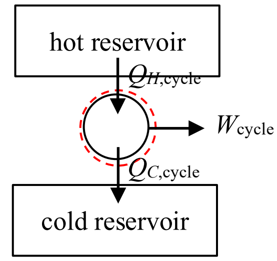
A system executes a power cycle while receiving 1050 kJ by heat transfer at a temperature of 525 K and discharging 700 kJ by heat transfer at 350 K. There are no other heat transfers.

a. Determine if the cycle is internally reversible, irreversible, or impossible.
b. Determine the thermal efficiency. Compare this value with the maximum possible efficiency.

SOLUTION:
To determine if the cycle is internally reversible, irreversible, or impossible, consider the Clausius Inequality,



$$\int_{A_{sys}} \frac{\delta Q_{\text{into,cycle}}}{T} \leq 0, \quad (1)$$

where,

Q_H/T_H = (1050 kJ)/(525 K) = 2 kJ/kg,

Q_C/T_C = (700 kJ)/(350 K) = 2 kJ/kg,

$$\Rightarrow \left(\int_b \frac{\delta Q_{\text{into}}}{T}\right)_{\text{cycle}} = \frac{Q_H}{T_H} - \frac{Q_C}{T_C} = 2 \text{ kJ/K} - 2 \text{ kJ/kg} = 0.$$

(Note $Q_C < 0$ since heat leaves the system. We're also assuming that the temperature at the boundaries to the system where the heat is added/removes is the same as the adjacent reservoir.)

Thus, we see that **the cycle is internally reversible.**

The thermal efficiency is,

$$\eta = 1 - \frac{Q_C}{Q_H}, \quad (2)$$

$\Rightarrow$ $\boxed{\eta = 0.33}$.

The maximum possible efficiency is,

$$\eta_{\max} = 1 - \frac{T_C}{T_H}, \quad (3)$$

$\Rightarrow$ $\boxed{\eta_{\max} = 0.33}$.

The cycle is operating at the maximum possible efficiency since it is internally reversible.