

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

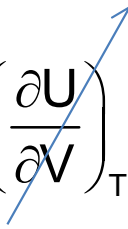
Sensible = No phase transitions, no chemical reactions, and no change in composition.

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

Total differential introduced
in L10, Slide 8, 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



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 sequence of screenshots illustrates the steps to access the heat capacity data for water in a simulator:

- Component List:** A window showing a list of components. '1 (62) Water' is selected. A blue arrow points to the 'View/Edit' button.
- View/Edit Component Data:** A window showing various data categories for the selected component. 'Heat Capacity Data' is selected, indicated by a blue arrow.
- Library Heat Capacity Data:** A window showing the heat capacity data for water. The 'Equation No.' is set to 107, which is circled in red. The coefficients A through G are listed on the right, also circled in red. A blue arrow points to the 'Help' button at the bottom.

CC/DIPPr eq 107 found here

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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 Methane, Ethane, and Propane. The 'Element 1' row for Methane is circled in red, indicating the value 33298 J/KMOL-K. The 'Element 2' row for Ethane is also circled in red, indicating the value 44256 J/KMOL-K. The 'Element 3' row for Propane is also circled in red, indicating the value 59474 J/KMOL-K. The 'Element 4' row for Methane is also circled in red, indicating the value 79933 J/KMOL-K. The 'Element 5' row for Ethane is also circled in red, indicating the value 84737 J/KMOL-K. The 'Element 6' row for Propane is also circled in red, indicating the value 126610 J/KMOL-K. The 'Element 7' row for Methane is also circled in red, indicating the value 2086.9 J/KMOL-K. The 'Element 8' row for Ethane is also circled in red, indicating the value 872.24 J/KMOL-K. The 'Element 9' row for Propane is also circled in red, indicating the value 844.31 J/KMOL-K. The 'Element 10' row for Methane is also circled in red, indicating the value 41602 J/KMOL-K. The 'Element 11' row for Ethane is also circled in red, indicating the value 67130 J/KMOL-K. The 'Element 12' row for Propane is also circled in red, indicating the value 86165 J/KMOL-K. The 'Element 13' row for Methane is also circled in red, indicating the value 991.96 J/KMOL-K. The 'Element 14' row for Ethane is also circled in red, indicating the value 2430.4 J/KMOL-K. The 'Element 15' row for Propane is also circled in red, indicating the value 2482.7 J/KMOL-K. The 'Element 16' row for Methane is also circled in red, indicating the value 50 J/KMOL-K. The 'Element 17' row for Ethane is also circled in red, indicating the value 298.15 J/KMOL-K. The 'Element 18' row for Propane is also circled in red, indicating the value 298.15 J/KMOL-K. The 'Element 19' row for Methane is also circled in red, indicating the value 1500 J/KMOL-K. The 'Element 20' row for Ethane is also circled in red, indicating the value 1500 J/KMOL-K. The 'Element 21' row for Propane is also circled in red, indicating the value 1500 J/KMOL-K.

Component	METHANE	ETHANE	PROPANE
Temperature units	K	K	K
Source	PURE37	PURE37	PURE37
Property units	J/KMOL-K	J/KMOL-K	J/KMOL-K
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?