Properties of Reservoir Fluids (PGE 362)

Reservoir Fluids Characteristics

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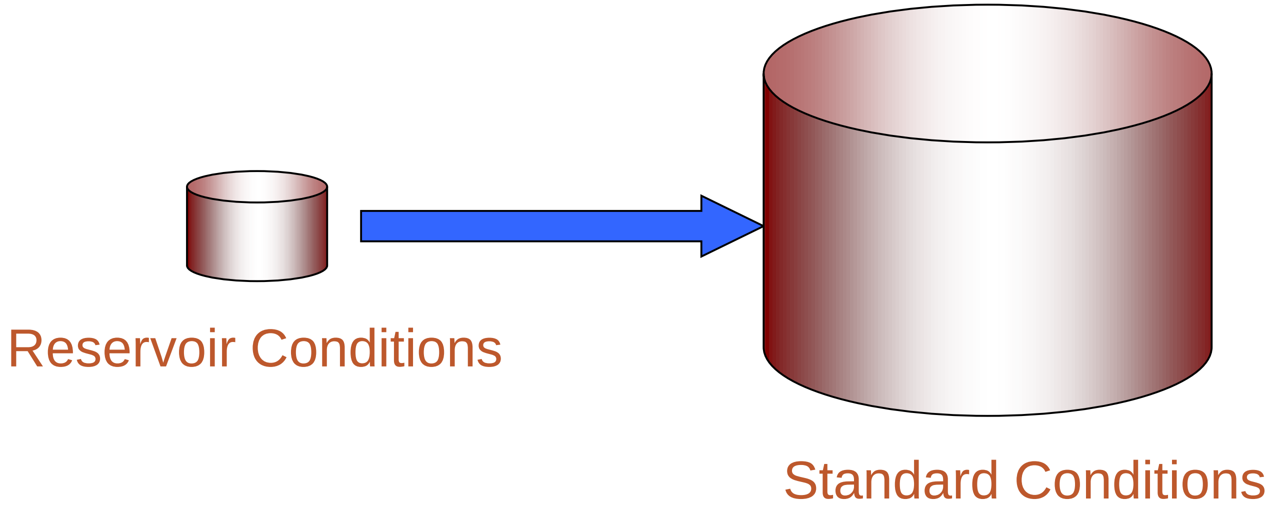
Gas Properties

Gas Formation Volume Factor (Bg):

The volume of gas at reservoir conditions required to produce one standard volume of gas at the surface condition.



Gas Properties

Gas Formation Volume Factor (Bg):

$$B_g = \frac{V_R}{V_{SC}} = \frac{\frac{znRT}{P}}{\frac{nRT_{SC}}{P_{SC}}}$$

SC: P =14.65 psia, T = 520 °R, z = 1.0

$$B_g = \frac{P_{SC}}{T_{SC}}\frac{zT}{P} = \frac{14.65}{(520)}\frac{zT}{P} = 0.0282\,\frac{zT}{P}\,\frac{res\ cu\ ft}{scf}$$

