The fugacity coefficient is

$$\phi = \frac{57.92\ \text{bar}}{70\ \text{bar}} = 0.8274.$$

Using the Compressibility Factor

Equation (7.14) gives the fugacity in differential form in terms of volume. It is useful to express this equation in terms of the compressibility factor. Subtracting the term $d\ln P = dP/P$ from both sides of that equation we obtain

$$d\ln\frac{f}{P} = \left(\frac{V}{RT} - \frac{1}{P}\right) dP, \quad (\text{const. } T),$$

which we rewrite as

$$d\ln\phi = (Z-1)\frac{dP}{P}, \quad (\text{const. } T).$$

By integration from the ideal-gas state ($Z = 1$, $\phi = 1$) along an isotherm we obtain

$$\ln\phi = \int_0^P (Z-1)\frac{dP}{P}, \quad (\text{const. } T). \tag{7.17}$$

According to this result, the fugacity coefficient can be obtained from an integral that involves the compressibility factor. The compressibility factor may be calculated from an equation of state, from tables, or it may be obtained experimentally.

A useful result is obtained if we restrict our attention to the part of the isotherm that is described by the truncated virial equation:

+

$$Z \approx 1 - \frac{BP}{RT}.$$

change minus to plus

Since the second virial coefficient depends only on temperature and integration along an isotherm, the result is

"P" missing from left-hand side

BP/RT = Z-1

$$\ln\phi \approx \frac{BP}{RT}. \tag{7.18}$$

Using $B/RT = Z - 1$ may be written in a simpler form as

$$\boxed{\ln\phi \approx Z - 1.} \tag{7.19}$$

This very simple approximation gives the correct answer in the ideal-gas state and is valid as an extrapolation to pressures sufficiently low that the compressibility factor may be approximated as a linear function of pressure.