INDIAN INSTITUTE OF TECHNOLOGY

ENERGY CONSERVATION AND WASTE HEAT RECOVERY (ME 60234)
WASTE HEAT RECOVERY (ME 60086)

Spring 2018: Mid-semester examination

Full marks: 100 | *Attempt all questions* | Time: 2 Hours

Instructions: Clearly mention any assumptions made by you. Give brief and to the point answers to the following questions.

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1. The surface temperature of a cylindrical furnace of diameter D and length L is to be kept at T_f by passing a fluid through an annular cooling jacket surrounding the furnace. The fluid with a constant specific heat c enters the jacket at a temperature T_i and leaves at a temperature T_e while the pressure drop is negligible. Draw a neat sketch of the system. Find out the required mass flow rate of the fluid stream. If the environment temperature is T_0, find out the exergy supplied by the furnace wall and the exergy gain of the fluid stream. What is the exergetic efficiency of the cooling jacket?

   One energy expert suggests to use the heat given by the furnace for a heat pump. Critically judge the merits and limitations of the proposal. 3+5+6+6+3+5

2. Make a neat sketch of a plate fin heat exchanger for cross flow arrangement of fluids. Can a plate fin heat exchanger be used for other arrangement of fluid streams? What are the functions of fins in such a heat exchanger? Suggest with justification one use of such heat exchanger for waste heat recovery or energy conservation. 4+2+3+3

3. Through examples explain how thermodynamics can provide the broad guideline for the design of a WHR device and how thermodynamic principles also have some limitations. 6+6

4. An air cooled condenser has a fluid condensing at 50 °C with air temperature rising by 8 °C, from 25 °C. The capacity of the unit is 10 kW. A variable speed fan is used for the air flow and the performance is obtained at 2400 rpm of the fan. If the air mass flow varies directly as the fan speed N and if the overall heat transfer coefficient varies as $N^{0.7}$. For the process requirement sometimes the fan is run at a speed of 1200 rpm. For these two fan speeds determine the rate of heat transfer, NTU and effectiveness of the heat exchanger. $NTU = \ln \frac{1}{1-\varepsilon}$, ε is the effectiveness of a phase change heat exchanger. 5×6

5. Indicate the differences of organic Rankine cycle, Kalina cycle and Tri-lateral flash cycle with a conventional Rankine cycle. Explain how these differences can be exploited for waste heat recovery. 3×3 +9