Repeating the calculation at several pressures we construct the following table that shows how pressure and temperature in the tank change during filling.

P (bar)	T (°C)	V (m^3/kg)	m (kg)
1	359.1	2.913160	0.34
5	362.5	0.581953	1.72
10	366.8	0.290572	3.44
15	370.9	0.193459	5.17
20	375.0	0.144911	6.90

Comments Throttling steam into the tank causes its temperature to drop. This throttling process, however, is not isenthalpic as in steady state. The difference is that eq. [A] is written, not between the inlet and outlet of the valve, as in eq. (6.53), but between the inlet of the valve and the *entire contents of the tank*. When a small amount of the gas passes through the valve, it mixes upon exit with the contents of the tank. We have assumed this mixing to be instantaneous, and it is this assumption that prevents us from analyzing in more detail the immediate exit point of the valve.

Example 6.25: Filling of Tank with Ideal Gas

Repeat the previous problem assuming steam to be an ideal gas with $C_P^{\mathrm{ig}} = 35.62$ J/mol K.

Solution The working equation is

$$U = H_1, \qquad \text{[A]}$$

as in the previous example, but the calculation of enthalpy and entropy must now be done using the ideal-gas equations. Since the equations for the ideal-gas enthalpy and internal energy gives these properties as differences rather than as absolute values, we need to introduce a reference state for these calculations. We pick the reference state to be the state in the steam main and set the enthalpy. Next, we write an equation for the internal energy in the tank (at pressure P, temperature T) based on the reference state. To do this, we first express internal energy in terms of enthalpy at P, T, then we calculate this enthalpy relative to the reference state:

$$U(P, T) = H(P, T) + PV = H_1 + C_P^{\mathrm{ig}}(T - T_1) + PV = H_1 + C_P^{\mathrm{ig}}(T - T_0) + RT.$$

Equation [A] now becomes

$$H_1 + C_P^{\mathrm{ig}}(T - T_1) + RT = H_1.$$

Solving for the temperature in the tank we find ~~for T~~:

$$T = \frac{C_P}{C_P - R} T_1.$$