Natural Gas Z-Factor, Density, Bg and Viscosity from Gas Gravity

Pseudo-critical properties of a natural gas from its gravity (Standing), Z by Hall–Yarborough, density, gas formation volume factor and Lee–Gonzalez–Eakin viscosity.

Method: Ahmed; Reservoir Engineering Handbook; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Gas gravity (air = 1)	0.70000	
Gas type	Natural gas	
Pressure (absolute)	2,000.0	psi
Temperature	65.556	°C

Calculated results

Parameter	Value	Unit
Pseudo-critical temperature	-56.831	°C
Pseudo-critical pressure	669.12	psi
Pseudo-reduced temperature	1.5658	
Pseudo-reduced pressure	2.9890	
Compressibility factor	0.81003	
Gas density	122.54	kg/m³
Gas formation volume factor (reservoir m³ per standard m³)	0.006980	m³/m³
Gas viscosity (Lee–Gonzalez–Eakin)	0.016923	cP

Notes for this case

• Sweet gas: with more than a few per cent CO_2 or H_2S, apply the Wichert–Aziz correction to the pseudo-critical properties first. Standing's correlation suits gravities up to about 0.75 for natural gas; Sutton's mixing rules suit heavier gases. B_g is at 14.7 psia and 60 °F.

Formula and method

$$T_{pc} = 168 + 325\gamma_g - 12.5\gamma_g^2, \quad p_{pc} = 677 + 15\gamma_g - 37.5\gamma_g^2 \ (^\circ\mathrm{R},\ \mathrm{psia})$$

$$B_g = 0.02827\frac{ZT}{p}, \quad \mu_g = 10^{-4}K\exp\left[X\left(\frac{\rho_g}{62.4}\right)^Y\right]$$

Variables

γ_g	Gas gravity (air = 1)	-
type	Gas type	-
p	Pressure (absolute)	Pa
T	Temperature	K
T_{pc}	Pseudo-critical temperature	K
p_{pc}	Pseudo-critical pressure	Pa
T_{pr}	Pseudo-reduced temperature	-
p_{pr}	Pseudo-reduced pressure	-
Z	Compressibility factor	-

ρ_g	Gas density	kg/m³
B_g	Gas formation volume factor (reservoir m³ per standard m³)	m³/m³
μ_g	Gas viscosity (Lee–Gonzalez–Eakin)	Pa·s

Method and standards

Standing's pseudo-critical properties (natural gas: 168 + 325γ − 12.5γ² °R, 677 + 15γ − 37.5γ² psia; condensate: 187 + 330γ − 71.5γ², 706 − 51.7γ − 11.1γ²); Hall–Yarborough Z by root search; Lee–Gonzalez–Eakin viscosity with K = (9.4 + 0.02M)T^1.5/(209 + 19M + T), X = 3.5 + 986/T + 0.01M, Y = 2.4 − 0.2X (T °R, ρ lb/ft³). Ahmed's eq. 2-19 prints 667 for the constant; his worked examples and Standing use 677.

Assumptions and limits

- Hall–Yarborough range 1.05 ≤ T_pr ≤ 3.

References

• Ahmed
• Reservoir Engineering Handbook
• 5th ed. (Gulf Professional Publishing, 2019)
• ch. 2: Standing pseudo-critical properties (eqs. 2-18 to 2-21)
• Hall–Yarborough Z
• B_g (eq. 2-53)
• Lee–Gonzalez–Eakin viscosity (eqs. 2-62 to 2-65)

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/chemical/oil-gas/natural-gas-properties-from-gravity

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Reopens the calculator with the inputs of this report.