S.E - IV | Mech | Thermal Engg.

07.12.12

100 : 2nd half-12-(k) JP

Con. 10061-12.

KONKAN GYANPEETH KARJAT Dist. Raigad COLLEGE OF ENGINEERING

KR–7214

(3 Hours) [Total Marks : 100

N.B.: (1) Question No. **1** is **compulsory**.
(2) Answer any **four** out of remaining **six** questions.
(3) Assumptions made should be **clearly** stated.
(4) **Use** of **steam** table and **mollier** chart are **permitted**.

1. Solve any **four** of the following :— **20**
   (a) Write short note on Boiler Mounting's.
   (b) Define the following :—
      (i) Reactive and non-reactive system
      (ii) Heat of combustion.
   (c) Enumerate the various uses of compressed air.
   (d) Comparison between centrifugal and axial flow compressor.
   (e) Effect of clearance volume of FAD and Columetric efficiency.

2. (a) Define clearly :— **8**
      (i) Lower calorific value
      (ii) Higher calorific value
      (iii) Enthalpy of reaction
      (iv) Enthalpy of formation.
   (b) A hydrocarbon fuel (C_7H_{16}) has enthalpy of combustion – 4856920 kJ/kg mole. **12**
   Find it's value of enthalpy of formation of CO_2 and H_2O respectively as –393791 and –288136 kJ/kg mole.

3. (a) What is the difference between rotary and reciprocating compressor ? What do you mean by surging and choking of compressor. **8**
   (b) Following data relate to a performance test of a single acting 14 cm × 10 cm reciprocating compressor – **12**

Suction pressure	=	1 bar
Suction temperature	=	20°C
Discharge pressure	=	6 bar
Discharge temperature	=	180°C
Speed of compressor	=	1200 rpm
Shaft power	=	6·25 kw
Mass of air delivered	=	1·7 kg/min

   Calculate the following :—
      (i) The actual volumetric efficiency
      (ii) The indicated power
      (iii) The isothermal efficiency
      (iv) The mechanical efficiency
      (v) The overall isothermal efficiency.

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4. (a) Show that the condition for minimum work required for two stage imperfect intercooling and different compression index for both stages is given by : **10**

$$P_2 = \left[\frac{J_3}{J_2}(P_1)^x (P_2)^y\right]^{\frac{1}{(x+y)}}$$

where $x = \frac{n_1 - 1}{n}$ and $y = \frac{n_2 - 1}{n_2}$.

(b) A centrifugal compressor with 70% isentropic efficiency delivers 20 kg of air per minute at a pressure of 3 bar. If the compressor recieves air at 20°C and at a pressure of 1 bar, find the actual temperature of the air at exit. Also find the power required to run the compressor, if it's mechanical efficiency is 95% take v and C_p for air as 1·4 and 1 kj/kg K respectively. **10**

5. (a) Fire tube boilers are not preferred for high pressure steam generation why ? **5**

(b) Draw a neat diagram of cochran boiler. **5**

(c) The following observations were made on a boiler plant during one hour test : **10**

steam pressure	=	20 bar
steam temperature	=	260°C
steam generated	=	37500 kg
temperature of water entering the economiser	=	15°C
temperature of water leaving the economiser	=	90°C
fuel used 4400 kg energy of combustion of fuel	=	30,000 kJ/kg

Calculate : (i) The equivalent evaporation per kg of fuel

(ii) The thermal efficiency of the plant

(ii) The % heat energy of the fuel energy utilised by the economiser.

6. (a) Prove that the maximum efficiency of Parson's steam turbine is equal to **8**

$$\frac{2\cos^2 \alpha 1}{1+\cos^2 \alpha 1}.$$

(b) A 50% reaction turbine (with symmetrical velocity triangle) running at the 400 rpm has the exit angle of the blades as 20°C and velocity of the steam relative to the blades at the exist 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 : **12**

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

(ii) The diagram work.

7. (a) What are the various methods employed to improve the specific output and thermal efficiency of open cycle gas turbine plant explain any two of them. **8**

(b) In a gas turbine plant, the air is compressed in a single stage compressor from 1bar to 9bar and from an initial temperature of 300 K. The same air is then heated to a temperature of 800K and then expanded in the turbine. The air is then reheated to a temperature of 800K and then expanded in the second turbine. Find the maximum power that can be obtained from the installation, if the mass of air circulated per second is 2 kg. Take C_p = 1kJ/kg K. **12**