Lectures

8th Semester B. Tech. Mechanical Engineering

Subject: I C Engines Lab

In-charge Course: Prof M Marouf Wani

Chapter: Engine Testing

Topic: Measurement of Performance Parameters Of I C Engines – 06-05-2020

Measurement of Engine Performance Parameters:

Internal combustion engines are mounted on the test rigs of I C engines Lab. Further the engine is fitted with instrumentation for the measurement of air consumption, fuel consumption, torque developed by the engine, engine speed and the power developed by the engine.

(i) Measurement of Torque:

Strain Gauge Type Load cell based electrical output signal:

Compatible to digital computerized data acquisition system:
Engine torque is normally measured with a dynamometer. The engine is clamped on a test bed and the shaft is connected to the dynamometer rotor. The rotor is coupled electromagnetically, hydraulically, or by mechanical friction to a stator, which is supported in low friction bearings. In case of hydraulic loading, the stator is balanced with the rotor stationary. The torque exerted on the stator with the rotor turning is shifted to a **strain gauge type load** cell mounted on a cantilever type support. The output of the load cell multiplied by the arm length of load cell from the centre of engine crank shaft is calibrated in terms of the engine torque.

(ii) Measurement of Speed:

Inductive Pickup based electrical output signal:

Compatible to digital computerized data acquisition system:
Inductive pickup is used to measure the rotational speed of crankshaft. The probe is attached to any high tension cord of a spark plug. For every high voltage supply based spark discharge in a spark plug, the flow of current in the high tension cord produces a magnetic field around the cord. The **make and break of this magnetic field**, corresponding to the firing order and therefore firing interval maintained by the distributor, triggers a voltage pulse in the inductive pickup attached on the cord. These **electrical pulses**, having a particular **frequency** for a particular engine speed is used as an input to the CPU of the computerized data acquisition system, are further calibrated in terms of the engine speed with the help of designed application software.

(iii) Measurement of Power:

Load cell based electrical signal for torque:
Inductive pickup based electrical signal for speed:
Compatible to digital computerized data acquisition system:
The load cell based electrical output signal representing the engine torque and the inductive pickup based electrical output signal representing the engine speed are used as input to the CPU of the computer of the data acquisition system. The computer is loaded with a suitable application software which converts these two electrical signals for torque and speed to the power developed by the engine.

(iv) Measurement of Fuel Consumption:

The fuel consumption can be measured by Volumetric method and Gravimetric method.

Volumetric method:

in case of volumetric method the fuel is supplied to the engine with the help of a **calibrated glass tube** fitted with a three way cock. A **stop watch** is used to measure the consumption of fuel on volumetric basis for a particular interval of time say **10 or 20 seconds.** This makes it possible to calculate the fuel flow rate under those engine operating conditions.

Gravimetric method:

Strain Gauge - Load cell based electrical output signal is compatible for digital computerized data acquisition system:
In case of computerized data acquisition system, the fuel consumption is measured by using gravimetric method involving the use of a strain gauge type of load cell having an electrical output. The fuel tank is mounted on a cantilever fitted with a strain gauge type of load cell. Under operating conditions the mass of fuel in the fuel tank decreases which changes the fuel tank based gravimetric load acting on the load cell. The change in the load acting on the load cell changes its electrical output. The change in the output of the load cell for a particular interval of time is calibrated in terms of the fuel consumption on gravimetric basis say kg/hour or say grams/sec.

(v) Measurement of Air Consumption:

Gravimetric Method:

With electrical output signal:
Compatible to computerized data acquisition system:
A mass (air) flow sensor (MAF) is a sensor used to determine the mass flow rate of air entering a fuel-injected internal combustion engine.
The air mass information is necessary for the engine control unit (ECU) to balance and deliver the correct fuel mass to the engine. This approach is used almost exclusively on electronic fuel injection (EFI) engines.
The sensor designed output is a 0.0 – 5.0 volt. The sensor has an intake air temperature (IAT) sensor incorporated into its housing for most post on-board diagnostics (OBDII) vehicles.
A **hot wire mass airflow sensor** determines the mass of air flowing into the engine's air intake system.
The **theory of operation** of the hot wire **[tungsten] mass airflow sensor** involves the heating of a wire suspended in the engine's air stream by applying a constant voltage over the wire. The wire's electrical resistance increases as the wire's temperature increases, which varies the electrical current flowing through the circuit, according to Ohm's law. When air flows past the wire, the wire cools, decreasing its resistance, which in turn allows more current to flow through the circuit, since the supply voltage is a constant. As more current flows, the wire's temperature increases until the resistance reaches equilibrium again.
The increase or decrease in the current flowing through the sensor is proportional to the mass of air flowing past the wire. The integrated electronic circuit converts the proportional measurement into a calibrated signal representing the **air flow on mass basis** [say **Kg/sec**]which is sent to the ECU.

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References:
1. User manual for the engine test rigs.
2. Wikipedia.