$$B_g = 0.00502\,\frac{zT}{P}\,\frac{res\ bbl}{scf}$$

$$B_g = 5.02\,\frac{zT}{P}\,\frac{res\ bbl}{Mscf}$$

Volume of an arbitrary amount of gas at reservoir T & P

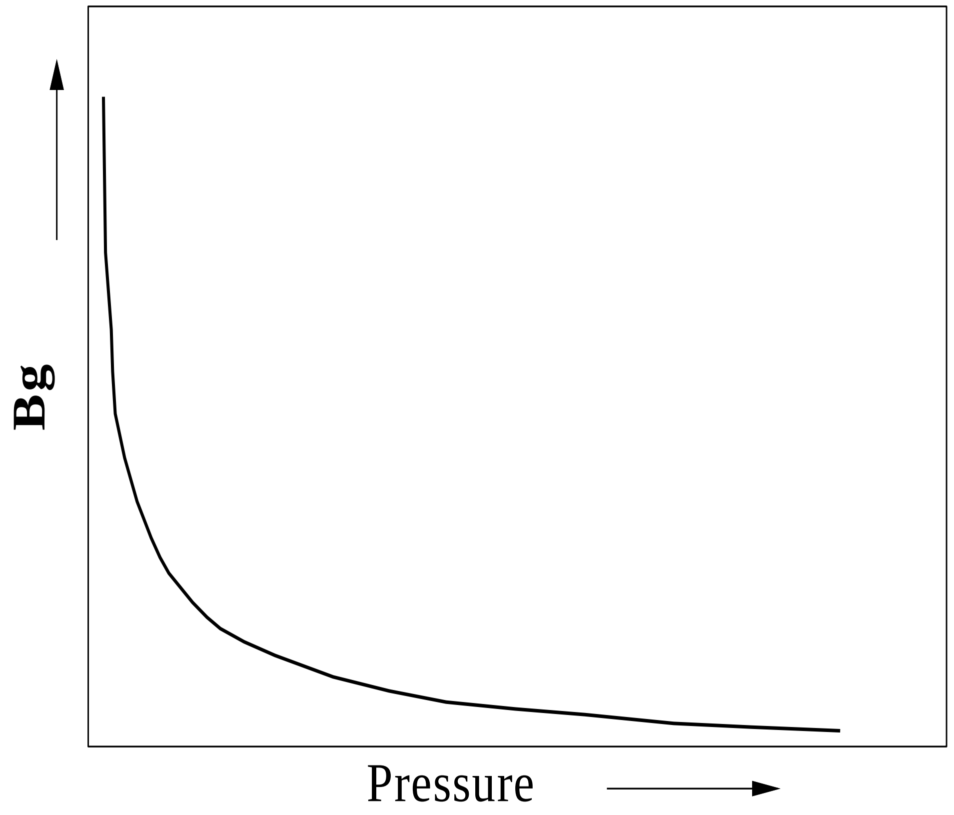
Volume at SAME amount At standard T & P

$$B_g = \frac{V_R}{V_{SC}}$$

Gas Properties

Gas Formation Volume Factor (Bg):

Typical shape of Bg



Gas Properties

Gas Formation Volume Factor (Bg):

Example:

A gas has a specific gravity of 0.74. Calculate its formation volume factor at 210° F and 2300 psia.

Solution:

Tc = 396° R, *Pc* = 665 psia

$$T_r = \frac{460+210}{396} = 1.69, \ P_r = \frac{2300}{665} = 3.46 \ , \ z = 0.86$$

$$B_g = 0.00502 \frac{(0.86)(670)}{(2300)} = 0.00126 \frac{res\ bbl}{scf} = 1.26 \frac{res\ bbl}{Mscf}$$

Gas Properties

Gas Viscosity (μ_g):
Viscosity is a measure of the resistance to flow exerted by a fluid.

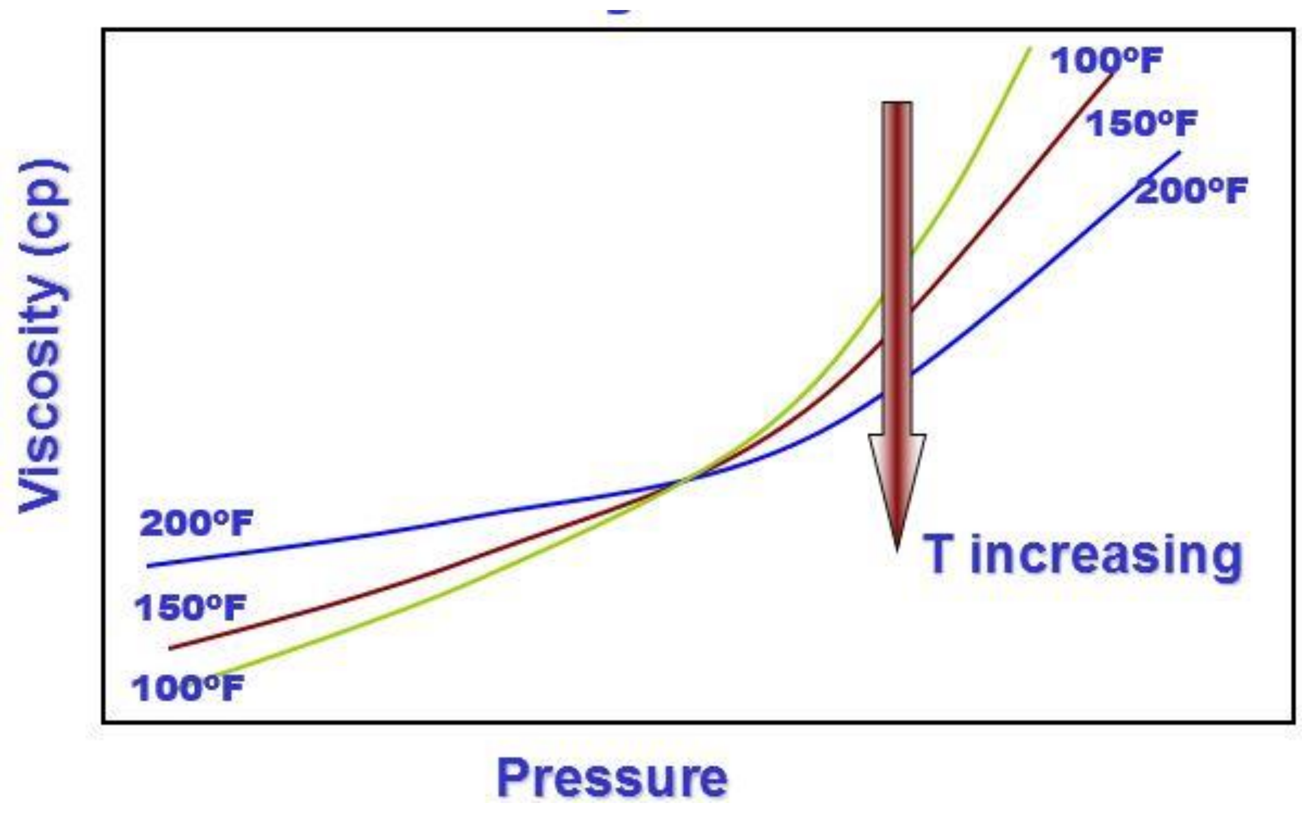
Units:
Dynamic (μ): Poise (p) = g mas/(sec cm)
or centipoise (cp) = g mas/(100 sec cm)
SI unit : Pascal second (Pa s) = 1 kg/(m s) = 10 p

