Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Sem-I Examination January 2010

Subject code: 711006 **Subject Name: Cryogenic heat exchanger**

Date: 27 / 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 **(a)** Explain with figure the phenomenon of two-phase flow in a horizontal pipe. **06**

(b) Define and distinguish clearly between film condensation and dropwise condensation. **06**

Q 2 **(a)** Why heat exchanger is considered as one of the most critical component in liquefaction system? Explain with example. **06**

(b) Derive the equation for two-dimensional steady state heat conduction in rectangular plate. **06**

OR

(b) Classify cryogenic heat exchanger and write a note on Giaque-Hampson heat exchanger. **06**

Q 3 **(a)** State and explain the factors affecting the effectiveness of heat exchanger. **06**

(b) Describe with neat sketch plate fin heat exchanger. **06**

OR

Q 3 **(a)** Explain the finite element philosophy to solve two-dimensional steady state heat conduction problems. **06**

(b) Exhaust gases (Cp = 1.12 kJ/kg-deg) flowing through a tubular heat exchanger at the rate of 1200 kg/hr are cooled from 400^0C to 120^0C. The cooling is affected by water (Cp = 4.18 kJ/kg K) that enters the system at 10^oC at the rate of 1500 kg/hr. If the overall heat transfer coefficient is 500 kJ/m^2-hr-deg, what heat exchanger area is required to handle the load for (a) parallel flow and (b) counter flow arrangement? **06**

Q 4 **(a)** Determine the heat transfer coefficient for nitrogen gas flowing inside a straight circular tube having an inside diameter of 20 mm. The nitrogen gas is at a bulk temperature of 95 K and the tube wall has temperature of 105 K. The mass flow rate of the nitrogen is 40 g / s and the gas pressure is 140 kPa. Take following properties for nitrogen gas at mean film temperature. **06**

$\mu = 6.98 \times 10^{-6}$ Pas. $k_t = 9.33$ mW/mK

$c_p = 1.067$ kJ/kgK Pr = 0.797

(b) State and explain Lockart Martinelli correlation of two-phase flow pressure drop for cryogenic fluids. **06**

OR

Q 4 **(a)** Discuss advantages and disadvantages of regenerator. **06**

(b) A regenerator is constructed of 1.5 mm diameter metal shot (density = 7800 kg / m^3 , sp. heat = 0.840 kJ / kg K.) The porosity of the matrix is 0.40 and the heating and cooling periods are equal at 2 secs. The fluid flowing through the regenerator is gaseous helium at an average temperature of 190 k and an average pressure of 405.3 kPa. The mass flow rate of the helium during the heating and cooling periods is equal to 35 g/s. Determine the required heat transfer surface area per unit length of the regenerator, if an effectiveness of 95 % is desired. **06**

Take properties of helium gas at 190K and 405.3 kPa are :

$\mu = 1.45 \times 10^{-6}$ Pas. $\rho = 1.026$ kg / m^3

$c_p = 5.2$ kJ/kgK Pr = 0.675

Q 5 **(a)** Critically discuss NTU-effectiveness and LMTD method for compact heat exchangers design. **06**

(b) Compare pool boiling and forced convection boiling. **06**

OR

Q 5 **(a)** What is conduction shape factor. Write conduction shape factor for (1) hollow cylinder (2) Concentric cylinder. **06**

(b) Explain step by step design methodology for heat exchanger. **06**

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