B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING THIRD YEAR FIRST SEMESTER SUPPLEMENTARY EXAM 2018

Subject-CHEMICAL ENGINEERING THERMODYNAMICS **Time- 3 hr** **FM-100**

Part - I (50)

Use separate answer script for each part

(Answer question no 1 or 2 and any two from the rest)

1. A gas are allowed to expand at a constant temperature from an initial absolute pressure of 400 Kpa to a final absolute pressure of 190 Kpa. Determine the final volume if the initial volume of gas is 4 m^3. Discuss the function of different components of refrigeration system. 4+6=10
2. Discuss the working principal of four stroke engine. How can you get the idea of defects in piston ring? 6+4=10
3. Discuss the principle of claude liquefaction cycle with net sketch? Write all the probable enthalpy balance equation in this cycle and solution process of different variable involve in these equation. 10+10+20
4. A R12 vapor compressor plant producing 8 tones of refrigeration operates with condensing and evaporating temperatures of 35^0 C and -10^0 C respectively. A suction line heat exchanger is used to subcool the saturated liquid leaving the condenser. Saturated vapor leaving the evaporator is superheated in the suction line heat exchanger to the extent that a discharge temperature of 60^oC is obtained after isentropic compression. Determine a) the sub cooling achieved in the heat exchanger , b) the refrigerant flow rate in kg/s, c) the cylinder dimensions of the two-cylinder compression, if speed is 900 rpm, stroke to bore ratio is 1:1, and the volumetric efficiency is 80%, d) the COP of the plant, and e) the power required to drive the compressor in kW.
   Discuss the Linde-Hamposon cycle for Air Liquefaction with T-S diagram. 12+8=20
5. An engine working on the Otto cycle is supplied with air at 0.11 MPa, 28^0C. the compression ratio is 8. Heat supplied is 2050kJ/kg. Calculate the maximum pressure and temperature of the cycle, the cycle efficiency, and the mean effective pressure. For air, C_p=1.005, C_v= 0.718, and R=0.287 kJ/Kg K. Discuss Diesel Cycle with net diagram. 14+6=20

[Turn over

EX/FTBE/T/311/2018(S)

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Subject: CHEMICAL ENGINEERING THERMODYNAMICS Time: Three Hours Full Marks: 100

Use Separate Answer Scripts for Part I and Part II

Part II (Marks-50)

Answer any **one** between 1 & 2 : **20**

1. a) Define Volume expansivity (β) and Isothermal compressibility K_T.
b) For acetone at 293.15 K and 1 bar

$$\beta = 1.487 \times 10^{-3}\ K^{-1}$$
$$K_T = 62 \times 10^{-6}\ bar^{-1}$$
$$V = 1.287 \times 10^{-3}\ m^3/kg$$

Find
i. The value of $(\delta P/\delta T)_V$
ii. The pressure generated when acetone is heated at constant volume from 293 K and 1 bar to 303 K.
iii. The volume change when acetone is changed from 293 K and 1 bar to 273 K and 10 bar.

5+(5+5+5)=20

2. a) Prove that for adiabatic process $TP^{(1-\gamma)/\gamma} = \text{Constant}$
b) In P-V diagram the slope for adiabatic process is steeper than Isothermal process-Justify that.
c) Derive the First and Second TdS equations. 5+5+(5+5)=20

Answer any **two** between followings: **15+15=30**

3. A binary system of Acetonitrile (1) / Nitromethane (2) conforms closely to Raoult's law. Vapor pressures for the pure species are given by the following Antoine equations;

$$\ln P_1^{sat}/\ kPa = 14.2724 - 2945.47/(T-49.15)$$
$$\ln P_2^{sat}/\ kPa = 14.2043 - 2972.64/(T-64.15)$$

Using the above equations fill up the following table and prepare a graph of P vs x_1 and P vs y_1 at temperature 348 K

x_1	0.00	0.25	0.50	0.75	1.00
P	?	?	?	?	?
y_1	?	?	?	?	?

15

4. Find an expression of Joule-Thomson Coefficient, μ. Derive the three Gibbs-Duhem Relations.

5+10=15

5. a) Prove that $dS = Cp.(dT/T) - R.(dP/P)$ ……………………………….equation (I)
b) For an ideal gas with constant heat capacities undergoing a reversible adiabatic (Isentropic) process.

$(T_2/T_1) = (P_2/P_1)^{(\gamma-1)/\gamma}$

Show that the same equation results from application of equation (I) with $\Delta S = 0$
c) Methane gas at 550K and 5 bar undergoes a reversible adiabatic expansion to 1 bar. Assuming methane to be an ideal gas at these conditions determine the final temperature given Cp for Methane gas = 22.75 J/mol K 5+5+5=15