MEC 4011
Laboratory Experiment

Compression Ignition Engine : Effects of Variation of Injection Duration and Injection Timing

Object:

To investigate the effects of the quantity of diesel injected and injection timing on engine performance. The engine performance is directly measured by dynamometer as brake torque. The measurements from the Engine Control Unit are also used to determine volumetric efficiency and brake specific fuel consumption.

Apparatus:

Peugout 2.0 litre HDi, 4 cylinder, common rail diesel engine,
Stuska water brake dynamometer,
Programmable ECU, Reata.
Data logged by ECU :
from sensors on engine : Mass Air Flow g/s, Manifold Absolute Pressure kPa, Air Temp ^{o}C (in column Air), Brake Torque (lb-ft or Nm)
other: RPM, Duration Of Injection per injector per 2 crank revolutions milli-seconds (in Column Fuel), measured fuel rail pressure, injection timing (advance angle before TDC).

Procedure

1. Engine is started and warmed up to operational temperature, i.e. with opened thermostat 70 or 80 Celsius.
2. The engine is loaded to a particular RPM and Load as directed during the laboratory session. High engine load in the range of 50 to 80% can be chosen. The fuel quantity is then varied by changing Duration Of Injection. The range of values of DOI can be varied from around 0.4 to 1.2 ms. The torque should be noted to vary with change in DOI, higher DOI produce higher loads but also possibility of black smoke. Note that all data being reported on screen is logged by the computer and will be available for analysis after lab session.

3. At the same RPM and load, the injection timing (Start Of Injection SOI) is varied from say 5 degrees Before Top Dead Centre to say 35degress BTDC. The torque should be noted to vary with injection timing.

4. Repeat the variation of DOI and injection timing as above for two other set-points of RPM and Load.

Results

The data logs can be opened and manipulated in Excel. Note that the logs might have portions of data that are from the ramping up or down to and from the actual set point of RPM and load. Also data might have a repetition of say DOI and torque for example due to the fact that DOI is made to vary from 0.4 ms to 1.2 ms and then back to 0.8 ms generates two portions of data with DOI from 0.8 to 1.2 ms.

For each set point of RPM and Load,

1: Plot Torque (Nm) versus DOI, DOI as logged in the computer data logs which is the imposed opening time to the injectors.

2: Compute mass flow of fuel per injection from

$$FlowPerInjection\ (ml/inj) = ((0.0244)(ActualDOI) + (0.0018))\left[\frac{\sqrt{P}}{\sqrt{300}}\right]$$

Where p is the fuel rail pressure in bar.

Actual DOI (ms) = DOI in logs minus FuelDurationCorrection.

$$FuelDurationCorrection\ (ms) = -\left(6x10^{-4}\right)P + 0.42 \qquad \text{for P} < 700\text{Bar}$$

&

$$FuelDurationCorrection\ (ms) = 0 \qquad \text{for P} \geq 700\text{Bar}$$

Hence calculate the total flow of diesel for the 4 cylinders at the test rpm.
3: Plot Specific Fuel Consumption (g/kWh) against DOI.
4: Calculate volumetric efficiency based on measured and logged MAF.
4: Plot Torque versus Injection Timing.
5: Plot BSFC versus Injection Timing.

Conclusions

Draw your own conclusions on the experiment and results obtained.

The Lab Report is to be handed back in printed format. Note that the number of curves being plotted is not large and hence colour is not really required. It is better to just plot data point without any connecting lines so that the quantity of data is visible and excess clatter by lines is avoided.