University of Al-Mustaqbal
College of Science
Department of Medical Physics

Thermodynamics and Heat

Second stage

Introduction

Lecture Six

Name of lecturer

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Thermal machines

The thermal machine is a sentence that takes energy in the form of heat and gives part of this energy in the form of work, using a medium. This is done periodically.

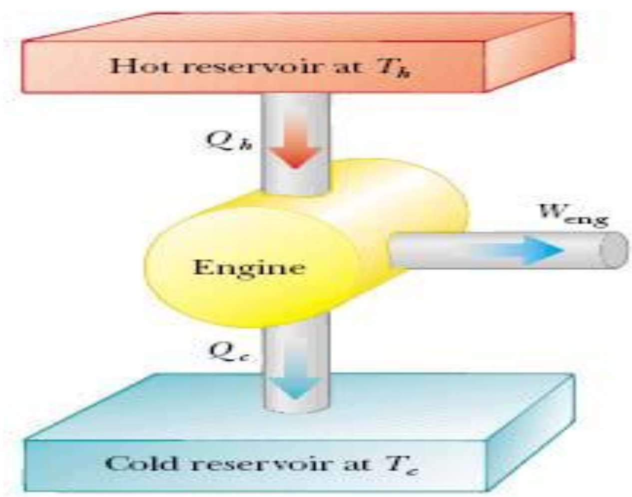
Steam engine where the medium is water vapor, and the cycle is as follows:

1. boiling water

2. the steam extend then motor piston moves

3. Re-cool and condense the vapor and return to the steam boiler

The thermal machine can be represented as follows:



Heat Engine:

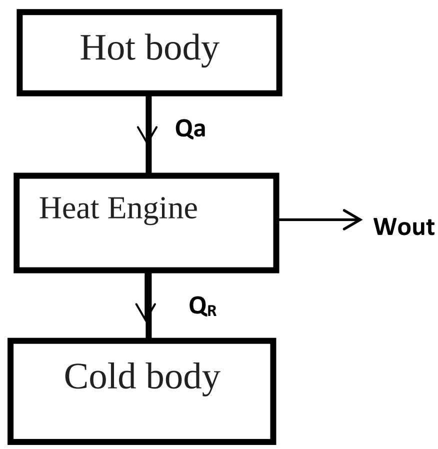
A thermodynamic system that works in a cycle and produces a work when the heat is added to it from the hot body, expelled from the hot body and partially expelled from the heat to the cold body. The thermal motor performance is expressed in thermal efficiency (η).

$$\eta = \frac{Wout}{Qh} = \frac{Qh - Qc}{Qh} \qquad \eta = 1 - \frac{Q_c}{Qh}$$

Q_h= The amount of heat added to the engine by the hot body.

Q_c = Amount of heat discharged from the engine to the cold body.

W_{out} = the work produced by the thermal engine.



Heat pumps:

Heat pumps are defined as transferring heat from the cold source to the hot source by taking mechanical action from the outside.

Figure blew shows the thermal pump, which is a thermodynamic system operating in the role and transfer heat from the cold body to the hot body. To accomplish this, the heat pump takes up a work from the surrounding medium.

The performance of the thermal pump is expressed by the Coefficient of Performance

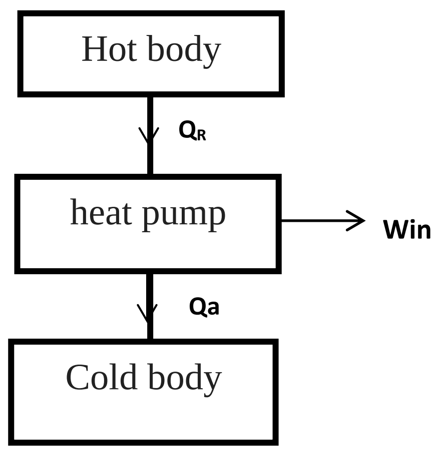
$$\textbf{C.O.P} = \frac{Qc}{Win} = \frac{Qc}{Q_h - Qc}$$

Where :

Q_c = Amount of heat absorbed by the heat pump from the cold body.

