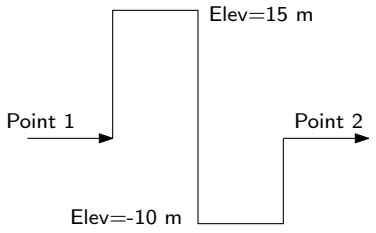
5.2.3 Two-phase Flow (continue)

5.2.3.2 Elevation Pressure Drop, ΔP_{elev}

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

$$\Delta P_{elev} = \frac{\rho_F . g}{C_{52}} \sum Z_{elev} \qquad (5.10)$$

$$\begin{aligned} \rho_F &= R_F.\rho_L + (1 - R_F)\rho_V \\ &= R_F.\rho_L \quad \text{(assuming vapour elev changes cancel out)} \\ R_F &= \text{Flanigan liquid holdup} \\ &= \frac{1}{1 + C_{55} v_{sg}} \quad \text{(curve fit)} \\ v_{sg} &= \text{Superficial gas velocity (m/s)[ft/s]} \\ \sum Z_{elev} &= \text{Sum of all uphill sections (m)[ft]} \\ C_{55} &= (1.0151) \text{ or } [0.3094] \end{aligned}$$



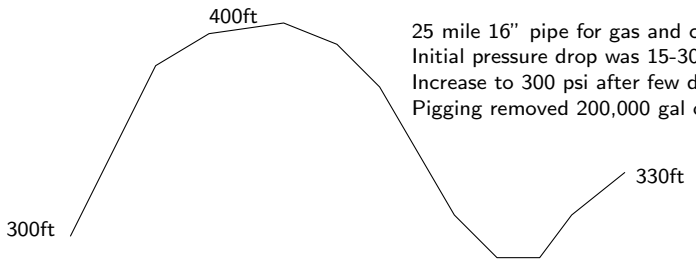
Liquids:

$$dPelev = \rho g(15 - 15 - 10 + 10) = 0$$

Two-phase:

$$\begin{aligned} dPelev &= \rho g(15 - 0 - 0 + 10) \\ &= \rho g(15 + 10) \\ &= \rho g \sum \text{(uphill sections)} \end{aligned}$$

Example - Two-phase elevation pressure drop



25 mile 16" pipe for gas and condensate in Texas.
Initial pressure drop was 15-30 psi.
Increase to 300 psi after few days.
Pigging removed 200,000 gal of liquid.

Case - Flanigan pipeline (1954)