Total No. of Questions—**12**] [Total No. of Printed Pages—**7**

[3862]-111

S.E. (Mechanical)(First Semester) EXAMINATION, 2010

APPLIED THERMODYNAMICS

(2008 COURSE)

Time : Three Hours **Maximum Marks : 100**

N.B. **:—** (*i*) Answer *three* questions from each Section.

(*ii*) Answers to the two Sections should be written in separate answer-books.

(*iii*) Neat diagrams must be drawn wherever necessary.

(*iv*) Figures to the right indicate full marks.

(*v*) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.

(*vi*) Assume suitable data, if necessary.

SECTION I

1. (*a*) Obtain an expression for entropy change in the form :

$$S_2 - S_1 = c_p \ln \frac{T_2}{T_1} - R \ln \frac{P_2}{P_1}.$$ [8]

(*b*) What are statements of second law of thermodynamics ? How is second law applicable to compressors and air receiver tanks ? [8]

P.T.O.

Or

2. (*a*) Air is compressed from 100 kPa and 17°C to 600 kPa and 57°C. What will be entropy change ? Now if this process is carried out in isentropic way by maintaining initial conditions and pressure ratio, what will be final temperature of air ? [8]

(*b*) Explain Clausius inequality. [8]

3. (*a*) Carbon steel balls of density 7833 kg/m^3 and C_p 0.465 kJ/kgK, diameter 8 mm are annealed by heating to 900°C and then by slow cooling at 100°C in the air. Air temperature is 35°C. If 1200 balls are to be processed per hour, determine total rate of heat transfer and lost work. [10]

(*b*) Derive expression for polytropic specific heat capacity. [6]

Or

4. (*a*) 0.1 m^3 of a gas is compressed from 120 kPa and 25°C to 1.2 MN/m^2 according to a law $PV^{1.2} = C$. Calculate work done, change of internal energy, heat transfer. Also state direction of heat transfer. [8]

(*b*) Obtain expression for non-flow energy. [8]

5. (*a*) Explain with sketch working of separating and throttling calorimeter. [8]

(*b*) What is throttling process ? Steam at 1.5 MPa and 0.7 dry is throttled to 0.10 MPa. Find out dryness fraction after throttle. [6]

(*c*) Explain significance of specific steam consumption and work ratio. [4]

Or

6. (*a*) Show Rankine cycle of P-V and T-S diagram when steam is superheated. Also discuss whether efficiency of cycle will change if reheat is employed. Show this process of reheat in two stages on Mollier chart. [8]

(*b*) A steam turbine plant working on Rankine cycle uses steam at 15 bar and condenses at 0.3 bar. Determine Rankine efficiency if :

(*i*) steam is dry saturated

(*ii*) superheated at 400°C.

Also find specific steam consumption in second case. Neglect feed pump work in both cases. [10]

SECTION II

7. (*a*) Distinguish between :

(*i*) Mass fraction and mole fraction

(*ii*) Lean mixture and rich mixture. [4]

(*b*) Explain NDIR method of gas analysis in brief. [4]

(*c*) The following data was obtained during experimental determination of calorific value of fuel by Bomb calorimeter :

Mass of coal = 0.78 gm

Mass of fuse wire = 0.032 gm

Calorific value of fuse wire = 7 kJ/gm

Mass of water in calorimeter = 2 kg

Water equivalent of calorimeter = 0.4 kg

Rise in temperature of calorimeter water = 3.2°C

Cooling correction = 0.01°C.

Determine HCV and LCV of coal at NTP conditions. Given the coal contains 90% of carbon and 5% of hydrogen. [8]

Or

8. (*a*) With the help of neat sketch discuss the method of determining calorific value of gaseous fuel. [8]

(*b*) The composition of dry flue gas as obtained by using Orsat apparatus was CO_2 = 9.8%, CO = 7.2%, H_2 = 3.4%, CH_4 = 0.3%, N_2 = 79.3%. Calculate :

(*i*) Air fuel ratio

(*ii*) Stoichiometric air

(*iii*) Mixture strength. [8]

9. (*a*) What are the advantages of multistaging in reciprocating air compressor ? [4]

(*b*) Differentiate between reciprocating and rotary compressors. [4]

(*c*) A single stage, single acting reciprocating air compressor delivers 0.7 kg of air per min at 6 bar. The suction temperature and pressure are 25°C and 1 bar. The bore and stroke of the compressor are 100 mm and 150 mm respectively. The clearance is 3% of swept volume. Assuming index of compression and expansion to be 1.3. Find :

(*i*) Volumetric efficiency of the compressor

(*ii*) Power supplied to drive the compressor if mechanical efficiency is 85%

(*iii*) Speed of the compressor (RPM). [10]

Or

10. (*a*) Discuss the factors those influence the volumetric efficiency of a reciprocating air compressor. [6]

(*b*) A two-stage reciprocating air compressor takes in air at 1 bar and 27°C. Air is delivered at 10 bar. The intermediate pressure is deal and intercooling is perfect. The law for compression is $PV^{1.35} = C$. The rate of discharge is 0.1 kg/s. Find :

(*i*) Power required to drive the compressor

(*ii*) Saving in work compared to single stage

(*iii*) Isothermal efficiency for multistage

(*iv*) Heat rejected in intercooler.

Take R = 0.287 kJ/kg K and C_p = 1 kJ/kg K. [12]

11. (*a*) Differentiate between mountings and accessories of the boiler. [4]

(*b*) Write a short note on artificial draught. [4]

(*c*) During the boiler trial the following data were obtained :

Duration of trial = 8 hrs.

Pressure of steam = 1400 kPa

Dryness fraction = 0.973

Feed water evaporated = 26700 kg

Hot well temperature = 50°C

Coal used = 4260 kg

CV of coal = 28900 kJ/kg

Air used per kg of fuel = 17 kg

Temperature of flue gases = 344°C

Boiler house temperature = 21°C

C_p of flue gases = 1.1 kJ/kg K.

Determine :

(*i*) Boiler efficiency

(*ii*) Equivalent evaporation

(*iii*) Heat lost to flue gases. [8]

Or

12. (*a*) Explain the term boiler efficiency and equivalent evaporation by writing its significance. [6]

(*b*) Explain how it is an advantageous using an economizer and superheater in steam power plant. [4]

(*c*) A 32 m high chimney is used to discharge hot gases at 297°C to the atmosphere which is at 27°C. Find the mass of air actually used per kg of fuel, if the draught produced is 12 mm of water. Also calculate draught measured in terms of hot gas column. [6]