6.17 Two-Phase Expansion Factor - Close-up Taps

- The two-phase expansion factor is based on the Omega equation of state proposed by Epstein et al (1983) and refined by Leung (1992).

$$\frac{\rho_{ref}}{\rho} = \omega \left[\frac{P_{ref}}{P} - 1\right] + 1$$

  Any two-phase point (including bubble point liquid) can be used as reference.

- The Omega equation of state matches liquid flow ($\omega = 0$) and isothermal compressible flow ($\omega = 1$) exactly.

  It is also a good approximation for both adiabatic compressible flow ($\omega \simeq \frac{1}{k}$) and two-phase flow ($\omega \simeq \frac{\alpha_1}{k}$ for non-flashing with α_1=inlet vapour vol fraction).

- Several equations have been proposed for ω causing a fair bit of confusion. It is the most accurate and easiest to calculate ω directly from its definition (ISO 4126).

$$\omega = \frac{\left(\frac{\rho_{1s}}{\rho_i} - 1\right)}{\left(\frac{P_{1s}}{P_i} - 1\right)} \quad \text{with } \omega \geq 0$$

P_{1s}, ρ_{1s} = Pressure and homogeneous density based on smaller of P_1 or P_s
P_i, ρ_i = Pressure and homogeneous density at intermediate point. Based on isentropic flash from P_{1s} to P_i, but isenthalpic flash is acceptable. API 520 uses $P_i = 0.9P_{1s}$, Diers uses $P_i = 0.7P_{1s}$.