Kinematic (*v*): viscosity/density : centipoise/gm/cc (cp/g/cc)

Gas Properties

Gas Viscosity (μ_g):

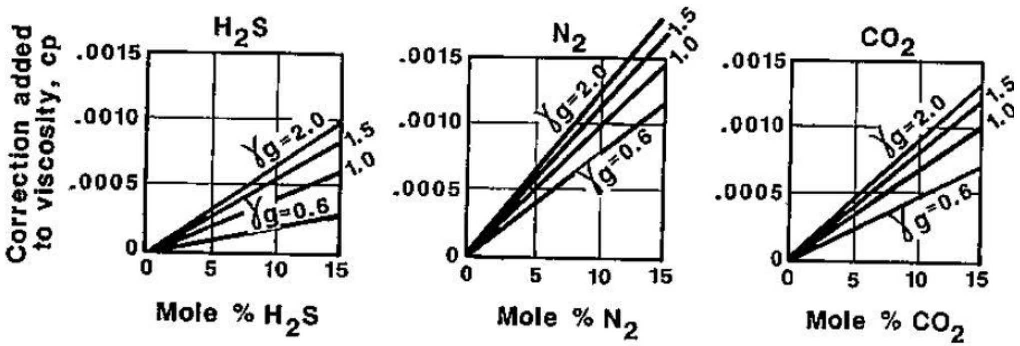
Typical shape:

