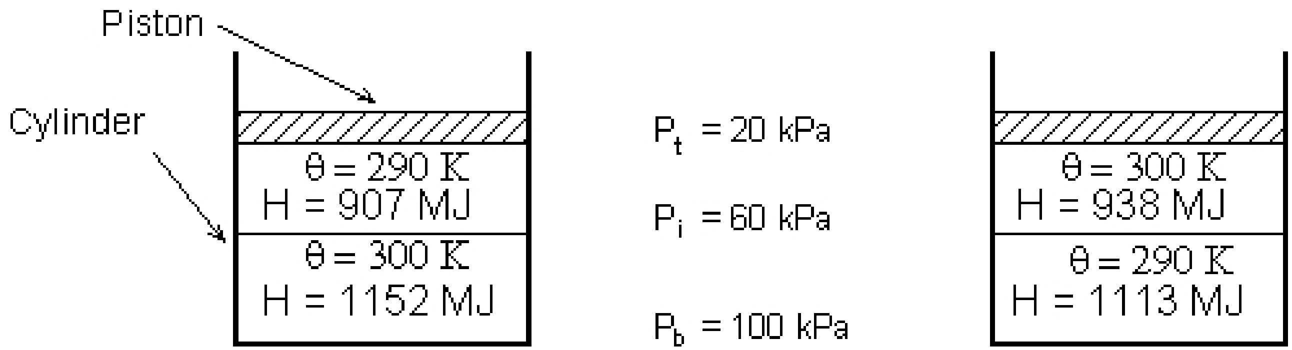
Margules re-arrangement of large air masses initially on top of one another.



Initial Conditon (high entropy on bottom)

Final condition (high entropy on top)

H = 2059 MJ

ΔH = 7115 kJ

H = 2052 MJ

$W = \Delta h$ = 872 J/kg

The work corresponds to a velocity of 42 m/s

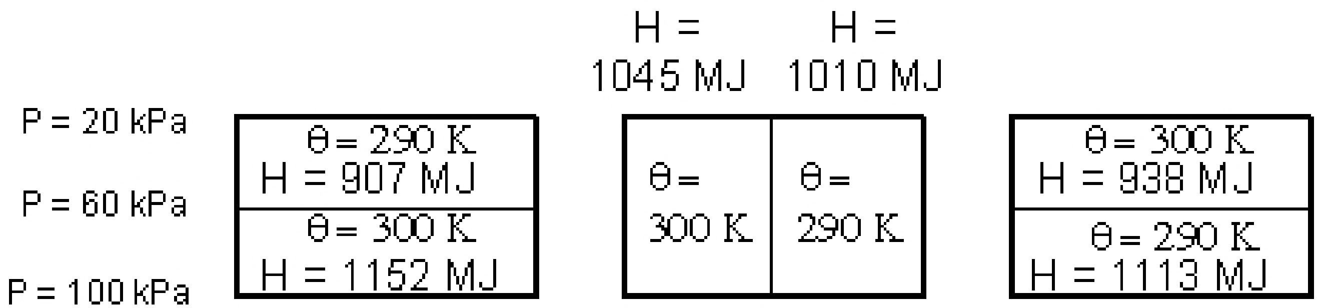
$m = (P_b - P_t)/g =$ 8163 kg

Notes:

Closed piston covered isolated thermodynamics system

Mass based on column area of one square meter

Margules re-arrangement of large air masses



State 1	State 2	State 3
(high entropy on bottom)	(side by side)	(high entropy on top)
H = 2059 MJ	H = 2055 MJ	H = 2052 MJ

