2.3 Two-phase Flow (continue)

2.3.2 Elevation Pressure Drop, ΔP_e

- Two-phase down flow. There is *no* pressure recovery (increase), due to the strong tendency for annular flow.
- Two-phase up flow. Based on the method of Flanigan (Oil Gas J, 1958)

$$\begin{aligned}
\Delta P_e &= \frac{R_F.\rho_L.g + (1 - R_F)\rho_V.g}{1000} \sum Z_{elev} \\
R_F &= \text{Flanigan liquid holdup} \\
&= \frac{1}{1 + 1.0151 v_{sg}} \qquad \text{(curve fit)} \\
v_{sg} &= \text{Superficial gas velocity (m/s)} \\
\sum Z_{elev} &= \text{Sum of all uphill sections (m)}
\end{aligned}$$

2.3.3 Acceleration Pressure Drop, ΔP_a

- If the pressure drop or vaporization is significant, the frictional ΔP is evaluated at an average density, and following acceleration pressure drop (for constant diameter) is added:

$$\Delta P_a = 6.254 \times 10^{-11} \times 2 \left[\frac{1}{\rho_2} - \frac{1}{\rho_1} \right] \frac{W^2}{D^4}$$

  - Homogeneous model (Simpson, Chem Eng, 1968).

$$\frac{1}{\rho_{1\,or\,2}} = \frac{1}{\rho_{ns1\,or\,ns2}} = \left[\frac{x_L}{\rho_L} + \frac{1 - x_L}{\rho_G} \right]_{1\,or\,2}$$

  - Constant Slip model (Dukler, AIChE, 1964).

$$\frac{1}{\rho_{1\,or\,2}} = \left[\frac{x_L^2}{\rho_L R_H} + \frac{(1 - x_L)^2}{\rho_G (1 - R_H)} \right]_{1\,or\,2}$$