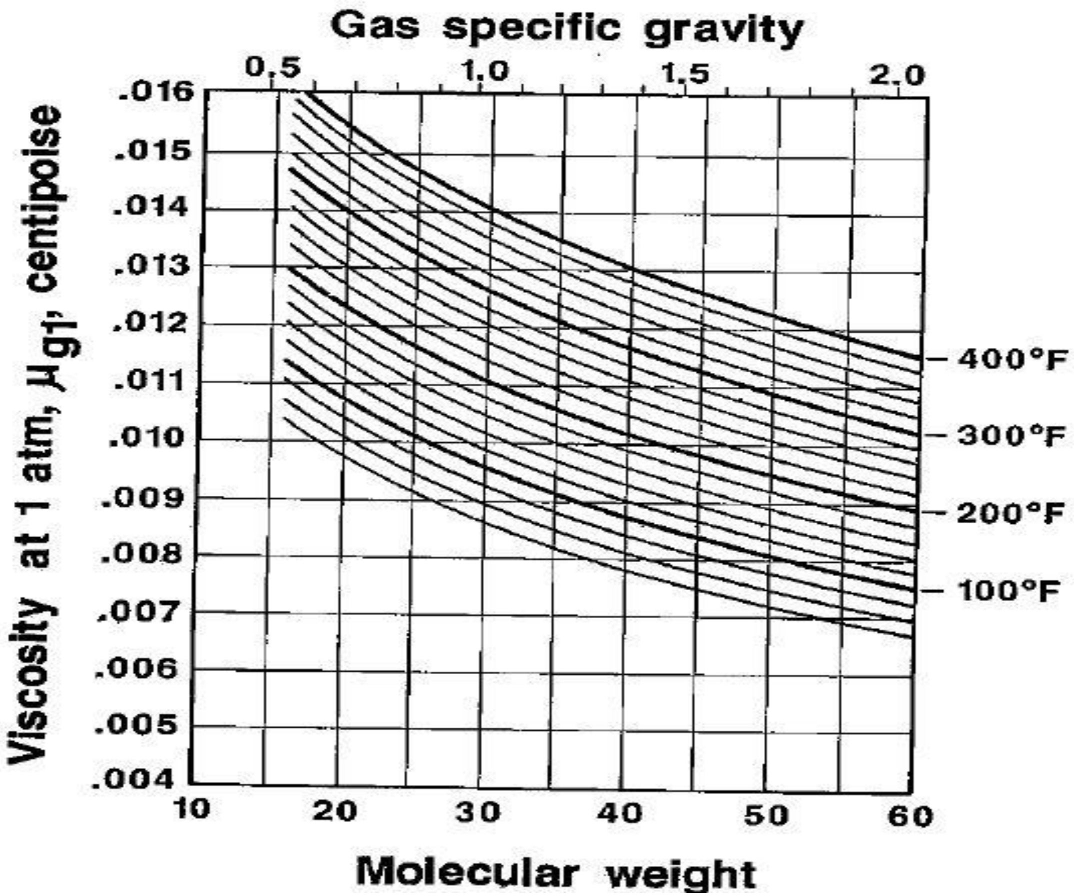


Gas Properties

Gas Viscosity (μ_g):

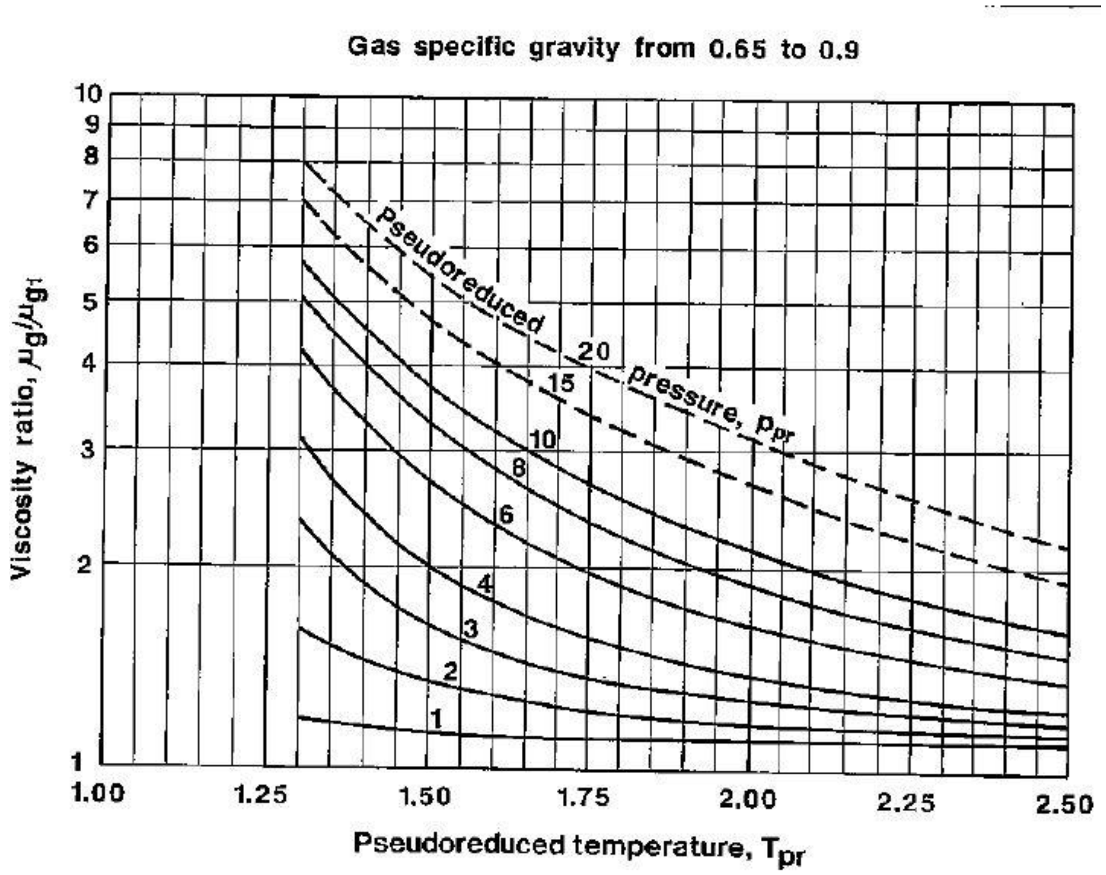
Correlation:





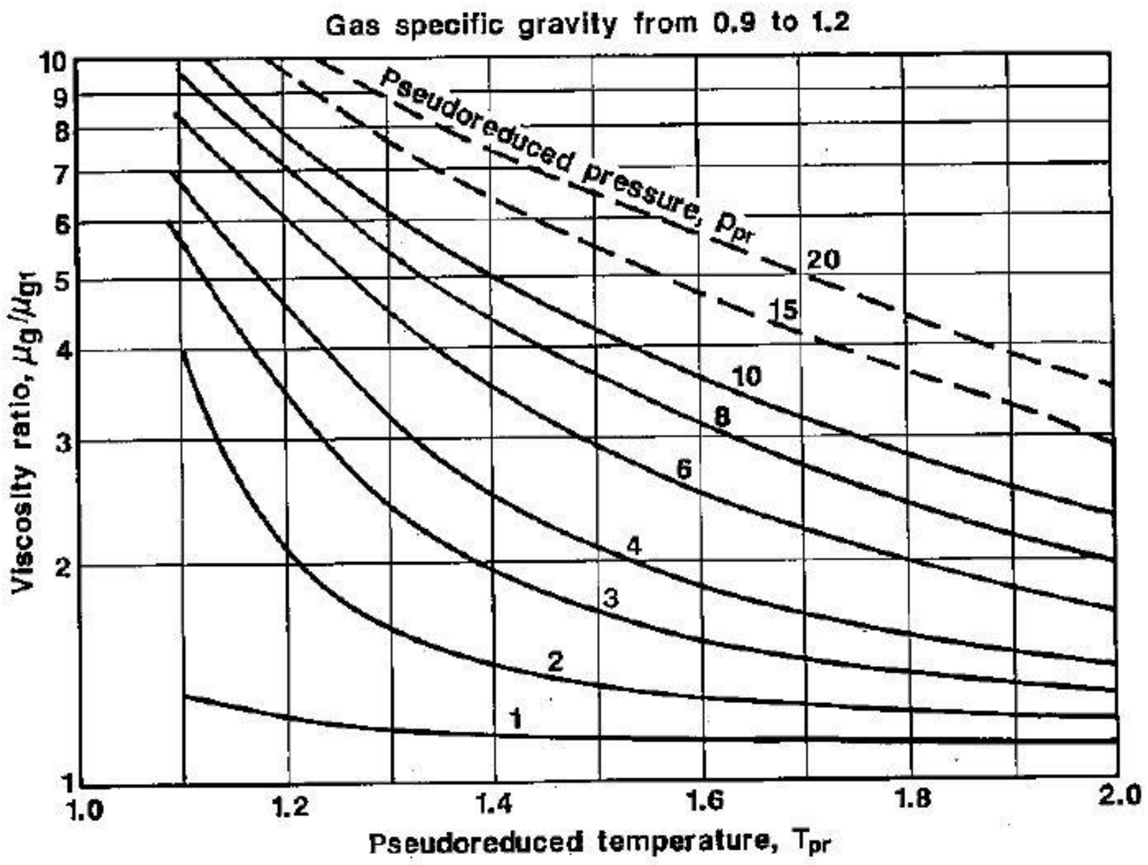
Gas Properties

Gas Viscosity (μ_g):
Correlation:



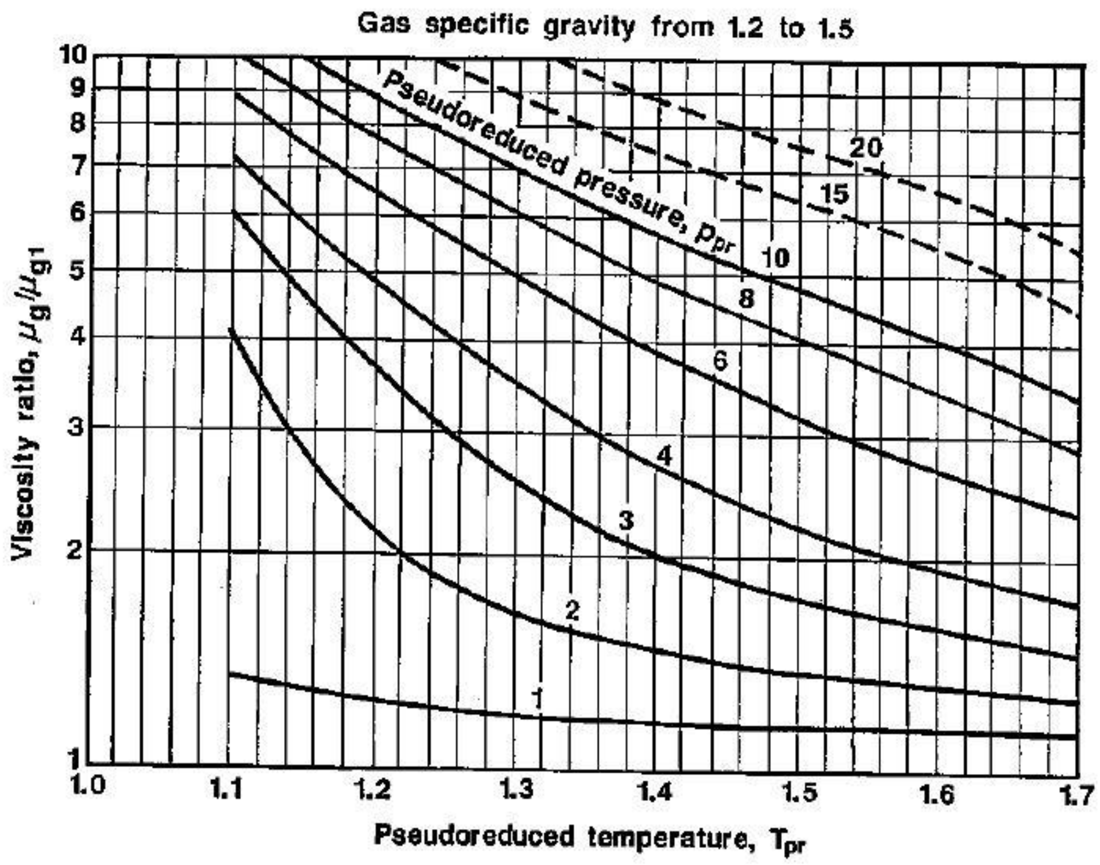
Gas Properties

Gas Viscosity (μ_g):
Correlation:



Gas Properties

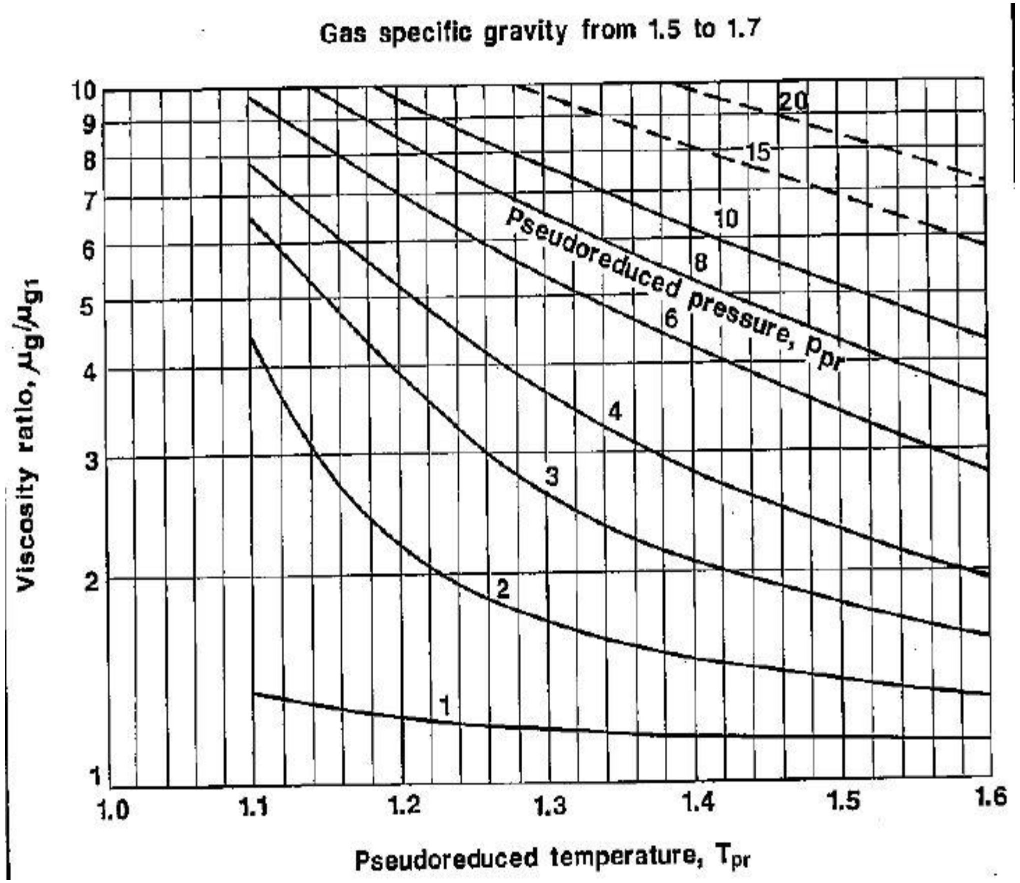
Gas Viscosity (μ_g):
Correlation:



Gas Properties

Gas Viscosity (μ_g):

<u>Correlation</u>:



Gas Properties

Gas Viscosity (μ_g):

Correlation:

EXAMPLE 6–9: *Calculate the viscosity of the gas mixture given below at 200°F and a pressure of one atmosphere absolute.*

Component	Composition, mole fraction
Methane	0.850
Ethane	0.090
Propane	0.040
n-Butane	0.020
	1.000

Gas Properties

Gas Viscosity (μ_g):

Correlation:

Solution:

First, calculate the specific gravity of the gas.

$$M_a = \sum_j y_j M_j$$

Component M_j	y_j	M_j	y_j
C_1	0.85	16.04	13.63
C_2	0.09	30.07	2.71
C_3	0.04	44.10	1.76
n-C_4	0.02	58.12	1.16
	1.02	M_a	19.26

$$\gamma_g = \frac{M_a}{29}$$

$$\gamma_g = \frac{19.26}{29} = 0.664$$

Second, determine viscosity.

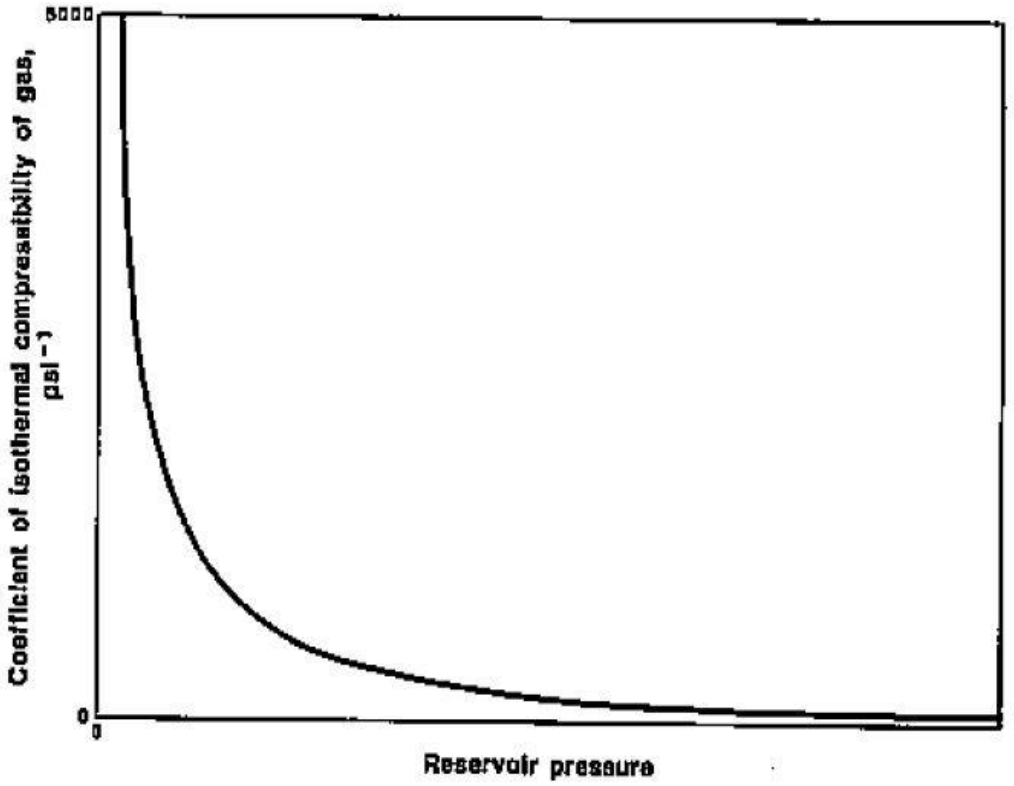
$$\mu_{g1} = 0.0125 \text{ cp at } 200°\text{F, Figure 6–8}$$

Gas Properties

Coefficient of Isothermal Compressibility of Gas (c_g):

The change in gas volume per change in pressure at constant temperature.