$\Delta H = 3558$ kJ $\quad$ $\Delta H = 3558$ kJ

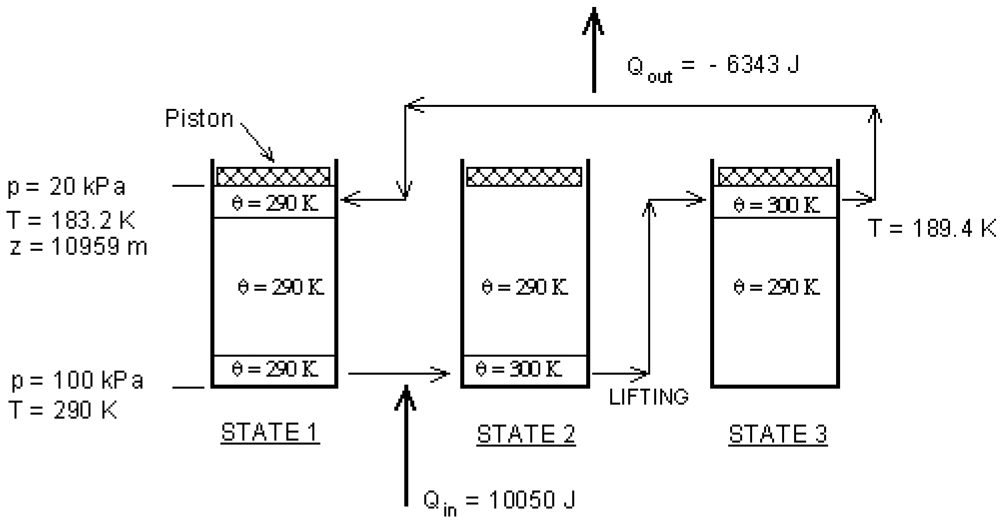
$\Delta h = 436$ J/kg $\quad$ $\Delta h = 436$ J/kg

$\Delta H = 7115$ kJ

$\Delta h = 872$ J/kg

The work in going from state 2 to state 3 is is half as much as in going from state 1 to state 3 because state 2 is an intermediate state.

Work production when a thin layer is raised



The work per unit mass can be calculated using four methods giving the same result.

1. Heat received minus heat given up

$$W = Q_{in} + Q_{out} = 3703 \text{ J}$$

2. Heat received multiplied by the Carnot efficiency based on the temperatures at which the heat is received and given up.

$$W = Q_{in} (1 - T_{out}/T_{in}) = 10050 (1 - 183.2/290) = 10050 * \mathbf{0.368} = 3703 \text{ J}$$

Corresponds to a velocity of 86 m/s.

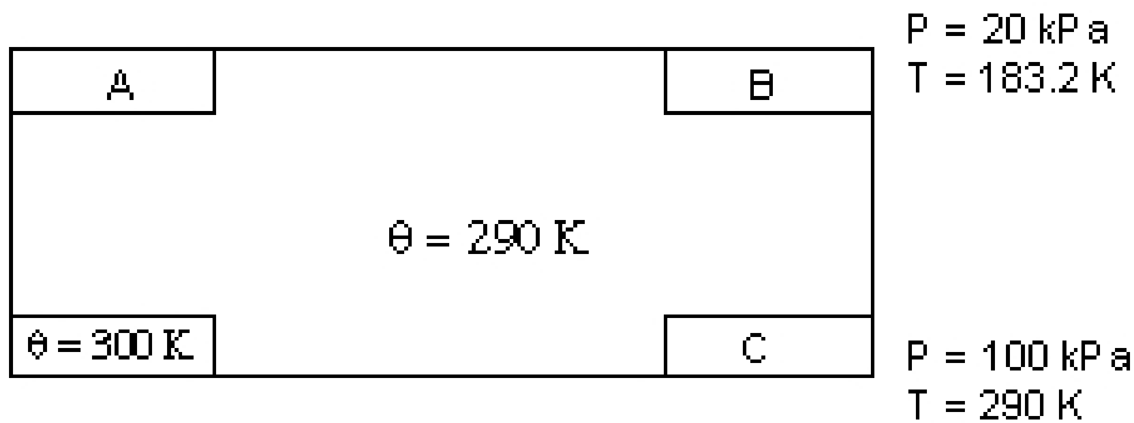
3. Previous Margules' equation for the enthalpy of large air mass.

4. Standard meteorological Convective Available Potential Enegy (CAPE) equation.

The work per unit mass raised is approximately four times higher than in the Margules mass on top of one other case because the air is raised approximately twice as high and because the work is allocated to the raised air only.

The work is related to the heat received and to the temperature at which heat is received by the Carnot efficiency, which is not evident when using large air masses.

Horizontal versus Vertical re-arrangement



The work is the same whether the 300 K potential temperature parcel is moved to A or B.

The work produced when the parcel is moved to C is zero.

Work is produced during upward heat transport, work is not produced as a result of horizontal heat transport.

Equations

Enthalpy per unit mass

$$h = C_p T$$

Enthalpy of a large air mass

$$H = f(P_1, P_2, \theta) = \frac{C_p \, \theta \, [(P_1)^{(k+1)} - (P_2)^{(k+1)}]}{g\,(k+1)\,(P_0)^k}$$

where $k = R / C_p = 2/7$

Entropy per unit mass

$$s = C_p \ln(\theta) + \text{constant}$$