use in commercial vehicles and/or other commercial application thereto.
(v) MPOB will only proceed with the agreed task upon receipt of an official Letter of Award/Work Order from the client.
(vi) MPOB undertakes to keep strictly confidential all information collected, or worked on during and in connection with or related to the above work. This provision shall not apply to any information that becomes part of public domain.

For more information, kindly contact:

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