Total No. of Questions : 10] [Total No. of Printed Pages : 4

Roll No. .....

ME–404(N)

B. E. (Fourth Semester)
EXAMINATION, June, 2011
(Mechanical Engg. Branch)
THERMAL ENGINEERING AND GAS DYNAMICS
[ME–404(N)]

Time : Three Hours

Maximum Marks : 100

Minimum Pass Marks : 35

Note : Attempt any *five* questions. Questions are given with internal choice. Use of Steam table, Mollier chart, Gas table and gas charts is permitted in the examination hall.

1. The following data were obtained during a trial on a steam boiler fixed with natural draught :

Feed water temperature	71°C
Feed water supplied per hour	4500 kg
Steam pressure (gauge)	10 bar (gauge)
Barometer reading	750 mm of Hg

Throttling calorimeter readings :

(i) Pressure of steam after throttling (gauge) = 15·5 mm of Hg

(ii) Temperature of steam after throttling = 104°C

(iii) Assume specific heat of superheated steam after throttling in calorimeter = 2·00 kJ/kg°K

P. T. O.

Coal fired/hr. = 100 kg

Higher calorific value of coal = 39350 kJ/kg

Moisture in fuel = 4·25% by weight

Temperature of fuel gases discharged = 275°C

Boiler house temperature = 25°C

Analysis of dry coal by weight was as follows :

C = 89%, H_2 = 3%, Ash = 4% and volatile matter = 4%.

The analysis of flue gas by volume was as follows :

CO_2 = 10·9%, CO = 1·1%, O_2 = 7% and N_2 = 81%.

Assume the specific heat of dry flue gases as 0·963 kJ/kg°K and specific heat of superheated steam in products of combustion 2·00 kJ/kg°K. Draw up the Heat Balance Sheet for the boiler per kg of cool fired ? Calculate thermal efficiency of the boiler. Also find the quantity of steam generated. 20

Or

2. The following observations were taken during a test on steam boiler :

Quantity of coal burnt/hr. = 720 kg

Feed water supplied/hour = 7000 kg

Calorific value of coal fired = 34000 kJ/kg

Feed water temperature entering Economiser = 25°C

Feed water temperature leaving Economiser = 80°C

Steam pressure = 10 bar

Dryness fraction of steam leaving boiler drum = 0·95

Temperature of the steam leaving superheater = 250°C

Determine the thermal efficiency of the boiler, also calculate the heat absorbed by feed water in various components as a percentage of total heat absorbed. 20

3. (a) Show that the thermal efficiency of a regenerative cycle in always higher than that of a straight Rankine cycle regardless of where the steam is tapped off. 9

(b) Prove that the overall efficiency of a Binary vapour cycle using mercury/water, is given by : 11

$$\eta = \eta_{Hg}(1 - \eta_s) + \eta_s$$

$\eta_{Hg} \rightarrow$ Thermal Efficiency of Mercury cycle

$\eta_s \rightarrow$ Thermal Efficiency of Steam cycle

Or

4. (a) Explain the basis for the choice of the number of regenerative heaters in a steam power generating system. 10

(b) Discuss the advantages of reheating the steam in high pressure steam power generating system. 10

5. Derive the following equations : 10 each

(a) $\dfrac{P_0}{P} = \left(1 + \dfrac{\gamma - 1}{2} M^2\right)^{\gamma/\gamma - 1}$

(b) $\dfrac{T^*}{T} = \dfrac{2}{\gamma + 1} + M^2 \dfrac{\gamma - 1}{\gamma + 1}$

with usual notations.

Or

6. Deduce the following equations : 10 each

(a) $\dfrac{\rho^*}{\rho} = \left[\dfrac{2}{\gamma + 1} + \dfrac{\gamma - 1}{\gamma + 1} M^2\right]^{1/\gamma - 1}$

(b) $\dfrac{A}{A^*} = \dfrac{1}{M}\left[\dfrac{2}{\gamma - 1} + \dfrac{\gamma - 1}{\gamma + 1} M^2\right]^{\frac{\gamma + 1}{2(\gamma - 1)}}$

with usual notations.

P. T. O.

7. Determine the size of the cylinder of a double acting air compressor of 32 kW, IP in which air is drawn in at 1 bar and compressed to 16 bar according to the law $PV^{1.25}$ = constant, RPM = 300, piston speed = 180 m/min., volumetric efficiency = 0·8. 20

Or

8. (a) Deduce an expression for optimum value of the entire cooler pressure in two stage compressor, stating clearly the assumptions made. 13

(b) Classify various types of air compressor. 7

9. A surface condenser of 0·7 m^3 capacity contains saturated steam and air at 42·3°C and 0·127 bar. Due to further motion in the condenser, the air leaks into the condenser and pressure increases to 0·28 bar and temperature falls to 37·3°C. Find the mass of air leaked. 20

Or

10. Write short notes on the following : 10 each

(a) Classification of heat exchanger

(b) Various types of cooling towers