Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. IST Semester–Remedial Examination – July- 2011

Subject code: 711006N

Subject Name: Cryogenic heat exchangers

Date:12/07/2011 **Time: 10:30 am – 01:00 pm**

Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Students are allowed to use their own charts & table.**

Q.1 **(a)** With neat sketches, explain pool boiling curve & different regimes of pool boiling. **07**

(b) Explain NTU-effectiveness method for design of parallel flow type heat exchangers. **07**

Q.2 **(a)** A valved-type regenerator has a matrix of 2688 kg of steel shot (c_s= 0.48 kJ/kg-K). The mass flow rate of the hot stream is 2.00 kg/s, and the mass flow rate of the cold stream is 1.80 kg/s. The total period for the regenerator is 9.00 minutes. The convective heat transfer co-efficient for the hot fluid is 416 W/m^2-K and the convective heat transfer co-efficient for the cold fluid is 388 W/m^2-K. The surface area for both the hot and cold streams is same & equal to 180 m^2. Determine the effectiveness for the regenerator. The regenerator and both the streams are air (cp = 1.006 kJ/kg-K). **07**

(b) Explain the design procedure for perforated plate heat exchangers. Also draw the neat sketch of the same. **07**

OR

(b) Sketch the different configurations of plate-fin heat exchangers. Explain the design methodology for cryogenic plate-fin heat exchangers **07**

Q.3 **(a)** Discuss the effect of longitudinal heat conduction in cryogenic heat exchanger. **07**

(b) Liquid ammonia (c_p= 4.480 kJ/kg-K) is used to pre-cool air (c_p=1.008 kJ/kg-K) in a counter flow shell and tube type heat exchanger. The liquid ammonia enters the heat exchanger on the tube side at -40^{o}C and a mass flow rate of 2.25 kg/s. The air enters the heat exchanger on the shell side at 35^{o}C and a mass flow rate of 6.0 kg/s. the desired exit temperature of the air is -17.5^{o}C. The overall heat transfer co-efficient for the heat exchanger is 340 W/m^2-K. Determine the required heat transfer surface area and heat transfer rate. **07**

OR

Q.3 **(a)** Two plate fin heat exchangers are arranged as shown in Fig.-1. Nitrogen gas (c_p=1.050 kJ/kg K) enters HX-1 at 305 K at a mass flow rate of 1.20kg/s. the nitrogen gas leaves HX-2 at 85 K. Helium gas(c_p=5.25 kJ/kg K) enters HX-2 at 70 K at a mass flow rate of 0.30 kg/s. The overall heat transfer co-efficient and surface area for HX-2 is 700 W/m^2-K and 13.5 m^2. The overall heat transfer co-efficient for the HX-1 is 515 W/m^2-K. HX-1 and HX-2 are cross flow heat exchangers with both fluids unmixed and the two exchangers are not identical. Determine (1) the effectiveness of HX-1 & HX-2 (2) outlet temperature of cold fluid through HX-1 (3) heat transfer rate through both the heat exchangers. **10**

(b) Advantages & disadvantages of regenerators over recuperative H.E. **04**

Q.4 **(a)** Estimate the temperatures at points 1, 2, 3 and 4 shown in Fig.2 using the relaxation technique. **09**

(b) Write a short note on thermal contact resistance. **05**

OR

Q.4 **(a)** Explain Freezing at cryogenic temperature (Discuss any one case). **07**

(b) A pipe of 10 cm OD passes through the centre of a concrete slab of cross section 60 cm x 60 cm. the outer surface of the pipe is maintained at 130^{o}C while the outer surface of the concrete slab is at 30^{o}C. Using the flux plot (graphical method) estimate the heat loss per metre length of the pipe. **07**

Q.5 **(a)** State and explain Lockhart – Martinelli correlations of two phase flow pressure drop for cryogenic fluids. **07**

(b) A copper tube having a diameter of 12.7 mm and a length of 900 mm is immersed in saturated liquid oxygen at 100 K and 254.2 kPa. The tube temperature is maintained at 106K. Determine the heat transfer rate, if nucleate boiling occurs on the tube surface. Use Rohsenow equation for nucleate boiling and $c_{sf} = 0.013$. Evaluate the properties of liquid oxygen at 100 K. **07**

OR

Q.5 **(a)** Explain the shape factor for one dimensional heat transfer and give shape factor formula for following cases: (i) Hollow sphere (ii) cylinder centered in a large plate (iii) Isothermal sphere buried in a semi infinite medium. **06**

(b) A plate-fin is constructed using straight fins, 7.87 mm high, 0.15 mm thick, with 492 fins/m width. The equivalent diameter for the flow passage is 3 mm, the free flow area for the exchanger is 0.070 m^2, and the exchanger length is 3 m. the fluid flowing is helium gas, which enters at 300K and 3.04 MPa and leaves at 100K. The heat exchanger is constructed of aluminum (k_t = 150 W/m–K). Determine the convective heat transfer coefficient for this surface and the fin effectiveness. **08**

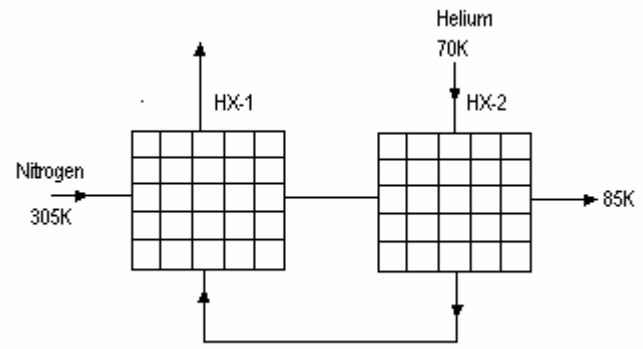

Fig. 1 Multipass crossflow platefin arrangement Q.3(a)

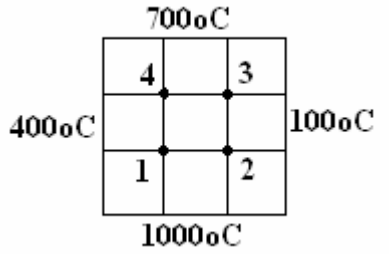

Fig.2 Q-4 (b) **OR**

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