$$c_g = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$$



Gas Properties

Coefficient of Isothermal Compressibility of Gas (c_g):

$$c_g = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$$

Ideal Gas: $V = \frac{nRT}{P}$: $\frac{\partial V}{\partial P} = -\frac{nRT}{P^2}$

$$c_g = -\left(\frac{P}{nRT}\right)\left(-\frac{nRT}{P^2}\right) = \frac{1}{P}$$

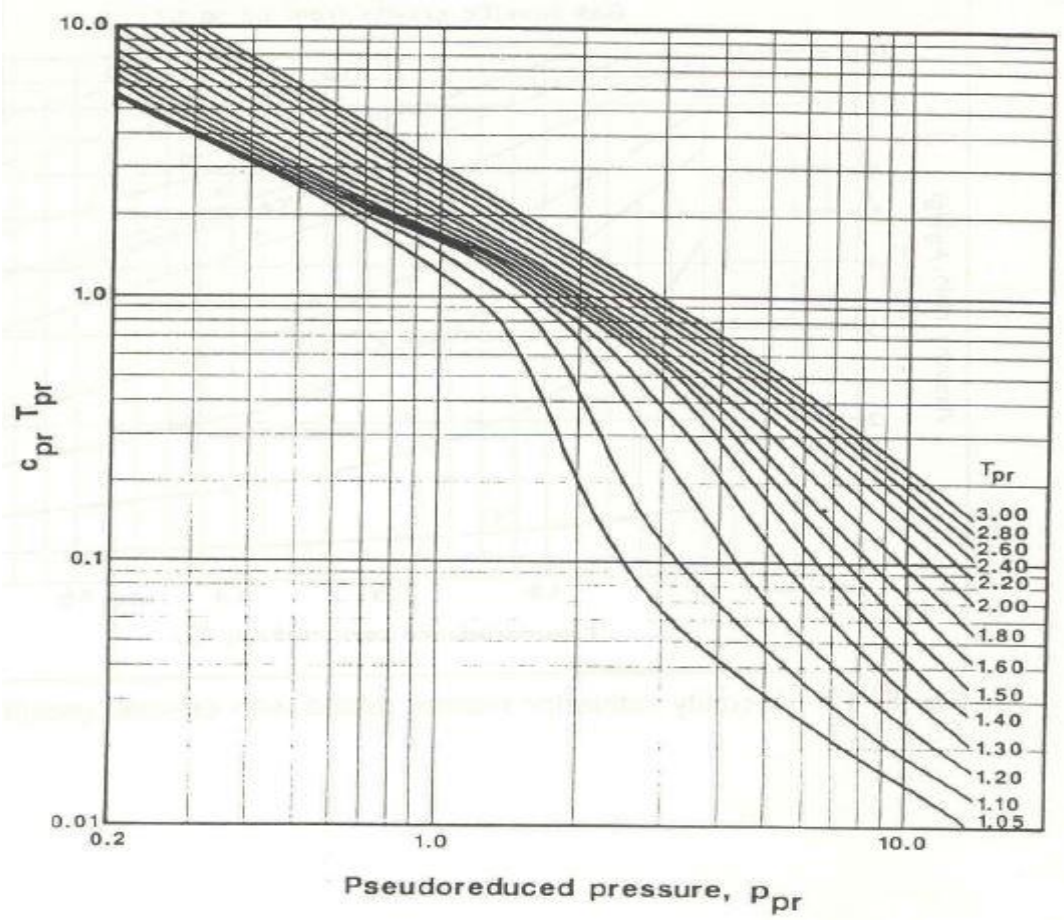
Real Gas: $V = \frac{znRT}{P}$: $\frac{\partial V}{\partial P} = nRT\,\frac{P\left(\frac{\partial z}{\partial P}\right)_T - z}{P^2}$

$$c_g = -\left(\frac{P}{znRT}\right)\left[nRT\,\frac{P\left(\frac{\partial z}{\partial P}\right)_T - z}{P^2}\right]$$

$$c_g = \frac{1}{P} - \frac{1}{z}\left(\frac{\partial z}{\partial P}\right)_T$$

Gas Properties

Coefficient of Isothermal Compressibility of Gas (c_g):



Gas Properties

Coefficient of Isothermal Compressibility of Gas (c_g):

Example:

Calculate the coefficient of isothermal compressibility of a dry gas with specific gravity of 0.818 at reservoir temperature of 220° F and 2100 psig.

Solution:

$T_{pc} = 406° R$

$P_{pc} = 647$ psig

$C_{pr} = c_g p_{pc}$

$$T_{pr} = 1.68 \text{ and } p_{pr} = 3.27$$

using appropriate $c_{pr}T_{pr}$ chart.

$$c_{pr}T_{pr} = 0.528$$

$$c_{pr} = \frac{0.528}{1.68} = 0.314$$

$$c_g = \frac{c_{pr}}{p_{pc}} = \frac{0.314}{647 \text{ psia}} = 486 \times 10^{-6} \text{ psi}^{-1}$$