3-7 COMPRESSIBILITY FACTOR Z – deviation from ideal-gas

Ideal Gas	$1 = \dfrac{Pv_{i.g.}}{RT}$		$\Rightarrow$	$v_{i.g.} = \dfrac{RT}{P}$
Compressibility factor	$Z = \dfrac{Pv}{RT}$	for real gas	$\Rightarrow$	$v = Z\dfrac{RT}{P} = Z \cdot v_{i.g.}$ (3-19)

Reduced properties	$T_R = \dfrac{T\ [K]}{T_{cr}\ [K]}$	reduced temperature	(3-20)
	$P_R = \dfrac{P}{P_{cr}}$	reduced pressure	
	$v_R = \dfrac{v}{R\dfrac{T_{cr}}{P_{cr}}}$	pseudo-reduced specific volume	(3-21)

Principle of corresponding states	$Z(T_R, P_R)$	is the same for all gases	Table A-15, p.932
	$Z(v_R, P_R)$	is the same for all gases	

Figure 3-49 Comparison of Z factors

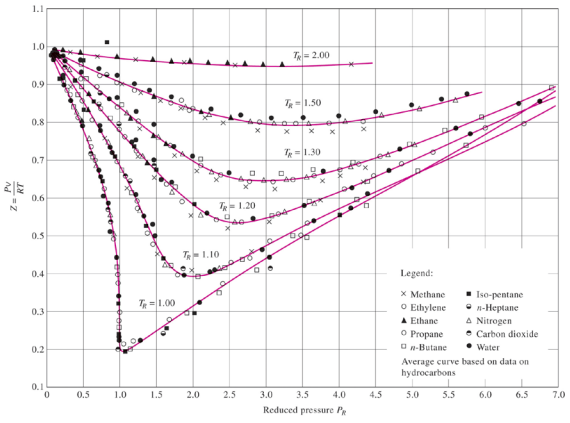
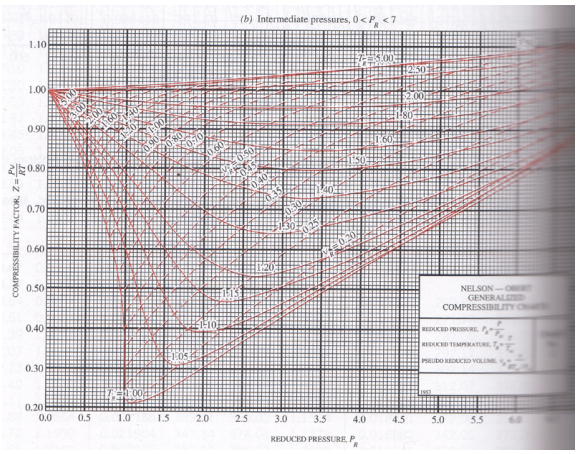


Table A-15 Generalized compressibility chart



Example 3-11	Find specific volume of R-134a at $P = 1.0\ MPa$ and $T = 50^oC = 273.15K$ (superheated vapor)		
Table A-1	$P_{cr} = 4.059\ MPa$, $T_{cr} = 374.2\ K$, $R = 0.08149\ \left[\dfrac{kJ}{kg \cdot K}\right]$		
Table A-13	v_{exact}	$= 0.021796$	Exact value
Ideal gas	$v_{i.g.} = \dfrac{RT}{P} = \dfrac{(0.08149)(323)}{(1000)} =$	0.026333	Error: 20.8 %
Z-factor	$T_R = \dfrac{T}{T_{cr}} = \dfrac{(273.15)}{(374.2)} = 0.863$, $P_R = \dfrac{P}{P_{cr}} = \dfrac{(1)}{(4.059)} = 0.246 \overset{A-15}{\Rightarrow} Z \approx 0.85$		
	$v = Z \cdot v_{i.g.} = (0.85)(0.026333) =$	0.02238305	Error: 2.7 %