

Given:

During an experiment conducted in a room at 25°C, a lab assistant measures that a refrigerator that draws 2 kW of power has removed 30,000 kJ of heat over a 20 minute period from a refrigerated space maintained at -30°C.

Required:

Determine the COP of the refrigerator and whether it is possible.

Solution:

The high and low temperatures of the cycle are defined as

$$T_H := 25 \text{ }^{\circ}\text{C} = 298.15 \text{ K} \quad T_L := (-30) \text{ }^{\circ}\text{C} = 243.15 \text{ K}$$

The rate of net work input to the cycle is defined as

$$\dot{W}'_{net,in} := 2 \text{ kW}$$

The heat accepted by the cycle is defined as

$$Q_L := 30000 \text{ kJ}$$

The period of time is defined as

$$\Delta t := 20 \text{ min}$$

The net work input of the cycle is found by

$$\dot{W}_{net,in} := \dot{W}'_{net,in} \cdot \Delta t = 2400 \text{ kJ}$$

The COP of the cycle is found by

$$COP_R := \frac{Q_L}{\dot{W}_{net,in}} = 12.50$$

The Carnot COP of the cycle is found by

$$COP_{Rrev} := \frac{1}{\frac{T_H}{T_L} - 1} = 4.421$$

Since $COP_{R,rev} < COP_R$ the cycle is impossible.