

Given:

A heat source at 800 K loses 2000 kJ of heat to a sink at 500 K and at 750 K.

Required:

Determine which heat transfer process is more irreversible.

Solution:

The temperature of the source is defined as

$$T_H := 800 \text{ K}$$

The heat lost by the source is defined as

$$Q_H := 2000 \text{ kJ}$$

The temperatures of the two sinks are defined as

$$T_A := 500 \text{ K} \quad T_B := 750 \text{ K}$$

Both processes involve heat transfer through a finite temperature difference so both are irreversible processes. The change in entropy due to the source is found by

$$\Delta S_{source} := -\frac{Q_H}{T_H} = -2.500 \frac{\text{kJ}}{\text{K}}$$

The change in entropy due to the two sources are found by

$$\Delta S_A := \frac{Q_H}{T_A} = 4.000 \frac{\text{kJ}}{\text{K}} \quad \Delta S_B := \frac{Q_H}{T_B} = 2.667 \frac{\text{kJ}}{\text{K}}$$

Thus the entropy generated by the two sinks are found by

$$S_{gen,A} := \Delta S_{source} + \Delta S_A = 1.500 \frac{\text{kJ}}{\text{K}}$$

$$S_{gen,B} := \Delta S_{source} + \Delta S_B = 0.1667 \frac{\text{kJ}}{\text{K}}$$

Since $S_{gen,B} < S_{gen,A}$, the sink A is more irreversible than sink B.

