

EXAMPLE IIa.3.4

In the text, the following example refers to a pressure search technique.

Example IIa.3.4. Consider a process where heat, mass, and work are exchanged with the surroundings. In the final state, u and v are known. Determine pressure and temperature of the final state.

Solution: The conservation equations of mass and energy are discussed later in this chapter. For now, our purpose of presenting this example is to indicate that in thermohydraulic computer codes, mass (m) is obtained from the conservation equation of mass, total internal energy (U) from the conservation equation of energy, and volume (V) from the volume constraint. Specific internal energy (u) and specific volume (v) are obtained from $u = U/m$ and $v = V/m$, respectively. While the steam tables are traditionally arranged in terms of pressure (P) and temperature (T), it is generally the u and v that are calculated in the analysis. We should then find P and T from u and v by iteration with the steam tables. This is called the *pressure search* method. An example of such iteration is given by Program A.II.1 in the accompanying CD-ROM.

To see how to perform a pressure search, we note that from the mass and energy equations, we have obtained $u_2 = c_1$ and from the volume constraint, we have obtained $v_2 = c_2$, where c_1 and c_2 are given constants. We now want to find P_2 and T_2 . Here we consider a case that state 2 is a saturated state. Thus we should also find x_2 .

We first express $v_2 = v_{f2} + x_2 v_{fg2}$ and $u_2 = u_{f2} + x_2 u_{fg}$. Next, we cancel the steam quality to obtain:

$$(c_1 - v_{f2})u_{fg2} - (c_2 - u_{f2})v_{fg2} = 0 \quad 1$$

In Appendix Table A.II.6, we have mathematical functions for v_f , v_{fg} , u_f , and u_{fg} versus temperature. If we substitute these functions in Equation 1, we find an equation, which is solely a function of temperature. The resulting equation can be solved by the Newton-Raphson iteration technique for solving non-linear algebraic equations (see Chapter VIIe).

The functions in Table A.II.6 are used in the computer program SAT_SYS, available in this folder. See also Program_A_II_1.