cP,

GIVEN

power cycle : T_c (lake) = 285 K , T_H = 300 K

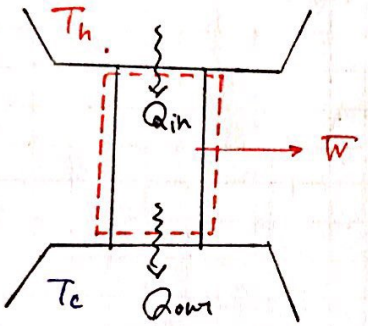
power output $\dot{W}$ = 10 kW , rejected heat = $\dot{Q}_{out}$ = 14,400 kJ/min

FIND

(a) thermal efficiency, η

(b) Max thermal efficiency, η_{max}

FIG



ASSUMP

open sys, irreversible, :SS

EQN

$\cancel{\Delta E}^{\,0} = Q - W$, $\eta = \frac{W_{cyc}}{Q_{in}}$

SOLN

(a) for a minute $W = \dot{W}(60) = 600$ kJ

$Q_{out} = 14400$ kJ $\Rightarrow$ $0 = Q_{in} - Q_{out} - W$

then

$0 = Q_{in} - 14400\text{ kJ} - 600\text{ kJ}$

$\therefore Q_{in} = 15000$ kJ (per minute)

thus $\eta = \frac{600\text{ kJ}}{15000\text{ kJ}} \times 100 = 4\%$

$\eta = 4.00\%$

(b) From Carnot's Theory

$\eta_{MAX} = 1 - \frac{T_c}{T_h} = 1 - \frac{285}{300} = 1 - 0.95 = 0.05$

$\eta_{MAX} = 5.00\%$

(11)

GIVEN

2 reversible refrigeration cycles.

※ 1st cycle

>> $T_{H1} = 27°C = 300.15K$, $T_{C1} = -8°C = 265.15K$

※ 2nd cycle

>> $T_{H2} = 27°C = 300.15K$, $T_{C2} = -28°C = 245.15K$

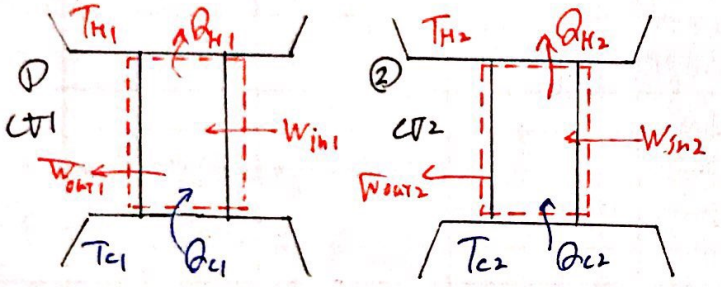
※ Both removes same amount of energy from heat transfer

$$Q_{C1} = Q_{C2}$$

FIND

ratio of net work input values, $\frac{W_{cyc1}}{W_{cyc2}}$

FBD



ASSUMP

open sys, SS, reversible

EQN

$\cancel{\Delta E}^{0} = Q - W$, $COP_R = \beta = \frac{Q_C}{W_{cyc}} = \frac{Q_C}{Q_H - Q_C} = \frac{T_C}{T_H - T_C}$

SOLN

(CV1) $COP_{R1} = \beta_1 = \frac{Q_{C1}}{W_{cyc1}} = \frac{T_{C1}}{T_{H1} - T_{C1}}$ ... ①

(CV2) $COP_{R2} = \beta_2 = \frac{Q_{C2}}{W_{cyc2}} = \frac{T_{C2}}{T_{H2} - T_{C2}}$ ... ②

$\frac{②}{①} \Rightarrow \frac{Q_{C2}}{W_{cyc2}} \cdot \frac{W_{cyc1}}{Q_{C1}} = \frac{T_{C2}}{T_{H2} - T_{C2}} \cdot \frac{T_{H1} - T_{C1}}{T_{C1}}$

since $Q_{C1} = Q_{C2}$

$$\frac{W_{cyc1}}{W_{cyc2}} = \frac{T_{C2}(T_{H1} - T_{C1})}{T_{C1}(T_{H2} - T_{C2})} = \frac{(245.15K)(300.15K - 265.15K)}{(265.15K)(300.15K - 245.15K)}$$

$$\approx 0.58836$$

$\boxed{0.588}$