AQ–2756

Faculty of Engineering & Technology

M.Tech. (Chemical Engg.) Second Semester (CBS) Examination

ENERGY TECHNOLOGY AND CONSERVATION

Paper—2 CE 4

Time—Three Hours] [Maximum Marks—80

INSTRUCTIONS TO CANDIDATES

(1) All questions carry marks as indicated.

(2) Answer **SIX** questions.

(3) Question No. **1** is compulsory.

(4) Due credit will be given to neatness and adequate dimensions.

(5) Assume suitable data wherever necessary.

(6) Diagrams and Chemical equations should be given wherever necessary.

(7) Illustrate your answers wherever necessary with the help of neat sketches.

(8) Use of slide rule, Logarithmic tables, Steam tables, Mollier's chart, Drawing instruments, Thermodynamic tables for moist air, Psychrometric charts and Refrigeration charts is permitted.

(9) Discuss the reaction, mechanism wherever necessary.

1. (a) During a non-flow process 40 kJ of heat is transferred to the system and 58000 Nm work is obtained from the system. Calculate the change in internal energy. For the same internal energy change, if the work transfer from the system is 45 kJ, find the magnitude and direction of heat transfer. 6

(b) 1 kg of gas in a cylinder fitted with a piston undergoes a nonflow process. The internal energy increases by 35 kJ. If the mechanical energy transfer to the system is 0.028 MJ, find the amount of thermal energy transfer and its direction. 5

(c) A working substance in a closed system 'n' given 50 kJ of work and simultaneously 15 kJ of heat is transferred to surroundings. Calculate change in internal energy.
Work out all problems by sign convention as well as input output method. 4

2. A fuel having a calorific value of 41 MJ uses 6.86 kg to develop 25 kw/hr. Calculate the thermal efficiency of the engine, fuel consumption/kwh, and the work done in 10 minutes. 13

3. The elements of a steam power plant consists of a boiler, turbine, condenser and a feed pump. Find the heat absorbed in the boiler, heat rejected in condenser, cycle work and feed pump work using the following data :

Enthalpy of liquid entering the boiler 198 kJ/kg at a velocity of 5 m/s. Enthalpy of steam leaving the boiler 3045 kJ/kg at 40 m/s. Enthalpy of steam from turbine 2000 kJ/kg at 200 m/sec. Condensed water is pumped back by feed pump at 5 m/sec having an enthalpy of 192 kJ/kg. 13

4. What are the limitations of a single stage compressor ? State the advantages of multistage compression. Explain with the help of a p – V diagram, the working of a 2 stage compressor with perfect inter-cooling. Derive condition for minimum work assuming polytropic compression. 13

5. A system is brought from state 'a' to state 'b' by 2 paths : 'acb' and 'adb', and then brought back from b to a along path 'ba'. During path acb, if the system receives 80 kJ of heat and does 30 kJ of work, calculate :

(1) Heat flowing into the system along adb, if W_{adb} is 10 kJ.

(2) When the system returns from b to a along ba it receives 20 kJ of work. Find the magnitude and direction of Qab.

(3) Of the internal energy at a and d are 0 and 40 kJ respectively find heat absorbed along ad and db. 13

6 The following particulars refer to a boiler unit. Economizer : 160 m^2, super heater : 185 m^2, Boiler : 280 m^2. Steam is generated at the rate of 7 Tones/hr at 1.7 MPa, 0.96 dry from feed water at 90° C which enters the economizer at 46° C. Steam leaves super heater at 250° C. Coal having a calorific value of 30 MJ/kg is consumed at the rate of 0.9 T/hr. Calculate the boiler efficiency and heat transfer rate in kJ/m^2 h for each unit. 13

7. Sulfur source are often from pyrites (Fe S_2). A cinder containing 84.7 Fe_2O_3 and rest gangue results from the combustion of pyrites containing 89.2 % FeS_2 and 10.8 % gangue. Sixteen kg mole of air is supplied to the burner per 100 kg of pyrites. The burner gases pass through a converter, the effluent gas from which shows 92.6 % N_2 by an Orsat analysis. Calculate the percentage of sulfur charged that is converted to SO_3. 13

8. 100 kg mole of a dry gas per minute containing 40 % SO_3 and 60 % N_2 is fed to the bottom of a counter current absorption tower. 50 kg of 60 % W H_2SO_4 in water is fed to the top of the tower. The conc. acid leaving the bottom contains 84.8 % W H_2SO_4. The exit gases leave the top of the tower at a total pressure of 737 mm Hg with a partial pressure of water vapour of 178 mm Hg. Calculate the % of entering SO_3 converted to H_2SO_4. 13

9. It is proposed to heat a house using a heat pump and the house is to be kept at 21° C, when the outside temperature is 0° C. If the heat transfer rate from the house is 15 kJ/sec, calculate the power to drive the heat pump. 13

10. Discuss briefly the following :

    (1) Adiabatic and actual flame temperature.

    (2) Development of power generation. 13