S.E(Sem-IV) / Mech / Thermal Engg / Dec 09

Con. 5243-09. SP-7736

(REVISED COURSE)

(3 Hours) [Total Marks : 100

N.B. : (1) Question No. **1** is **compulsory** and solve any **four** from question Nos. **2** to **7**.
(2) Assume **suitable** data if **necessary** and **state** it **clearly**.
(3) Use of Mollier chart and Steam table is **permitted**.

1. Discuss and explain the following (any **four**) :— 20
   (a) Heating values of fuel.
   (b) Advantages of compounding of steam turbine.
   (c) Important featurs of high pressure boiler.
   (d) Effect of multistaging in compressor and turbine in gas power cycle.
   (e) Effect of pressure ratio on work output and volumetric efficiency of compressor.
   (f) Effect of air leakage in case of condensers.

2. (a) Define :— 4
   (i) Enthalpy of combustion.
   (ii) Calorific value at constant pressure and constant volumes.
   (iii) Adiabatic combustion temperatrure.
   (iv) Actual air fuel ratio.

   (b) One kg of liquid octane (C_8H_{18}) is burnt completely with 50% excess air, in a constant volume container. Before combustion, both liquid octane and air are at 25 °C and 1 atmospheric pressure. The combustion products are at 1600 K at the end of combustion. Calculate the heat transfer per kg-mole of fuel. 12

   Use the following data :—

Substance	$h_+^{'0}$ (MJ/K mol)'	h_{298} K(MJ/K mol)	h_{1600} K(MJ/K mol)
C_8H_{18} (Liquid)	– 250	—	—
O_2	—	8·68	52·96
N_2	—	8·67	50·57
H_2O (gas)	– 241·8	9·90	62·75
CO_2	– 393·5	9·36	76·93

   (c) Discuss the effect of back pressure on the performance of CD nozzle. 4

3. (a) Define : 8
   (i) Free air delivered in compressor.
   (ii) Isothermal efficiency of compressor.
   (iii) Volumetric efficiency of compressor.
   (iv) Adiabatic efficiency of compressor.

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(b) A single stage double acting air compressor is required to deliver 14 m^3 of air per minute measured at 1·013 bar at 15 °C. The delivery pressure is 7 bar and the speed is 300 rpm. Take the clearance volume as 5% of the swept volume with the compression and expansion index of n = 1·3. Calculate— **12**

(i) Swept volume of the cylinder
(ii) The delivery temperature
(iii) Indicated power.

4. (a) Describe different types of condensers. **8**

(b) A steam generator evaporates 18,000 kg/h of steam 12·5 bar and a quality of 0·97 from feed water at 105 °C, when the coal is fired at 2040 kg/h. If the higher calorific value of the coal is 27,400 kJ/kg. Find :— **12**

(i) The heat rate of boiler in kJ/h ;
(ii) The equivalent evaporation ;
(iii) The thermal efficiency.

5. (a) A stage of turbine with Parson's blading delivers dry saturated steam at 2·7 bar from fixed blade at 90 m/s. The mean blade height is 40 mm and the moving blade exit angle is 20°. The axial velocity of steam is 3/4th of the blade velocity at the mean radius. Steam is supplied to the stage at the rate of 9000 kg/h. Calculate :— **12**

(i) The wheel speed in rpm
(ii) The diagram power
(iii) The diagram efficiency
(iv) Enthalpy drop in the stage.

(b) Classify different types of steam turbine. **4**

(c) Describe air motors. **4**

6. (a) Describe boiler mountings and accessories. **8**

(b) The pressure ratio of an open cycle gas turbine power plant is 5·6. Air is taken at 30 °C and 1 bar. The compression is carried out in two stages with perfect intercooling in between. The maximum temperature of the cycle is limited to 700 °C. Assuming that isentropic efficiency of each compressor stage as 85% and that of turbine as 90%, determine the power developed and efficiency of the power plant, if the air flow is 1·2 kg/s. The mass of fuel may be neglected and it may be assumed as Cp = 1·02 kJ/kg K and V = 1·41. **12**

7. Write notes on any **four** :— **20**

(a) Perfect intercooling in compressor
(b) Differentiate between water tube and fire tube boiler.
(c) Entropy changes for reacting mixtures.
(d) Vacuum efficiency of compressors.
(e) Condition for maximum efficiency in case of impulse turbine.
(f) Applications of gas turbines.
