

CH365 Chemical Engineering Thermodynamics

Lesson 16 Sensible Heat Effects

Ethylene Glycol Process

Slide 2

- Sensible heat effects are associated with temperature change
- Latent heat (phase changes) – no temperature change
- Heat of Reaction
- Heat of Mixing

“Sensible” Heat Effects

Sensible = No phase transitions, no chemical reactions, and no change in composition.

$$U = U(T, V)$$

Total differential introduced
in L10, Slide 9, page 138

$$dU = \left(\frac{\partial U}{\partial T} \right)_V dT + \left(\frac{\partial U}{\partial V} \right)_T dV$$

0 for constant volume process,
ideal gases, or incompressible fluids

L11, Slide 3

$$dU = C_V dT$$

Eq. 4.1

$$Q = \Delta U = \int_{T_1}^{T_2} C_V dT$$

$Q = \Delta U$ for mechanically reversible, constant
volume process (why? $\Delta U = Q + W$)

Mean Heat Capacity

Integral evaluated forms – “user-defined functions” – simplifies working with mixtures

These forms are used in later derivations in the textbook.

Ideal Gas Heat Capacity in Simulators

Improved function – used in professional simulators such as CC and Aspen+

F. A. Aly and L. L. Lee, "Self-Consistent Equations for calculating the Ideal Gas Heat Capacity, Enthalpy, and Entropy," *Fluid Phase Equilibria*, 1981, Vol. 6, Issues 3-4, pp. 169-179.

a, b, c, d & e are constants published and maintained by DIPPr (link on course web site).

$$C_p = C_p(T) = a + b \cdot \left(\frac{c/T}{\text{Sinh}[c/T]} \right)^2 + d \cdot \left(\frac{e/T}{\text{Cosh}[e/T]} \right)^2$$

hyperbolic sine
hyperbolic cosine

DIPPr Eq 107

The image shows a sequence of three software windows illustrating how to find the DIPPr equation 107 for ideal gas heat capacity:

- Component List**: A window showing a list of components. "1 (62) Water" is selected. A blue arrow points to the "View/Edit" button at the bottom.
- View/Edit Component Data**: A window with a sidebar menu. A blue arrow points to the "Heat Capacity Data" option.
- Library Heat Capacity Data**: A window showing data for "Water".
 - The "Ideal Gas Heat Capacity" section shows "Equation No." set to 107 (circled in red).
 - The "Coefficients" table for Equation 107 is circled in red:

Component ID:	62
A	33359
B	26798
C	2609.3
D	8888
E	1167.6
F	
G	
 - The "Liquid Heat Capacity" section shows "Equation No." set to 100.
 - The "Solid Heat Capacity" section shows "Equation No." set to 100.
 - A blue arrow points to the "Help" button at the bottom left.

CC/DIPPr eq 107 found here

Ideal Gas Heat Capacity in Simulators

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$$C_p = C_p(T) = a + b \cdot \left(\frac{c/T}{\text{Sinh}[c/T]} \right)^2 + d \cdot \left(\frac{e/T}{\text{Cosh}[e/T]} \right)^2 \quad \text{DIPPr Eq 107}$$

hyperbolic sine
hyperbolic cosine

The screenshot shows the Aspen+ software interface. The 'Results - Pure Components' window is open, displaying the 'T-Dependent' tab. The 'View' dropdown is set to 'Parameters'. The 'Parameter' dropdown is set to 'CPIGDP-1'. A table of results is shown for three components: METHANE, ETHANE, and PROPANE. The table has columns for 'Component', 'Temperature units', 'Source', and 'Property units'. The 'Element 1' row is circled in red, showing values 33298, 44256, and 59474. The 'Element 2' row shows values 79933, 84737, and 126610. The 'Element 3' row shows values 2086.9, 872.24, and 844.31. The 'Element 4' row shows values 41602, 67130, and 86165. The 'Element 5' row shows values 991.96, 2430.4, and 2482.7. The 'Element 6' row shows values 50, 298.15, and 298.15. The 'Element 7' row shows values 1500, 1500, and 1500.

Component	METHANE	ETHANE	PROPANE
Element 1	33298	44256	59474
Element 2	79933	84737	126610
Element 3	2086.9	872.24	844.31
Element 4	41602	67130	86165
Element 5	991.96	2430.4	2482.7
Element 6	50	298.15	298.15
Element 7	1500	1500	1500

Aspen+/DIPPr eq 107 found here

Questions?