Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER III (NEW) – EXAMINATION – WINTER-2016

Subject Code: 2733905 **Date:25/10/2016**

Subject Name: Solar Refrigeration and Air-conditioning

Time:02:30 pm to 05:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of solar refrigeration data book, steam table and refrigerant property table is permitted after verification.**

Q.1 **(a)** A C.O.P. of a jet ejector refrigeration system (JERS), uses refrigerant R-718, is 0.5. The ratio of motive refrigerant to flash refrigerant is 1.808 Kg of motive refrigerant per Kg of flash refrigerant. A motive refrigerant is supplied to JERS at 7 bar and in saturated condition when the refrigerant in the flash chamber is at 5°C. Make up refrigerant is supplied to the cooling system at 17 °C and condenser is operated at 5 cm of Hg pressure. The nozzle efficiency is 90 % and thermo compressor efficiency is 70 %. Assume the quality of refrigerant at the entry of thermo compressor is 0.92. Take specific heat of refrigerant is 2.1kJ/Kg-K. **11**

Determine:

1) Refrigeration capacity per Kg of flashed refrigerant.
2) Mass flow rate of motive refrigerant per ton of refrigeration.
3) Quality of flash refrigerant from flash chamber.
4) Quality of motive refrigerant just before the mixing.
5) Entrainment Efficiency.

(b) Explain in brief - solar energy: potential for solar cooling. **03**

Q.2 **(a)** A cylindrical parabolic collector uses thermic fluid to supply a heat to vapour absorption cooling system (VACS). The heat required by VACS is 1310.4 W. To supply heat required by VACS, outlet temperature of thermic fluid from collector must achieve 156°C, so twisted tap is inserted in absorber tube. A cylindrical parabolic collector has dimensions as follows: **11**

Concentration ratio = 9.3863

Length of collector to aperture width ratio = 2.92

Absorber tube, inner diameter = 3.8 cm, outer diameter = 4.1cm

Glass cover, inner diameter = 5.5 cm, outer diameter = 6.4cm

Overall loss coefficient = 13.3 W/m^2 K, Absorbed flux = 490 W/m^2

Ambient temperature = 32° C, Fluid inlet temperature = 150° C

The properties of thermic fluid at mean fluid temperature is ρ = 750 Kg/m^3, ν = 2.42 x 10^{-6} m^2/s, C_p = 2.4 kJ/Kg-K, k = 0.12 W/m-K.

Calculate,

1) Find the twisted tap ratio.
2) Mean temperature of Absorber tube.

(b) Describe desirable thermodynamic properties of working fluid for Rankine cycle solar cooling system. **03**

OR

(b) Draw layout of dual fluid Rankine cycle solar cooling system. **03**

Q.3 **(a)** Explain in brief modelling studied by Kaushik and Kaudinya for (i) open surface solar regenerator (ii) Forced flow solar regenerator. **09**

(b) Define desorption. Discuss the comparative study of various solid adsorbant done by Lavan *et. al.* **05**

OR

Q.3 **(a)** Explain brine still solar regenerator studied by kaudinya for hot and humid climate with neat sketch and discuss the effect of initial solution temperature on water desorption rate. **07**

(b) Explain working of solar MEC system studied by Neilson with neat sketch. Also represent solar MEC cycle on psychrometric chart. **07**

Q.4 **(a)** Explain intermittent cycle vapour absorption solar refrigeration cycle with neat sketch. **06**

(b) A cylindrical hot water storage tank, 1.9 m in diameter and 2.3 m height, is made from a steel plate (ρ = 7800 kg/m^3 , C_P = 0.46 kJ/kg-K) 9 mm thick. Apart from the mass of steel required for making the surface, an additional 220 kg of steel is required in the form of angles, etc. for strengthening the tank, which is insulated all round with glass wool insulation 22 cm thick (k = 0.045 W/m-k). The initial temperature of the water in the tank is 53.1 °C at 10.00 a.m. in the morning on a particular day and the variation of useful heat gain obtained from collector, load requirement and ambient temperature up to 12:00 p.m. (Afternoon) is shown in table below. Assuming that the water in the tank is always well-mixed; calculate the temperature of water in storage tank 1t 12:00 p.m. **08**

Time	q_u (kJ/h)	q_{load} (kJ/h)	T_a (°C)
10-11	62000	28000	32
11-12	70000	32000	34

OR

Q.4 **(a)** Explain open cycle vapour absorption solar refrigeration cooling system with neat sketch. **06**

(b) The temperatures in a hot water stratified tank are to be determined by assuming that the tank consists of two equal well-mixed sections with inlets at the top and in-between the two sections. The following data is given. **08**

Hour	Mass flow rate, *m* (kg/h)	Inlet temperature to tank, T_{fo} (°C)	Mass flow rate for load, m_{load} (kg/h)	Ambient temperature , T_a (°C)
13:00-14:00	2500	85	340	33

It is also given that,

1) Mass of water in the tank = 8000 kg
2) $(UA)_{t1}$ = 34 *kJ/h*-°C, $(UA)_{t2}$ = 31 *kJ/h*-°C
3) Make up water enters at 25^{0}C at the same rate as the rate of withdrawal to the load,
4) At 13:00 hr, T_{L1i} = 75 ^{0}C, T_{L2i} = 60 ^{0}C

Calculate the values of T_{L1} and T_{L2} at 14:00 hr.

Q.5	**(a)**	Explain the modelling of NH_3 - H_2O vapour absorption solar cooling system.	**08**
	(b)	Derive an expression of C.O.P. for thermoelectric refrigeration system. Also draw the neat latout of thermoelectric refrigeration system.	**06**

OR

Q.5	**(a)**	Explain solar operated vapour absorption heat pump system with neat sketch.	**08**
	(b)	Discuss in brief various cost included in capital cost of solar air-conditioning cost evaluation.	**06**

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