Birla Institute of Technology and Science, Pilani

ME F433 Solar Thermal Process Engineering

Comprehensive Exam (Closed Book)

Time: 3 hrs Marks: 40 Date: 14 / 12 / 2016

Note: Assume suitable data wherever necessary.
Underline the answers and the assumptions you make.

Q.1 (a) Determine the convective heat transfer coefficient for air flow in a channel 1 m wide by 2 m long. The channel thickness is 15 mm and the air flow rate is 0.03 kg/s. The average air temperature is 35◦C. (b) If the channel thickness is halved, what is the heat transfer coefficient? (c) If the flow rate is halved, what is the heat transfer coefficient? [6]

Q.2. A counter flow heat exchanger is located between a collector and a storage tank. The fluid on the collector side is an antifreeze, a glycol-water mixture with Cp= 3850 J/kg K. Its flow rate is 1.25 kg/s. The fluid on the tank side is water, and its flow rate is 0.864 kg/s. The *UA* of the heat exchanger is estimated to be 6500 W/K. If the hot glycol from the collector enters the exchanger at 62°C and the cool water from the tank enters at 35°C, what is the heat exchange rate and what are the outlet temperatures? Solve using equations only. [6]

Q.3. For cooking food for small family which type of concentrating solar collector/cooker is suitable. It should be handy, portable and easy to operate. Explain with neat sketch the working of the same. [4]

Q.4. India One solar thermal power plant is being installed recently in India. This is one of its kind power plant with direct steam generation and thermal storage. At which location this plant is installed. Explain with neat sketch it's working. [6]

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Q.5. Explain with neat sketch the working of Solar tower thermal power plant which is to be operated round the clock having super heater and single re-heater. Also explain the basic thermodynamic cycle for such plant with T-s plot. [6]

Q.6 Calculate the loss coefficient U_L for a 60-mm cylindrical receiver at 200°C. The absorber surface has an emittance of 0.31. The absorber is covered by a glass tubular cover 90 mm in outer diameter and 4 mm thick. The space between the absorber and cover is evacuated. The wind speed is 5 m/s and the sky and air temperatures are 2°C and 10°C, respectively. The cover temperature is measured to be 292.9K. [5]

Q.7. A cylindrical parabolic concentrator having 2.0 m width and 8 m length has an absorbed radiation of 400 W/m^2. The absorber and the transparent envelope have a diameter of 55 and 85 mm, respectively. The inlet temperature of the fluid entering the absorber is 220 °C at a mass-flow rate of 0.04 kg/s. Calculate the useful gain and exit-fluid temperature for the following parameters: C_p =3.26 kJ/kgK, h_{fc}= 280 W/m^{2}K, U_L = 12 W/m^{2}K, K = 16 W/mK, tube thickness= 5 mm, T_a = 22°C.

The collector-efficiency factor is given by

$$F' = \frac{1/U_L}{\frac{1}{U_L} + \frac{D_2}{h_{fi}D_1} + \left(\frac{D_2}{2K}\ln\frac{D_2}{D_1}\right)}$$

and the flow rate factor is given by

$$F_R = \frac{\dot{m}C_f}{A_r U_L}\left\{1 - \exp\left(-\frac{F'A_r U_L}{\dot{m}C_f}\right)\right\}$$

[7]

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