-11-S.G. 37

6516-11. Sem IV / mech / 13-12-11 / Thermal Engg. MP-4258

(3 Hours) [Total Marks : 100

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) Methods to improve efficiency of a gas turbine.
   (b) Difference between pressure compounding and velocity compounding of a steam turbine.
   (c) Effect of air leakage on vaccum efficiency of a condenser.
   (d) Differentiate between enthalpy of combustion and enthalpy of formation.
   (e) Discuss about mountings and accessories of boilers.
   (f) Effect of pressure ratio on volumetric efficiency of a compressor.

2. (a) Define :— 4
   (i) Higher and Lower heating valve of fuel.
   (ii) Stoichiometric air fuel ratio.
   (iii) Adiabatic combustion temperature.
   (iv) Calorific valve at constant pressure and constant volume.

   (b) One Kg. of liquid octane ($C_8 H_{18}$) is burnt completely with 150% excess air in a constant volume container. Before combustion, both liquid octane and air at 25°C and 1 atmospheric pressure. The combustion products are at 1600K at the end of combustion. Calculate the heat transfer per kg-mole of fuel. Use of following data :— 10

Substance	h_o(MJ/Kmol)	h_{298k} (MJ/Kmol)	h_{1600k}(MJ/Kmol)
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 perfect intercooling and ideal intercooler pressure for minimum work input to the compressor. 6

3. (a) Discuss the effect of clearance volume and free air delivered on volumetric efficiency of compressor. 8
   (b) A single acting two stage compressor with complete intercooling delivers 10·5 Kg/min of air at 16 bar. The suction occurs at 1 bar and 27°C. The compression and expansion processes are reversible, polytropic index n = 1·3. Calculate. 12
   (i) The power required to drive the compressor.
   (ii) The isothermal efficiency.
   (iii) The free air delivery.
   (iv) The heat transferred in intercooler. The compressor runs at 440 r.p.m.

4. (a) Differentiate between surface and evaporative condensers. 6
   (b) A steam generator evaporates 18000 kg/h of steam at 12·5 bar and a quality of 0·97 from feed water at 105°C, when the coal is fired at the rate of 2040 kg/h. If the higher calorific valve of the coal is 27400 KJ/kg, find :— 8
   (i) The heat rate of boiler in KJ/h;
   (ii) Equivalent evaporation
   (iii) The thermal efficiency.
   (c) Prove that the critical pressure ratio for minimum discharge through the nozzle is given by : $\frac{P_2}{P_1} = \left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}$. 6

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5. (a) Prove that condition for manimum blade efficiency of a reaction turbine is given by relation : $(\eta_b)_{max} = \frac{2\cos^2\alpha}{1+\cos^2\alpha}$ 8

   (b) A 50% reaction turbine (with symmetrical velocity triangles) running at 400 r.p.m. has the exit angle of the blades as 20° and the velocity of steam relative to the blades at the exit is 1·35 times the mean blade speed. The steam flow rate is 8·33 kg/s, and at a particular stage the specific volume is 1·381 m^3/kg. Calculate for this stage : 8

   (i) A suitable blade height, assuming the rotor mean diameter 12 times the blade height.

   (ii) The diagram work.

   (c) Differentiate between reacting and non reacting (mixture) system. 4

6. (a) Differentiate between water tube and fire tube boiler. 4

   (b) The air in a gas turbine plant is taken in at low pressure at 293K and 1·05 bar and after compression it is passed through intercooler, where its temperature is reduced to 300K. The cooled air is further compressed in high pressure compressor and then passed in the combustion chamber, where its temperature is increased to 750°C by burning the fuel. The combustion products expand in high pressure turbine which runs the compressor and further expansion is continued in low pressure turbine. Which runs the alternator. The gases coming out from low pressure turbine are used for heating the incoming air from high pressure compressor and then expanded to atmosphere. 12

   Pressure ratio of each compressor = 2

   η_{iso} (each compressor stage) = 82%

   η_{iso} (each turbine stage) = 82%

   ε (HE effectiveness) = 0·72

   Air flowrate = 16 kg/s, Calorific value of fuel = 42, 000 KJ/kg,

   C_v (gas) = 10 KJ/kgk, C_p (gas) = 1·15 KJ/KgK.

   γ_{air} = 1·4, V_{gas} = 1·33. Neglecting fuel mass calculate.

   (i) Power output (ii) Thermal efficiency (iii) Specific fuel consumption.

   (c) Differentiate between high pressure and low pressure boiler. 4

7. Write notes on any **four**:— 20

   (a) The important feature of High Pressure Boiler

   (b) Applications of Gas Turbine

   (c) Air Pump Capacity

   (d) Classification of Steam Turbine

   (e) Entropy change of reacting mixture

   (d) Advantages of multistaging in compressor and turbine in gas power plants.
