The term in the right-hand side is known as the Poynting factor. This equation is valid to incompressible phases in general (liquids away from the critical point, and solids in general). A practical result is obtained if we choose the initial state to be the saturated liquid at the given temperature:

$$f(P, T) = f_L \exp\left(\frac{P - P^{\text{sat}}}{RT} V_L\right),$$

where P^{sat} is the saturation pressure, V_L, is the molar volume of the saturated liquid, and f_L is its fugacity. Using $f_L = \phi^{\text{sat}} P^{\text{sat}}$, the final result is

$$\boxed{f = \phi^{\text{sat}} P^{\text{sat}} \exp\left(\frac{P - P^{\text{sat}}}{RT} V_L\right).} \tag{7.16}$$

This equation allows us to obtain the fugacity in the compressed liquid region from tabulated values at saturation.

Example 7.4: Saturated Liquid
Calculate the fugacity and fugacity coefficient of saturated liquid water at 25 °C.

Solution The fugacity of the saturated liquid is equal to the fugacity of the saturated vapor

$$f_L = f_V = \phi^{\text{sat}} P^{\text{sat}}$$

The saturation pressure at 25 °C is 0.03166 bar and at such low pressure the vapor phase is ideal, that is, $\phi^{\text{sat}} \approx 1$. Therefore, the fugacity is equal to the saturation pressure,

$$f_L = f_V \approx 0.03166 \text{ bar},$$

and the fugacity coefficient is 1.

Example 7.5: Poynting Factor
Calculate the fugacity and fugacity coefficient of water at 25 °C, 100 bar, using data from the steam tables.

V_L (make L is subscript)

Solution Under these conditions water is a compressed liquid; therefore, the Poynting equation will be used. The liquid volume at 25 °C is $V^L = 1.003 \text{ cm}^3/\text{g} = 18 \times 10^{-6} \text{ m}^3/\text{mol}$. The Poynting factor is

$$\exp\left[(18 \times 10^{-6})\frac{(100 - 0.03166) \times 10^5}{(8.314)(298)}\right] = 1.075.$$