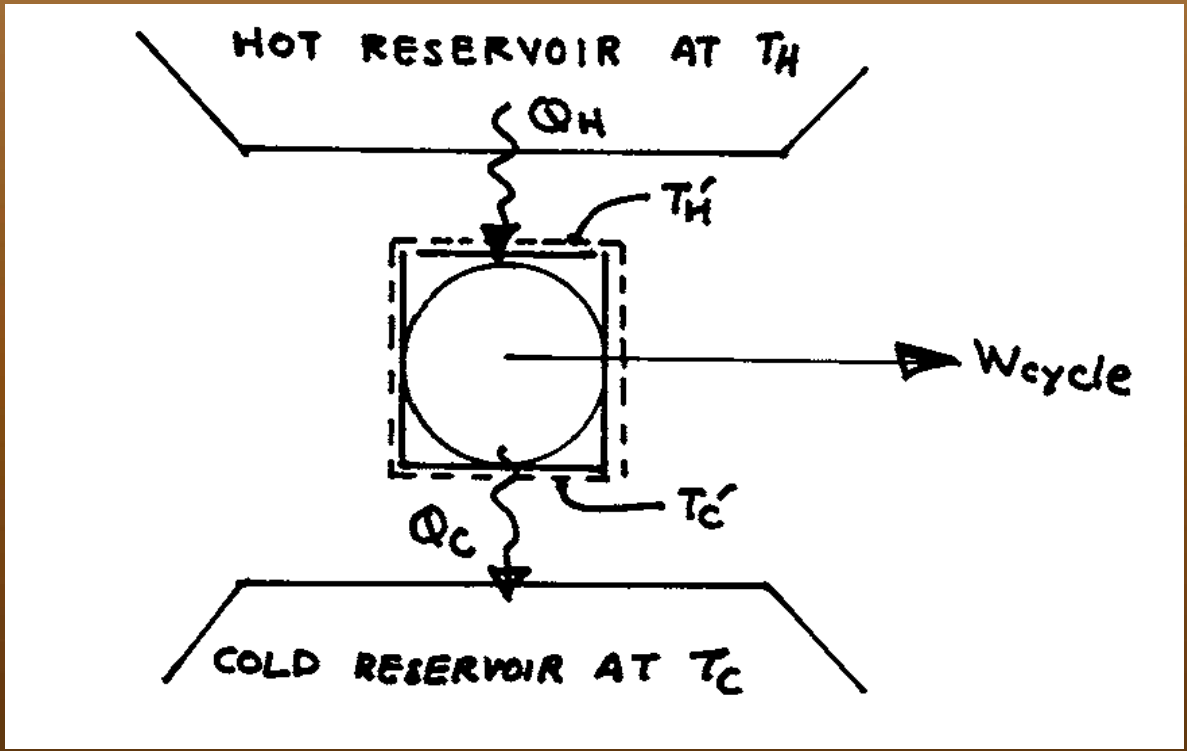
SET Problem session

NUIDEA

Nuclear Units Informatics Design Engineering Architect

Problem

A system undergoes a cycle while receiving heat Q_H at T'_H and discharging Q_C at T'_C. Find an expression for Work done by the cycle in terms of Q_H , T'_H, T'_C and σ. State the relationship of T'_H, T'_C to T_H , T_C respectively. Also obtain an expression for work done when there is no internal irreversibilitys and no irreversibilitys.


HOT RESERVOIR AT T_H
Q_H
T_H'
W_{cycle}
T_C'
Q_C
COLD RESERVOIR AT T_C

Solution

First law for the cycle gives

$$W = Q_H - Q_C$$

Entropy balance: Change in entropy= Incoming – Outgoing+Generation (Irreversibility, Friction etc.)

For cycle Change in entropy is zero as it is a state function.

$$0 = \frac{Q_H}{T'_H} - \frac{Q_C}{T'_C} + \sigma$$

Solving for Q_C and substituting in the equation for work.

$$W = Q_H\left(1 - \frac{T_C'}{T_H'}\right) - T_C'\sigma$$

b) For you to do....

c) External irreversibilities are associated with heat transfer between the reservoir and the system. If these are absent then $T_H = T_H'$ & $T_C = T_C'$. Internal irreversibilities are present within the cycle, if these are absent then $\sigma = 0$. So the maximum theoretical work which can be obtained is

$$W = Q_H\left(1 - \frac{T_C}{T_H}\right)$$