3.5 PROPERTY TABLES

For most substances, the relationships among thermodynamic properties are too complex to be expressed by simple equations. Therefore, properties are frequently presented in the form of tables. Some thermodynamic properties can be measured easily, but others cannot and are calculated by using the relations between them and measurable properties. The results of these measurements and calculations are presented in tables in a convenient format. In the following discussion, the steam tables are used to demonstrate the use of thermodynamic property tables.

Property tables of other substances are used in the same manner. For each substance, the thermodynamic properties are listed in more than one table. In fact, a separate table is prepared for each region of interest such as the superheated vapor, compressed liquid, and saturated (mixture) regions.

1. SATURATED LIQUID AND SATURATED VAPOR STATES:

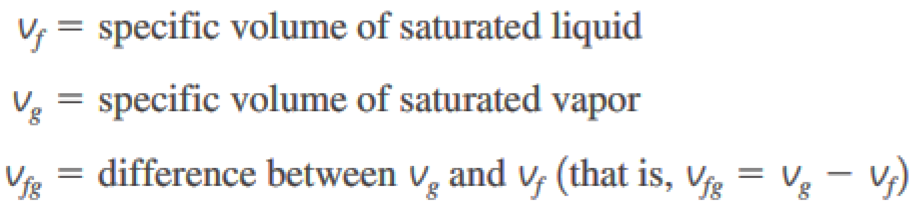
When water is in the saturated phase, Table (A-4) and Table (A-5) are used to get the required properties. Both tables give the same information, the only difference is that in Table (A-4) properties are listed under temperature and in Table (A-5) under pressure. Therefore, it is more convenient to use Table (A-4) when temperature is given and Table (A-5) when pressure is given. The use of Table (A-4) is illustrated in Figure (3.3).

$$Saturated\ \text{water} \Rightarrow \text{Table (A} - 4) \text{ and Table (A} - 5) \Rightarrow \text{to get properties}$$

$$Saturated\ \text{water @ T} = \text{given} \Rightarrow \text{Table (A} - 4) \Rightarrow \text{to get properties}$$

$$Saturated\ \text{water @ P} = \text{given} \Rightarrow \text{Table (A} - 5) \Rightarrow \text{to get properties}$$

The subscript (*f*) is used to denote properties of a saturated liquid, and the subscript (*g*) to denote the properties of saturated vapor. Another subscript commonly used is (*fg*), which denotes the difference between the saturated vapor and saturated liquid values of the same property. For example,

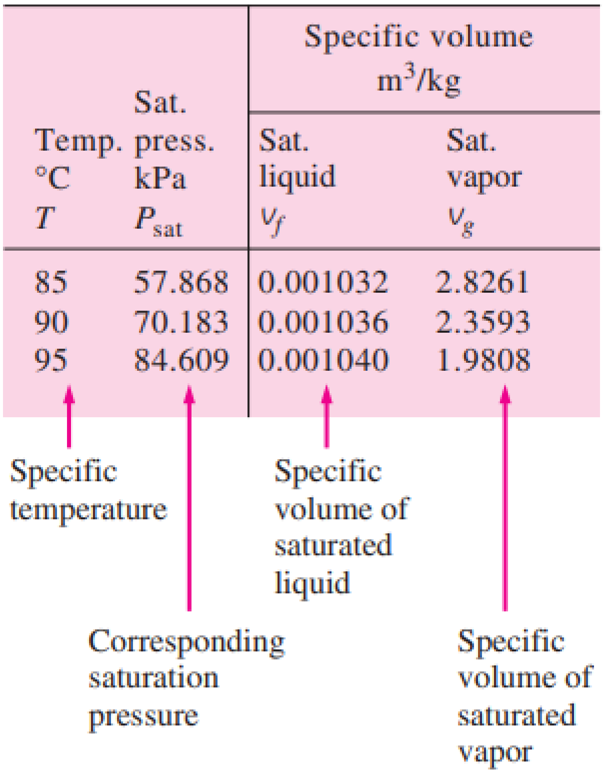


v_f = specific volume of saturated liquid

v_g = specific volume of saturated vapor

v_{fg} = difference between v_g and v_f (that is, $v_{fg} = v_g - v_f$)

The quantity (h_{fg}) is called the enthalpy of vaporization (or latent heat of vaporization).



Temp. °C T	Sat. press. kPa P_{sat}	Specific volume m^3/kg Sat. liquid v_f	 Sat. vapor v_g
85	57.868	0.001032	2.8261
90	70.183	0.001036	2.3593
95	84.609	0.001040	1.9808

Specific temperature

Corresponding saturation pressure

Specific volume of saturated liquid

Specific volume of saturated vapor

Figure (3.3) A partial list of Table (A-4)

Example (1): A rigid tank contains (50 kg) of saturated liquid water at (90 °C). Determine the pressure in the tank and the volume of the tank.

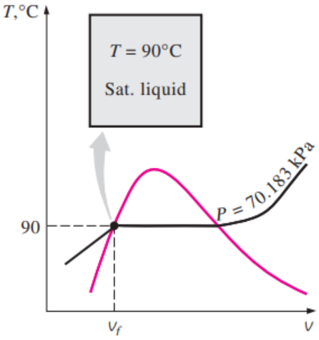
Solution:

$$Saturated\ \text{water @ T} = 90\ \text{°C} \Rightarrow \text{Table (A} - 4) \Rightarrow P = P_{sat} = 70.183\ kPa$$

$$Saturated\ \text{water @ T} = 90\ \text{°C} \Rightarrow \text{Table (A} - 4) \Rightarrow v = v_f = 0.001036\ kg/m^3$$

Then the total volume of the tank becomes

$$V = v_f m = 0.001036 * 50 = 0.0518\ m^3$$

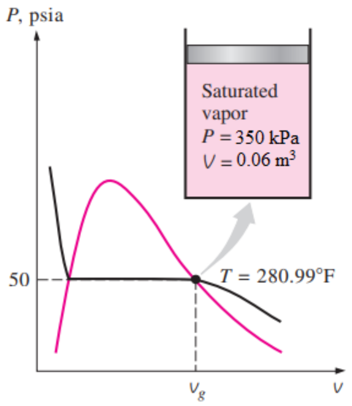


Example (2): A piston cylinder device contains (0.06 m^3) of saturated water vapor at (350 kPa) pressure. Determine the temperature and the mass of the vapor inside the cylinder.

Solution:

$$Saturated \text{ water @ P} = 350 \text{ kPa} \Rightarrow \text{Table (A} - 5) \Rightarrow T = T_{sat} = 138.86\ ℃$$

$$Saturated \text{ water @ P} = 350 \text{ kPa} \Rightarrow \text{Table (A} - 5)$$



$$\Rightarrow v = v_g = 0.52422\ kg/m^3$$

Then the total volume of the tank becomes

$$V = v_g m \Rightarrow m = \frac{V}{v_g}$$

$$m = \frac{0.06}{0.5243} = 0.114\ kg$$