

**4-58** A rigid vessel that contains a saturated liquid-vapor mixture is heated until it reaches the critical state. The mass of the liquid water and the volume occupied by the liquid at the initial state are to be determined.

**Analysis** This is a constant volume process ( $\nu = V/m = \text{constant}$ ) to the critical state, and thus the initial specific volume will be equal to the final specific volume, which is equal to the critical specific volume of water,

$$\nu_1 = \nu_2 = \nu_{cr} = 0.003106 \text{ m}^3/\text{kg} \quad (\text{last row of Table A-4})$$

The total mass is

$$m = \frac{V}{\nu} = \frac{0.3 \text{ m}^3}{0.003106 \text{ m}^3/\text{kg}} = 96.60 \text{ kg}$$

At  $150^\circ\text{C}$ ,  $\nu_f = 0.001091 \text{ m}^3/\text{kg}$  and  $\nu_g = 0.39248 \text{ m}^3/\text{kg}$  (Table A-4). Then the quality of water at the initial state is

$$x_1 = \frac{\nu_1 - \nu_f}{\nu_{fg}} = \frac{0.003106 - 0.001091}{0.39248 - 0.001091} = 0.005149$$

Then the mass of the liquid phase and its volume at the initial state are determined from

$$m_f = (1 - x_1)m_t = (1 - 0.005149)(96.60) = \mathbf{96.10 \text{ kg}}$$

$$V_f = m_f \nu_f = (96.10 \text{ kg})(0.001091 \text{ m}^3/\text{kg}) = \mathbf{0.105 \text{ m}^3}$$

