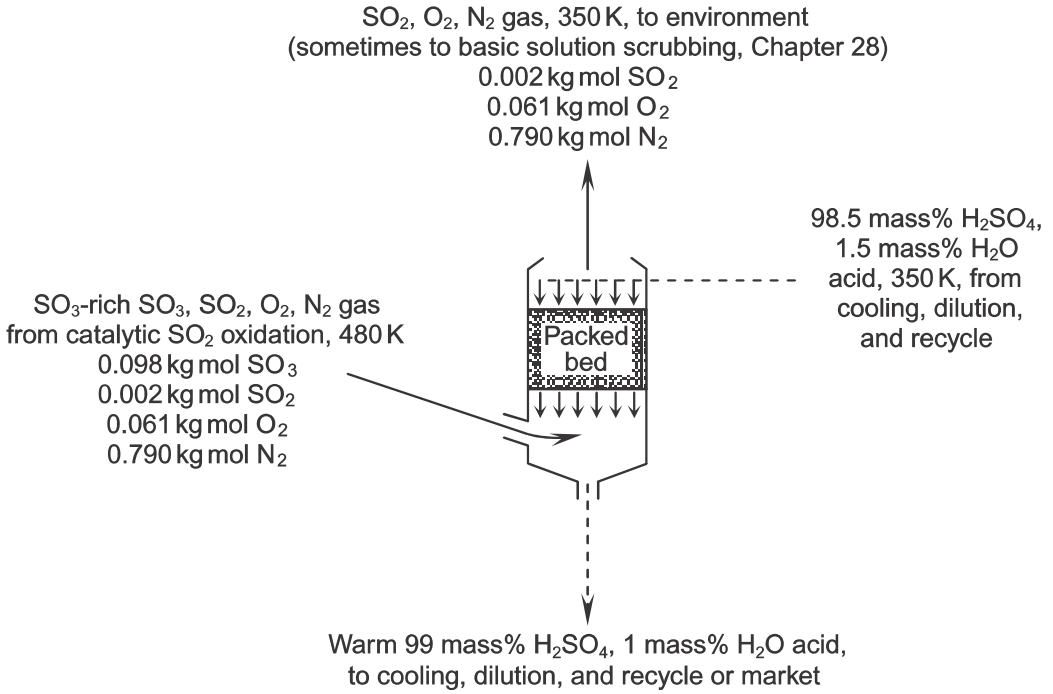

Figure 24.1 Figure 23.1's single contact absorption tower. Its quantities, temperatures, and gas compositions are used in Sections 24.1 and 24.2 calculations. The molar quantities are all per kg mol of Section 23.3's first catalyst bed feed gas. The calculations assume that all input SO_3 reacts to form $H_2SO_4(\ell)$. Note that *output gas* temperature = *input acid* temperature.

24.2.1 $H_2SO_4(\ell)$-$H_2O(\ell)$ enthalpy of mixing

Mixing of $H_2SO_4(\ell)$ and $H_2O(\ell)$ releases heat. This means that the enthalpy of sulfuric acid is lower than the combined enthalpies of pure $H_2SO_4(\ell)$ and $H_2O(\ell)$.

Calorimetric measurements indicate that the enthalpy of mixing $H_2SO_4(\ell)$ and $H_2O(\ell)$ is given by the following equation:

$$\underset{\substack{\mathrm{H_2SO_4}\\ \mathrm{MJ/kg\ mol\ of\ H_2SO_4}}}{\Delta H_{\mathrm{mix}}} = -1.82 * \text{mass\% } H_2O \text{ in sulfuric acid} \tag{24.1}$$

(for acid containing up to ~10 mass% H_2O; Duecker and West, 1966)

The enthalpy of H_2SO_4-in-acid may, therefore, be represented by:

$$\underset{\mathrm{H_2SO_4}(\ell)}{H_{\mathrm{T}}} = \underset{\mathrm{H_2SO_4}(\ell)}{H^{\circ}_{\mathrm{T}}} - 1.82 * \text{mass\% } H_2O \text{ in sulfuric acid} \tag{24.2}$$

(MJ/kg mol of H_2SO_4).