Course : Applied Thermal Engineering (UMT303)

Batch: B.E. Mechatronics (2nd yr.) **Faculty: Dr. Sayan Sadhu**

Tutorial No. 11 **Topic: IC Engine**

Q1. A four-stroke CI engine of 3.5 litre capacity develops indicated power on average of 13.1 kW/m3 of free air induced per minute, while running at 3600 rpm and having a volumetric efficiency of 82 per cent, referred to free air conditions of 1.013 bar and 25°C. A blower driven mechanically from the engine is proposed to be installed for supercharging. It works through a pressure ratio of 1.75 and has an isentropic efficiency of 70 per cent. Assume that at the end of the intake stroke the cylinders contain a volume of charge equal to the swept volume, at the pressure and temperature of the delivered air from the blower. Taking all mechanical efficiencies to be 80 per cent, estimate the net increase in brake power of the engine due to supercharging. **[Ans. 28.69kW]**

Q2. A diesel engine is fitted with a turbocharger which comprises a radial compressor driven by a radial exhaust gas turbine. The air is drawn into the compressor at a pressure of 0.97 bar and a temperature of 30°C and is delivered to the engine at a pressure of 2.1 bar. The engine operates on an air-fuel ratio of 18 and the exhaust leaves the engine at 580°C and 1.9 bar. The turbine exhausts at 1.06 bar. The isentropic efficiencies of the compressor and turbine are 0.75 and 0.85 respectively. Taking Cpa = 1.01 kJ/K and γa = 1.4 for air and Cpex = 1.15 kJ/kgK and γex = 1.33, determine

a) the temperature of air leaving the compressor

b) the temperature of the gases leaving the turbine

c) the mechanical power loss in the turbocharger as a percentage of the power generated in the turbine.

[Ans. a) 129.73°C; b) 482.25 °C; c) 15.14%]

Q3. During a test on a diesel engine used for driving a dc generator, following observations were made. The output of the generator was 215 A at 210 V, the efficiency of the generator being 85%. The quantity of fuel supplied to the engine was 11.8 kg/h, the calorific value of fuel being 43 MJ/kg. The air-fuel ratio was 18:1. The exhaust gases were passed through an exhaust gas calorimeter for which the observations were as follows: Water circulated through the calorimeter = 560 litres/h, Temperature rise of water = 38°C, Temperature of exhaust gases at exit from calorimeter = 97°C, Specific heat of exhaust gases = 1.04 kJ/kgK, Ambient temperature = 30°C. If the heat lost to the jacket cooling water was 32% per cent of the total energy released by combustion, draw up an energy balance sheet of the engine.

Q4. Following are the observations made for a 20 minute trial of a two stroke diesel engine. Net brake load = 680 N, mep = 3.0 bar, N = 360 rpm, Fuel consumption = 1.56 kg, Cooling water = 160 kg, Water inlet temperature = 32°C, Water outlet temperature = 57°C, Air used/kg fuel = 30 kg, Room temperature = 27°C, Exhaust gas temperature = 310°C, Cylinder dimensions = 210 mm bore and 290 mm stroke, Brake diameter = 1m, Calorific value of fuel = 44 MJ/kg, Steam formed per kg fuel in the exhaust = 1.3 kg, specific heat of steam in exhaust = 2.093 kJ/kgK, Specific heat of dry exhaust gases = 1.01 kJ/kgK. Calculate

a) the indicated power and the brake power and mechanical efficiency

b) the percentage of indicated power, cooling water, exhaust gas and unaccounted loss

[Ans. a)18.08kW; 12.818kW;70.89%, b) 31.61%,24.4%,27.51%,16.47%]