

ME 201

Thermodynamics

Compressible Substance Property Evaluation Guide

Substances that are undergoing a phase change or have the potential to undergo a phase change must be considered compressible substances. Occasionally, we can identify these types of substances by clue words that are used, such as: boiling, condensation, steam, saturated, vapor, water, and refrigerant.

Properties for compressible substances must be obtained from tabular data. Normally, the property data is organized into four tables

Saturation Pressure Table

Saturation Temperature Table

Superheated Vapor Table

Compressed Liquid Table

In order to use the correct table, it is essential that the fluid phase be identified. We recognize five fluid phases

Subcooled or Compressed Liquid

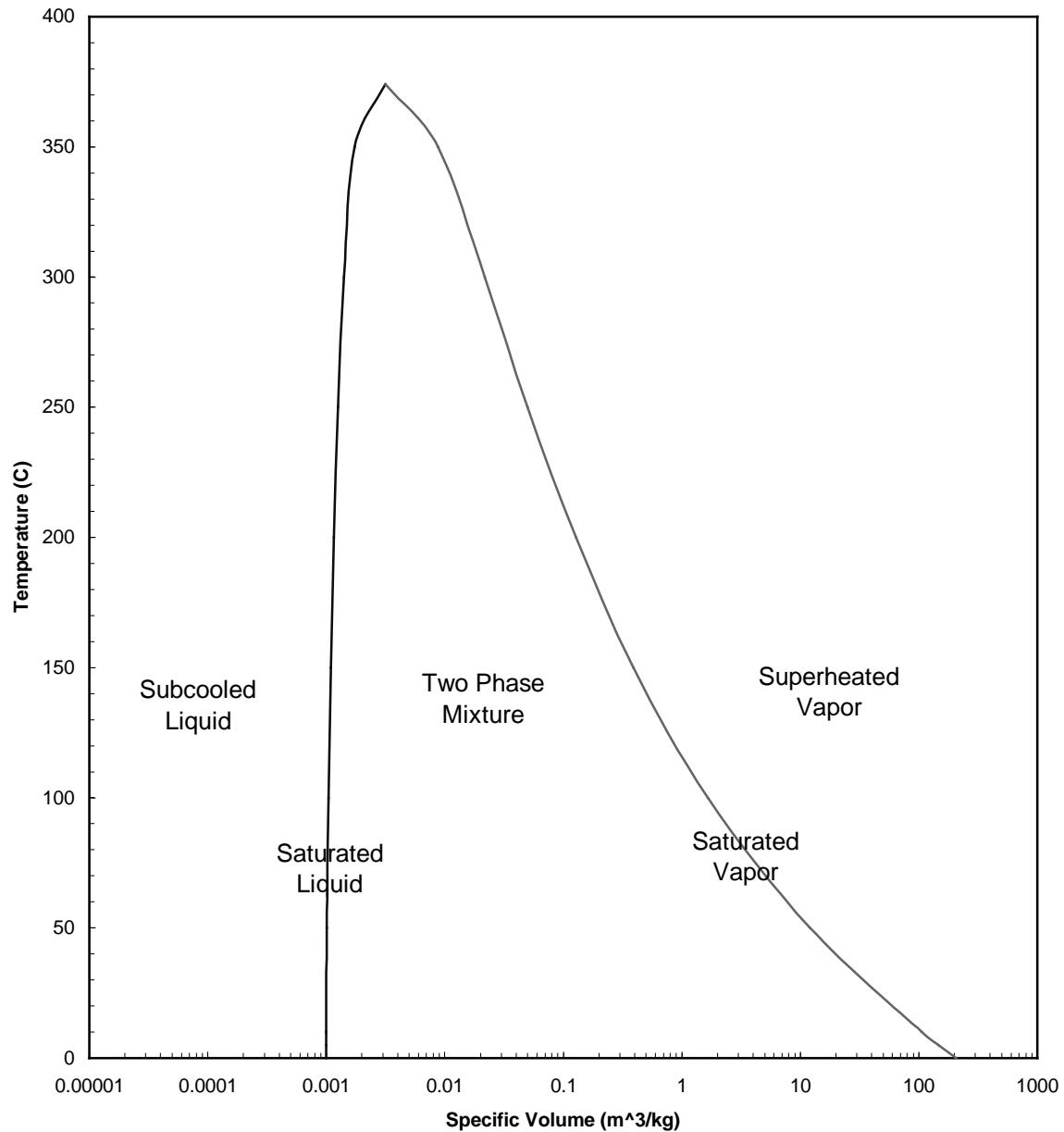
Saturated Liquid

Two Phase Mixture with a quality, x , given as the fraction of vapor in the mixture

Saturated Vapor

Superheated Vapor

We can recognize these phases more clearly by looking at a T-v graph of the substance.



The solid line is called the vapor dome.

To determine the phase, we consider two paths.

1. T and P are given

(a) Go to the Saturation Pressure Table and read the saturation (boiling) temperature at the given pressure.

(b) The phase is determined as shown below

If $T_{\text{given}} > T_{\text{sat}}$, phase: superheated vapor

If $T_{\text{given}} < T_{\text{sat}}$, phase: subcooled liquid

If $T_{\text{given}} = T_{\text{sat}}$, phase: indeterminate

2. T or P (designated by X) and u, h, v, or s (designated by y) are given

(a) Go to the appropriate saturation table and read the saturated liquid and saturated vapor values for the property y at the given value of X.

(b) The phase is determined as shown below

If $y_{\text{given}} > y_g$, phase: superheated vapor

If $y_{\text{given}} = y_g$, phase: saturated vapor

If $y_{\text{given}} < y_f$, phase: subcooled liquid

If $y_{\text{given}} = y_f$, phase: saturated liquid

If $y_f < y_{\text{given}} < y_g$, phase: two phase with quality,

$$x = \frac{y - y_f}{y_g - y_f}$$

3. The fluid phase can be given in the problem by stating the substance is saturated liquid or saturated vapor or by being given a value for the quality.

For a two phase mixture with the quality given any property, y, can be determined by

$$y = x \cdot y_g + (1 - x) \cdot y_f$$

or

$$y = y_f + x \cdot y_{fg}$$