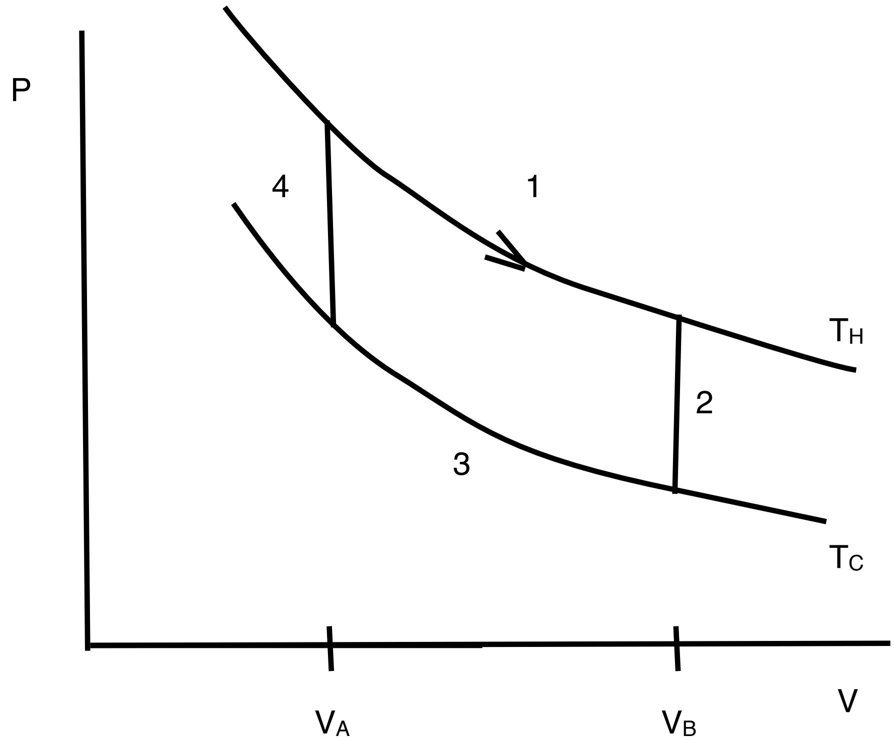
Stirling cycle



Steps of the Stirling cycle:

1) Isothermal expansion from V_A to V_B at T_H.
   Q_1 from the hot reservoir is converted to work W_1.
2) Isochoric cooling from T_H to T_C.
   There is heat flow from the working substance (ideal gas) to the cold reservoir as the working substance cools.
3) Isothermal compression from V_B to V_A at T_C.
   Work done on the gas results in heat flow to the cold reservoir.
4) Isochoric heating from T_C to T_H.
   The temperature of the working substance is raised by heat flow Q_4 from the hot reservoir.

The total heat flow into the engine from the hot reservoir is Q_1+Q_4.
The net work done by the engine is W_1+W_3 with $W_1 > 0$ and $W_3 < 0$.
Thus the efficiency is $e = (W_1+W_3)/(Q_1+Q_4)$.
Using previous results for work in an isothermal process,

$$W_1 + W_3 = nRT_H \ln\left(\frac{V_B}{V_A}\right) + nRT_C \ln\left(\frac{V_A}{V_B}\right) = nR\left(T_H - T_C\right)\ln\left(\frac{V_B}{V_A}\right).$$

$$Q_1 = W_1 = nRT_H \ln\left(\frac{V_B}{V_A}\right).$$

In the isochoric compression of step 4 there is no work and

$$Q_4 = \Delta U = nR\frac{q}{2}\left(T_H - T_C\right)$$

Then it is just some algebra to obtain

$$e_S = \frac{W_1 + W_3}{Q_1 + Q_4} = \frac{T_H - T_C}{T_H + X} \quad \text{with} \quad X = \frac{q}{2} \frac{T_H - T_C}{\ln\left(\frac{V_B}{V_A}\right)}.$$

Since X is positive, $e_S < \frac{T_H - T_C}{T_H} = e_C$ i.e. the Stirling efficiency is less than the Carnot efficiency. Why is that? Is the Stirling cycle reversible? In particular, are the two isochoric processes reversible? Is placing a gas at T_H in contact with a reservoir at T_C and letting it cool reversible?