Basic nitrogen, ppm: 350
Hydrogen, wt %: 12.3
Heat of combustion (gross), MJ/kg: 44.65
Heat of combustion (net), MJ/kg: 42.03
Pour pt., °C.: 39
Acid No., mg KOH/g: 0.05
Vis., cSt @ 50° C.: 24.5
Vis., cSt @ 100° C.: 6.4
Aniline pt., °C.: 87.8
Aniline gravity product: 4,655
UOP K factor: 11.9
Wax content, wt %: 34

Range, °C. : 360+ (680+ °F.)
Yield range, vol %: 81.4-100
Yield range, wt %: 78.8-100
Yield, vol %: 18.7
Yield, wt %: 21.2
Gravity, °API: 22.1
Specific gravity, 60/60° F.: 0.9215
Density @ 15° C., g/ml: 0.9210
Molecular wt.: 403
Sulfur, wt %: 0.15
Total nitrogen, wt %: 0.15
Hydrogen, wt %: 11.9
Heat of combustion (gross), MJ/kg: 44.40
Heat of combustion (net), MJ/kg: 41.83
Pour pt., °C.: 42
Acid No., mg KOH/g: 0.05
Vis., cSt @ 50° C.: 43.5
Vis., cSt @ 100° C.: 8.0
Aniline pt., °C.: 87.2
Aniline gravity product: 4,177
UOP K factor: 11.8
Wax content, wt %: 31
Wax softening pt., °C.: 48
Asphaltenes, wt %: 0.2
Ramsbottom C, wt %: 2.8
Con. carbon, wt %: 3.7
V/Ni/Fe, ppm: <0.5/2/7

Range, °C. : 540+ (1,004+ °F.)
Yield range, vol %: 97.4-100
Yield range, wt %: 96.8-100
Yield, vol %: 2.6
Yield, wt %: 3.2
Gravity, °API: 8.3
Specific gravity, 60/60° F.: 1.0125
Density @ 15° C., g/ml: 1.0119
Sulfur, wt %: 0.27
Total nitrogen, wt %: 0.39
Hydrogen, wt %: 10.2
Carbon, wt %: 88.0
Heat of combustion (gross), MJ/kg: 42.79
Heat of combustion (net), MJ/kg: 40.52
Pour pt., °C.: 75
Acid No., mg KOH/g: 0.05
Vis., cSt @ 100° C.: 273
UOP K factor: 11.5
Wax content, wt %: 14.5
Asphaltenes, wt %: 1.5
Ramsbottom C, wt %: 18.7
Con. carbon, wt %: 18.7
V/Ni/Fe, ppm: 0.5/12/49

*Calculated
†Performed on 650° F.+ cut
§Performed on 1,000° F.+ cut
¶Fe may be high; Sample was not washed to remove tramp iron.

Program calculates Z-factor for natural gas

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The Fortran program called "Physic" presented in this article (see box) calculates the gas deviation or compressibility factor, Z, of natural gas. The author has used the program for determining discharge-piping pressure drop.[1]

The calculated Z is within 5% accuracy for natural hydrocarbon gas with a specific gravity between 0.5 and 0.8, and at a pressure below 5,000 psia.

Z-factor

Many petroleum engineering and process design calculations require Z. But, experimental data from pressure-volume-temperature (PVT) measurements are seldom available.

Therefore, charts and tables are often used to obtain Z as a function of pseudoreduced temperature, T_r, and pressure, P_r.[2] Computer programs are also available to calculate Z solely as a function of temperature and pressure.[3,4]

Numerical methods and mathematical representations of the charts can also be used to estimate Z. However, these charts are often time consuming and involve complex calculations.

Various methods for estimating Z were reviewed by Takacs.[5]

Equations

$$Z = F_1 \left\{ \frac{1}{\left[1 + \frac{(A_6 P 10^{[1.785 S_g]})}{T^{3.825}} \right]} + F_2 \cdot F_3 \right\} + F_4 + F_5 \quad (1)$$

where:

$$F_1 = P(0.215 S_g - 0.15) - 0.202 S_g + 1.106 \quad (2)$$

$$F_2 = 1.4e^{[-0.0054 (T - 460)]} \quad (3)$$

$$F_3 = A_1P^5 + A_2P^4 + A_3P^3 + A_4P^2 + A_5P \quad (4)$$

$$F_4 = [0.154 - 0.152 S_g] P^{(3.18 S_g - 1)} e^{(-0.5 P)} - 0.02 \quad (5)$$

$$F_5 = 0.35 \left[(0.6 - S_g) e^{[-1.039 (P - 1.8)^2]} \right] \quad (6)$$

The values of the constants A_1, A_2, A_3, A_4, A_5, and A_6 are:

$$A_1 = 0.001946$$
$$A_2 = -0.027635$$
$$A_3 = -0.136315$$
$$A_4 = 0.23849$$
$$A_5 = 0.105168$$
$$A_6 = 3.44 \times 10^8$$

$$S_g = \frac{\text{Density of gas}}{\text{Density of air}} = \frac{\rho_{gas, 60^\circ F.}}{\rho_{air, 60^\circ F.}} \quad (7)$$

$$S_g = \frac{\text{Molecular weight of gas}}{\text{Molecular weight of air}} = \frac{M_{w, gas}}{M_{w, air}} \quad (8)$$