# Problem Set 9

## Problem 5.43

Heat in the amount of 150 kJ is transferred directly from a hot reservoir at $T_H = 550\,K$ to two cooler reservoirs at $T_1 = 350\,K$ and $T_2 = 250\,K$. The surroundings temperature is $T_\sigma = 300\,K$. If the heat transferred to the reservoir at $T_1$ is half that transferred to the reservoir at $T_2$, calculate:

(a) The entropy generation in kJ/K.
(b) The lost work.
(c) How could the process be made reversible?

## Problem 5.44

A nuclear power plant generates 750 MW. The reactor temperature is 315 °C and a river with water temperature of 20 °C is available.

(a) What is the maximum possible thermal efficiency of the plant, and what is the minimum rate at which heat must be discarded to the river?

(b) If the actual thermal efficiency of the plant is 60% of the maximum, at what rate must heat be discarded to the river, and what is the temperature rise of the river if it has a flow rate of 165 cubic meters per second?

## Problem 5.50

Ethylene vapor is cooled at atmospheric pressure from 830 to 35 °C by direct heat transfer to the surroundings at 25 °C. With respect to this surroundings temperature, what is the lost work of the process in kJ/mol?

Show that the same result is obtained as the work which can be derived from reversible heat engines operating with the ethylene vapor as the heat source and the surroundings as the sink. The heat capacity of ethylene is given in Table C.1 of App. C.

## Problem 5.17

A Carnot engine operates between temperature levels of 600 K and 300 K. It drives a Carnot refrigerator, which provides cooling at 250 K and discards heat at 300 K. Determine a numerical value for the ratio of heat extracted by the refrigerator (“cooling load”) to the heat delivered to the engine (“heating load”).