ChE 226 Lecture 5

Representation of Processes in 2 Dimensions

Conversions Between Axes
  P-T, you should know general form
  What is equivalent P-V?

Processes made from a sequence of segments between 2 points.
  Ideal Gases
  Constant P, V or T
  Adiabatic…

Calculation of $W$ and $Q$ ($\Delta U$ and $\Delta H$)

Specific Processes
  Note sign (direction)

Combinations and Measuring with the easiest variables.

A Group Exercise, if time.
More about Adiabatic Processes \([Q = 0]\)

\[
\Delta U = W = - \int_{V_1}^{V_2} PdV = \int_{T_1}^{T_2} C_v dT
\]

\[
- \int_{V_1}^{V_2} \frac{RT}{V} dV = \int_{T_1}^{T_2} C_v dT \text{ for I.G.}
\]

thus, \(\frac{dT}{T} = - \frac{R}{C_v} \frac{dV}{V}\)

Also, \[
\Delta H = \int_{P_1}^{P_2} VdP = \int_{T_1}^{T_2} C_p dT
\]

thus, \(\frac{dT}{T} = \frac{R \frac{dP}{C_p P}}{P}\)

\[
\frac{C_p}{C_v} \frac{d \ln V}{d \ln P} = \gamma \frac{d \ln V}{d \ln V}
\]

From Whence: \(PV\gamma = \text{Const.}\); \(\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma - 1} = \frac{\left(\frac{P_2}{P_1}\right)^{\gamma - 1}}{\gamma - 1}\)

and \(W\) can be calculated:

\[
W = - C_v dT = R \left(\frac{T_1 - T_2}{\gamma - 1}\right) = \frac{P_1 V_1 - P_2 V_2}{\gamma - 1} = \frac{RT_1}{\gamma - 1} \left(1 - \frac{P_2}{P_1}\right)^{\gamma - 1} = \frac{P_1 V_1}{\gamma - 1} \left(1 - \frac{P_2}{P_1}\right)^{\gamma - 1}
\]

Recall Also \(\Delta H = \Delta U + \Delta(PV) = \Delta U + \Delta(nRT)\)
\[ \Delta U + \frac{m \Delta u^2}{2} + mgh = Q + W \]
\[ \Delta H + \frac{m \Delta u^2}{2} + mgh = Q + W \]

Note the use (or not) of mass, what is the basis?
Note also the use of \( g_c \)

*Some Hints:*

per unit mass: \( Q + W_s = \frac{\Delta u^2}{2g_c} + \Delta H \)

\[ \frac{uA}{V} = \frac{u d^2}{V} \]
or for liquids: \( uA \approx u d^2 \)