Q_h = Amount of heat expelled by the heat pump to the hot body.

W_{in}= The work required for the heat pump



Example: Household fridge, air conditioner

Carnot cycle

Carnot's cycle in physics and thermodynamics is one of the most famous dynamic reflex courses named after the French engineer Sadi Carnot (1796-1832).

Carnot's cycle is a theoretical thermocouple cycle that has a significant reflection in thermodynamics as it gives the maximum to get the work through a thermal cycle between two different degrees of heat. Through the Carnot cycle, the thermal efficiency of a particular machine can be calculated. That is, it gives us the part of the total thermal that we put into the machine to get them to work.

Through periodic reflections (Carnot cycle) the heat can be converted into a work because the amount of transformation in the state functions (internal energy - the entropy) is equal to zero.

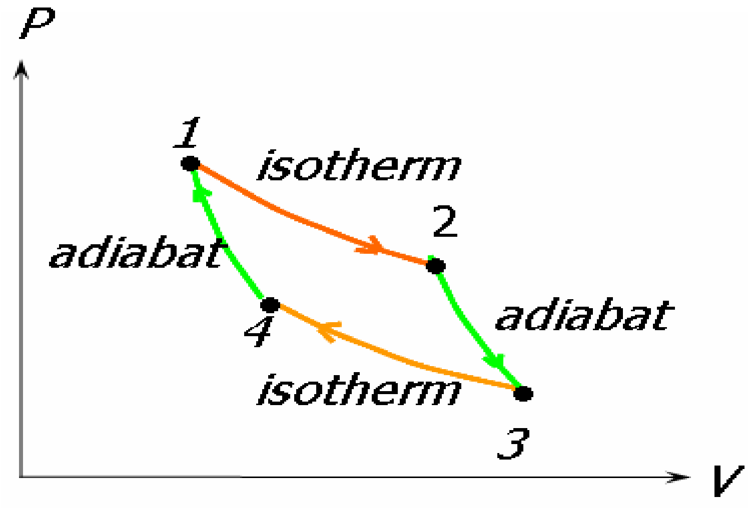
This cycle includes four steps that are reflective:

- 1 The process of extend by temperature stability.

2 - The process of extension adipatic.

- 3 compression by of temperature stability.

4 - The process of compression adipatic .



1- Process No. (1)

The gas expands at a When temperature is confirmed at high temperature of V_1 to V_2 and therefore performs a work .The heat escapes from the hot reservoir to the gas.

2 - Process No. (2)

The cylinder is isolated and the gas is allowed to expand adipatic from V_2 to V_3 (q = 0) and its temperature drops from T_2 to T_1 and the gas performs a work .

Since the gas is isolated, there is no heat exchange between it and the tank.

3 - process No. (3)

When the temperature is confirmed, the volume of the gas is reduced from V_3 to V_1 and thus the ocean performs a work at the expense of the gas and therefore a quantity of heat is transferred from the gas to the tank.

4- Process No. (4)

The gas is compressed backwards (in a large process) from V_4 to V_1 and the piston performs a work on the gas during the compression process.

Since steps 2 and 4 are numerically equal and different by signal , therefore they are equal and cancel each other and thus the work done at the cycle is:

$$\mathbf{W = W1 + W3}$$

$$\mathbf{W2 = - Cv\ dT}$$

$$\mathbf{W4 = Cv\ dT}$$

$$\mathbf{W2 + W4 = - Cv\ dT + Cv\ dT = 0}$$

$$\mathbf{\Delta E = q + W}$$

$$\mathbf{- q = W}$$

$$\mathbf{- q = - P\ dV}$$

$$\mathbf{W1 = n\ RT\ ln\ V2 / V1}$$

$$W3 = n\,RT \ln V2 / V1$$