Department of Mechanical and Marine Engineering
University of Plymouth

MECH 225 Engineering Science 2

Perkins Diesel Engine

Objective

To gain an understanding of the design and operation of a diesel engine, and to determine its performance characteristics, brake specific fuel consumption, thermal efficiency and air-fuel ratio as functions of the brake power.

Equipment

The engine is a four cylinder Perkins diesel (Type 4.108) water cooled, with each cylinder of bore 79.725 and stroke 88.9 mm. The compression ratio is 22:1.

The engine is coupled to a Heenan-Froude (Type SG14) water cooled dynamometer, such that the torque, T, and the speed in rev min^{-1}, N, can be measured.

The fuel consumption is measured by noting the time, t, required to use a given volume, V, of fuel.

The air mass flow rate is metered by using an Orifice Plate fitted to an air reservoir attached to the inlet manifold of the engine. The pressure across the orifice is measured by means of an inclined water manometer. (See section 3.7(c) and (d) of the notes.)

Data

The lower calorific value (L.C.V.) of the fuel = 43,250 $kJkg^{-1}$. This is the energy produced by combustion of 1 kg of fuel.
The density of the fuel, ρ = 820 kg m^{-3}
The diameter of the orifice in the air flow meter, D = 60 mm
The coefficient of discharge for the meter, C_d = 0.6

Theory

An engine is designed to produce a work output. The net rate of work output of a diesel engine is called the Brake Power, $\dot{W}$.

The thermal efficiency is defined as the ratio of the net power output to the rate of heating input. $$\eta_{th} = \frac{\dot{W}_{net}}{\dot{Q}_{in}}$$

The brake specific fuel consumption (BSFC) is the rate at which fuel is consumed per kW of power developed, and is measured in kg/KWh

Before carrying out this experiment, complete the following:

1. Derive an expression for brake power in terms of T and N.

2. Derive an expression for the mass flow rate of the fuel in terms of V, t and the density of the fluid.

3. Derive an expression for the thermal efficiency in terms of the brake power, the mass flow rate of the fuel and its L.C.V.

4. Show that the air mass flow rate is given by:

$$\dot{m}_{air} = 3.896 D^2 \sqrt{\frac{h P_{amb}}{T_{amb}}}$$

where h is the manometer reading in mm, P_{amb} is the ambient pressure in kPa, and T_{amb} is the ambient temperature in Kelvin.
You may assume that R for air is 287 $kJkg^{-1}\ K^{-1}$

Experimental procedure

The engine will be operated by the technician. Observe and make notes of the operating procedure. Once steady conditions have been reached, for each load adjustment record the following:

Engine speed, N (rev min^{-1})

Torque T (Nm)

Volume of fuel used, V (ml) (Note 10^6 ml = 1 m^3)

Time to collect fuel, t (s)

Manometer reading, h (mm)

Record also:

Ambient pressure, P_{amb}

Ambient temperature, T_{amb}

Report

This should include the following elements:

1. A statement of the aim of the experiment
2. The development of the theory, carried out before doing the experiment.
3. A labelled schematic diagram of the apparatus
4. A brief description of the procedure
5. Results tables
6. Sample calculations to illustrate your method of working (and allow it to be checked).
7. Separate graphs for (a) BSFC, (b) thermal efficiency and (c) air-fuel ratio against brake power.
8. Observations – mention any peculiarities or known errors observed during the test.

9. Discussion and conclusions. To help you with this section the following questions may be profitably addressed but try and think of a few ideas of your own. Why must the fuel be clean? Is there an optimum performance condition? What happens to all the energy released by the combustion process? Apply the First Law of Thermodynamics to this experiment.

Notes

- Results and graphs should be presented in spreadsheet form. Tabulated results are required to support graphs. Sample calculations may be hand-written. Pay attention to the number of decimal places you use – can you justify the accuracy you imply?
- Pay particular attention to good practice when plotting graphs of experimental results.
- Make sure you use “scatter graphs” in Excel, not “line graphs”; are you aware of the difference?
- The discussion is a key part of any experimental report – it carries a lot of marks.
- This is an individual coursework submission - it is to be your own work – **action will be taken in cases of plagiarism.**

Marking criteria will include:

Accuracy with which results are processed; clarity of presentation of results; level of detail and accuracy of discussion; presentation of report.

MMS/PKD/MJE 2003