Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Sem-I Examination January 2010

Subject code: 711601 **Subject Name: Advanced Thermodynamics**

Date: 20 / 01 / 2010 **Time: 12.00 – 2.30 pm**

Total Marks: 60

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 Explain with neat sketch Lithium bromide-water vapour absorption cycle. Also discuss about the selection criteria of this refrigeration cycle. **12**

Q.2 (a) For 200 kw (56.869 TR) ammonia – water absorption refrigeration plant determine the followings: **06**

i) Flow rate of ammonia required in cycle. Consider 2.5% heat loss. Evaporation temperature in chiller is - 10° C.

ii) Calculate heat duty of absorber. Heat of solution of ammonia is 2000 kJ/kg NH_3.

iii) Calculate heat duty of condenser of distillation column. Reflux ratio of distillation column is 0.3137. Condensation temperature of ammonia vapour in condenser is 40° C.

iv) Calculate the heat duty of generator (reboiler) of distillation column.

v) Calculate the COP.

Data

Temperature C	Enthalpy kJ/kg.	
	Liquid	Vapour
- 10	301.4	1597.8
40	538.5	1637.2

(b) With reference to a generalized reaction of type. **06**

$$aA + bB \rightarrow cC + dD$$

evaluate equilibrium constant for chemical reaction equilibrium from basic thermodynamics data, ΔHf°, ΔGf° and Cp equations. Derive the necessary equation from first principles.

OR

(b) With reference to generalized reaction of type. **06**

$$aA + bB \rightarrow cC + dD$$

evaluate heat of reaction at any temperate T and pressure P under nonideal conditions. Derive the necessary equation from first principles.

Q.3 Explain method for DEWP calculation with the help of block diagram and all supportive equations. **12**

OR

Q.3 Explain method for DEWT calculation with the help of block diagram and all supportive equations. **12**

Q.4 A feed stock of n-butane is cracked at 750 K and 1.2 bar to produce olefins. Only two reactions have favourable equilibrium conversions at these conditions. **12**

$C_4 H_{10} \rightarrow C_2 H_4 + C_2 H_6$ (I)

$C_4 H_{10} \rightarrow C_3 H_6 + CH_4$ (II)

If these reactions reach equilibrium what is product composition? At 750 K equilibrium constants for both reactions are

$K_I = 3.856, \quad K_{II} = 268.4$

OR

Q.4 Synthesis gas for methanol may be produced by the catalytic reforming of methane with steam. **12**

$CH_{4(g)} + H_2O_{(g)} \rightarrow CO_{(g)} + 3H_{2(g)}$ (I)

$CO_{(g)} + H_2O_{(g)} \rightarrow CO_{2(g)} + H_{2(g)}$ (II)

K_I at 1300 K = 13.845

K_{II} at 1300 K = 0.5798

Assume equilibrium is attained for both reactions at 1 bar and 1300 k.

i) Would it be better to carry out the reaction at pressure above 1 bar?
ii) Would it better to carry out the reaction at a temperature below 1300 K. Reaction (I) is endothermic and reaction (II) is exhothermic.
iii) Estimate the molar ratio of H_2 to CO in the synthesis gas if the feed consists of an equimolar mixture of steam and methane.
iv) Repeat part (iii) for a steam to methane mole ratio in the feed of 2.

Q.5 The following isomerization reaction occurs in liquid phase: A → B, where A and B are miscible liquids for which **12**

$G^E/RT = 0.1\, x_A\, x_B$

If $\Delta G°_{298} = -1000$ J/mol what is the equilibrium composition of mixture at 25° C? How much error is introduced if one assumes that A and B form an ideal solution?

OR

Q.5 A feed to a column has the composition given in the table below, and is a pressure of 14 bar and a temperature 60° C. Based on calculations verify that the given mixture is a Vapour-liquid mixture at given conditions. **12**

Feed	kmol/h	Ki
ethane	20	3.8
propane	20	1.3
isobutene	20	0.43
n-pentane	20	0.16
	80	

Also determined the flow rates and composition of vapour and liquid phases.

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