253.
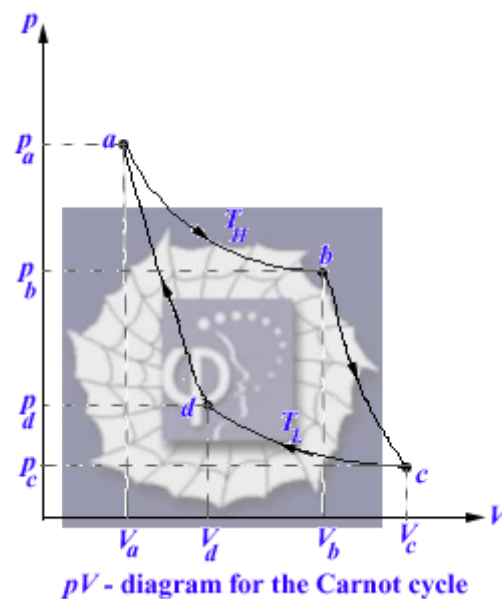
Problem 26.13 (RHK)

For the Carnot cycle, we have to show that the work done by the gas during process bc has the same absolute value as the work done on the gas during process da.

pV - diagram for the Carnot cycle

Solution:

Let the ratio of the specific heats of the ideal gas undergoing the Carnot cycle be γ and its amount be n moles. The process *ab* is an isothermal expansion at temperature T_H and the process *cd* is an isothermal compression at temperature T_L.

Therefore,

$$T_b = T_a,$$

and

$$T_d = T_c.$$

Processes *bc* and *da* are adiabatic. In an adiabatic process the work done on the gas is given be

$$W = \frac{\left(p_f V_f - p_i V_i\right)}{\gamma - 1}.$$

Equation of state of an ideal gas is

$$pV = nRT.$$

Therefore, the work done on the gas during the process *bc* will be

$$W_{bc} = \frac{nR\left(T_c - T_b\right)}{\gamma - 1} = \frac{nR\left(T_c - T_a\right)}{\gamma - 1}.$$

And, the work done on the gas during the process *da* will be

$$W_{da} = \frac{nR\left(T_a - T_d\right)}{\gamma - 1} = \frac{nR\left(T_a - T_c\right)}{\gamma - 1}.$$

We note that

$$\left|W_{bc}\right| = W_{da} \qquad .$$