ME 3007: Energetics

Compressibility

For $Z_r = Z/Z_c$:

$$Z_r = 1 + \frac{B}{V_r} + \frac{C}{V_r^2} + \frac{D}{V_r^5} + \frac{c_4}{T_r^3 V_r^2}\left(\beta + \frac{\gamma}{V_r^2}\right)\exp\left(-\frac{\gamma}{V_r^2}\right)$$

where

$$B = b_1 - \frac{b_2}{T_r} - \frac{b_3}{T_r^2} - \frac{b_4}{T_r^3}$$

$$C = c_1 - \frac{c_2}{T_r} + \frac{c_3}{T_r^3}$$

$$D = d_1 + \frac{d_2}{T_r}$$

Constant	Simple Fluid (0)	Reference Fluid (r)
b_1	0.1181193	0.2026579
b_2	0.265729	0.331511
b_3	0.15479	0.027655
b_4	0.030323	0.203488
c_1	0.0236744	0.0313385
c_2	0.0186984	0.0503618
c_3	0	0.016901
c_4	0.042724	0.041577
d_1 x 10^4	0.155488	0.48736
d_2 x 10^4	0.623689	0.0740336
β	0.65392	1.226
γ	0.060167	0.03754

$\omega^{(r)} = 0.3978$

For properties such as enthalpy:

$$\frac{H-H^*}{R_uT_c}=\left[\frac{H-H^*}{R_uT_c}\right]^{(0)}+\left(\frac{\omega}{\omega^{(r)}}\right)\left\{\left[\frac{H-H^*}{R_uT_c}\right]^{(r)}-\left[\frac{H-H^*}{R_uT_c}\right]^{(0)}\right\}$$

$$\frac{H-H^*}{RT}=-T\left[\frac{\partial((G-G^*)/R_uT)}{\partial T}\right]_P \quad\Bigg|\quad \frac{G-G^*}{R_uT}=\int_0^P (Z-1)\frac{dP}{P} \qquad \text{(constant T)}$$

$$\frac{H-H^*}{R_uT}=-T\int_0^P\left(\frac{\partial Z}{\partial T}\right)_P\frac{dP}{P} \qquad \text{(constant T)}$$

$$\begin{aligned}\frac{H-H^*}{R_uT_c} &= T_r\left[Z-1-\frac{b_2+2b_3/T_r+3b_4/T_r{}^2}{T_rV_r}\right.\\ &\qquad\left.-\frac{c_2-3c_3/T_r{}^2}{2T_rV_r{}^2}+\frac{d_2}{5T_rV_r{}^5}+3E\right]\end{aligned}$$

$$E=\frac{c_4}{2T_r{}^3\gamma}\left[\beta+1-\left(\beta+1+\frac{\gamma}{V_r{}^2}\right)\exp\left(-\frac{\gamma}{V_r{}^2}\right)\right]$$

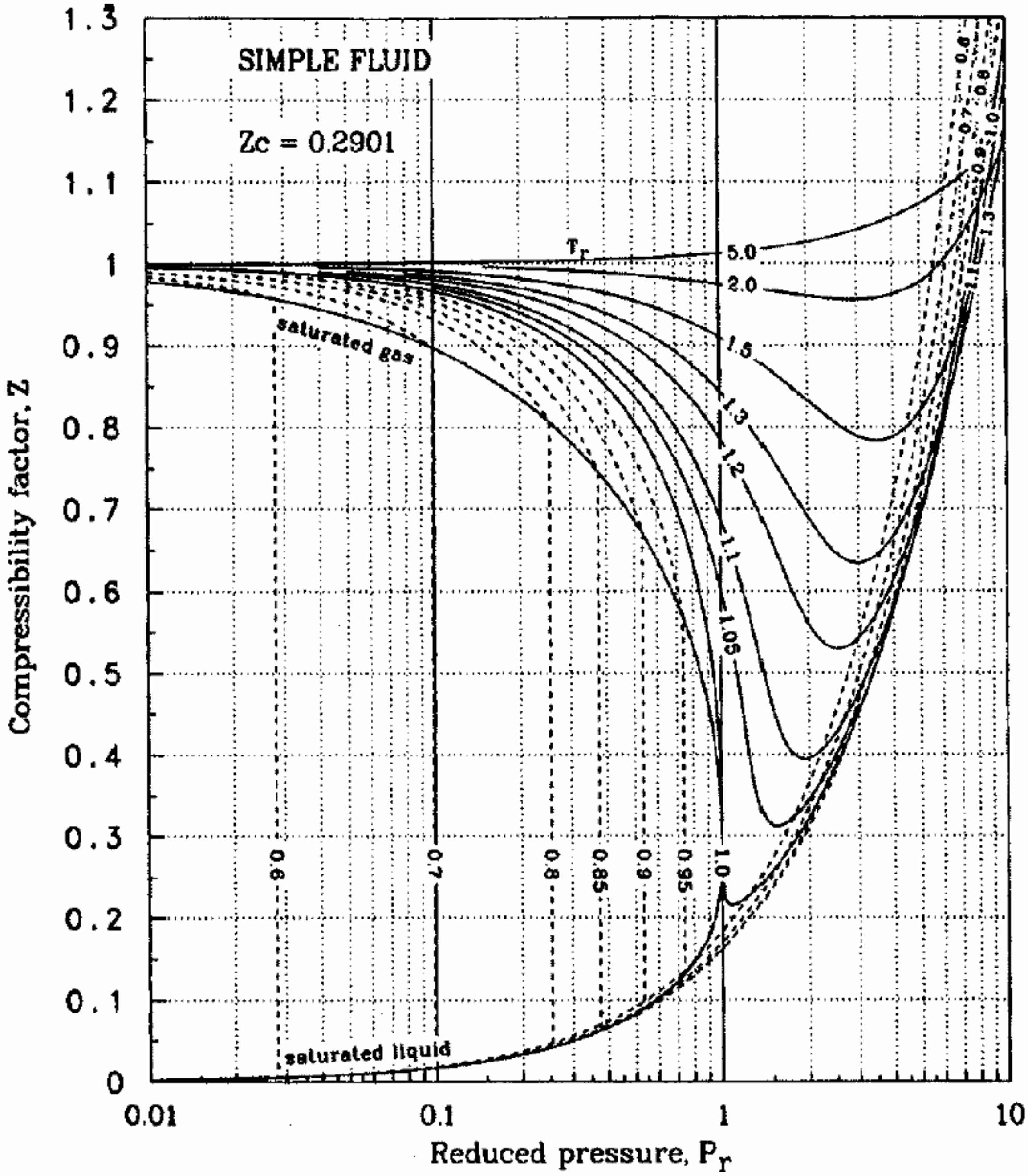

Figure D.1 Lee-Kesler Simple Fluid Compressibility Factor.

Lee- Kesler Simple Fluid Enthalpy Departure Chart