Chapter 30

Appendix: Units and Constants

This a collection of useful constants and a few notes on their derivations as applicable. It is also a basket for other information I think you might need.

30.1 Mass

Mass is a fundamental physical property representing the amount of matter in a substance, independent of gravity. In reservoir engineering, mass is essential for quantifying the amount of fluids—oil, gas, and water—within the reservoir and throughout the production system. It is used in material balance calculations, fluid transport modeling, and compositional simulations where conservation of mass is a governing principle. Mass-based properties such as density, mass flux, and specific gravity also play critical roles in estimating reserves, designing separation equipment, and predicting phase behavior.

From	**To**	**Multiply by**	**Inverse (To → From)**
g	kg	**0.001**	**1000**
kg	g	**1000**	**0.001**
oz (mass)	g	28.3495	0.035274
oz (mass)	kg	0.0283495	35.274
lbm	g	453.59237	0.00220462
lbm	kg	**0.45359237**	**2.20462**
slug	kg	14.5939	0.0685218
slug	lbm	32.174	0.031081
tonne (metric ton)	kg	**1000**	**0.001**
tonne	lbm	2204.62	0.000453592
short ton (US)	lbm	**2000**	**0.0005**
short ton	kg	907.18474	0.00110231
long ton (UK)	lbm	**2240**	**0.000446429**
long ton	kg	1016.0469	0.000984207
Dalton (Da)	kg	$1.66053906660 \times 10^{-27}$	$6.02214076 \times 10^{26}$
eV/c^2	kg	$1.78266192 \times 10^{-36}$	$5.60958885 \times 10^{35}$
Planck mass	kg	2.176434×10^{-8}	4.59458×10^{7}

Table 30.1: Mass unit conversions (bold = exact by definition)

The **slug** is a unit of mass in the U.S. gravitational (engineer's) system: 1 slug = 32.174 lbm under standard gravity. The **tonne** (metric ton) is defined as exactly 1000 kg. It differs from the **short ton (US)** = 2000 lbm and the **long ton (Imperial)** = 2240 lbm.

30.2 Lengths and Distance

Length is a measure of distance and is the basis of most spatial calculations. There are antiquated length measurements that you might encounter, such as the *furlong*. While rarely used in technical petroleum engineering, furlongs occasionally show up in historical documents, land measurements, or legal descriptions (especially in older leases or surveys). One furlong is also equal to 10 chains or 40 rods. 1 furlong = 660 ft = 220 yd = 10 chains = 40 rods = 1/8 mile. Conversion factors for length are in Table 30.2.

Oilfield units frequently use feet (ft), inches (in), and miles (mi), while SI uses meters (m) and centimeters (cm). Conversions include:

From	To	Multiply by	Inverse (To → From)
1 inch	cm	**2.54**	0.393700787
1 foot	inch	**12**	0.083333
1 yard	feet	**3**	0.333333
1 mile	feet	**5280**	0.000189394
1 mile	km	1.60934	0.621371
1 foot	m	0.3048	3.28084
1 inch	m	0.0254	39.3701
1 cm	inch	0.393700787	**2.54**
1 m	ft	3.28084	0.3048
1 km	mile	0.621371	1.60934
1 m	inch	39.3701	0.0254
1 m	micron (μm)	**1e6**	**1e-6**
1 micron (μm)	m	**1e-6**	**1e6**
1 angstrom (Å)	m	**1e-10**	**1e10**
1 m	Å	**1e10**	**1e-10**
1 rod	feet	**16.5**	0.060606
1 m	light-year	1.057×10^{-16}	9.4607×10^{15}
1 light-year	m	9.4607×10^{15}	1.057×10^{-16}
1 km	ft	3280.84	0.0003048
1 ft	km	0.0003048	3280.84

Table 30.2: Length unit conversions (exact values in bold)

Be aware that log measurements, well depths, and reservoir dimensions may be quoted in any of these units depending on region or legacy practice. Log measurements in particular may reference measurements from GL, KB, or DF (ground level, kelly bushing, or drill floor) as well as sea level. Logs are reported as measured depth (MD) or corrected in various ways including true vertical depth (TVD). However, the units are typically feet or meters.

30.3 Area

Area is a measure of the extent of a two-dimensional surface and is expressed in square length units (*e.g.*, m^2, ft^2) or specialized areal units (acres, hectares). In reservoir engineering, area is fundamental to volumetric calculations, including the estimation of oil or gas initially in place (N, G), where it defines the areal extent of the reservoir. It also plays a critical role in flow equations, such as Darcy's law, where the cross-sectional flow area influences the volumetric flow rate. Accurate determination of reservoir area from structure maps, isopachs, and seismic data is essential for reliable reserves estimation and field development planning.

Acres are traditionally defined as the area of one chain by one furlong (66 by 660 feet), which is exactly equal to 10 square chains, 1/640 of a square mile, so 640 acres is one square mile. Occasionally, you will run across "section" as an areal unit. The section, township, and range system is a method of land description commonly used in oil and gas to identify specific locations on a map, particularly in much of the central and western United States. This system is based on the Public Land Survey System (PLSS), which divides land into a grid. A township is a square area measuring 6 miles by 6 miles, or 36 square miles. Each township is further divided into 36 sections, each 1 mile by 1 mile, or 640 acres. These sections are numbered in a specific pattern starting in the northeast corner and snaking back and forth. Range describes how far east or west a township is from a principal meridian (a north-south reference line), while township in this context also refers to how far north or south it is from a baseline (an east-west line). So, for example, “Section 14, Township 3 North, Range 2 West” identifies one square mile of land located 3 tiers north of the baseline and 2 columns west of the principal meridian. Oil professionals use this system routinely for legal descriptions in leases, well permitting, and field development, as it provides an unambiguous way to define land parcels.

An "acre-foot" is the *volume* equivalent to one foot high over an acre. There are 43,560 ft^3 in an acre-ft, *a constant you should probably memorize* because of its use in calculating GIP. For OIP the analog term is 7758.367347 barrels per acre-ft (just *remember 7758*). Some useful units include:

Area Conversion Table

Unit	**Symbol**	**Equivalent in m^2**	**Equivalent in ft^2**
Square meter	m^2	1	10.7639 ft^2
Square foot	ft^2	0.092903 m^2	1
Acre	ac	4,046.86 m^2	43,560 ft^2
Hectare	ha	10,000 m^2	107,639.1 ft^2
Square kilometer	km^2	1,000,000 m^2	10,763,910 ft^2
Square mile	mi^2	2,589,988 m^2	27,878,400 ft^2
Darcy (area)	D	9.86923×10^{-13} m^2	1.062×10^{-8} ft^2

Table 30.3: Area conversion table including SI, field, and permeability-related units

Notes

- 1 hectare = 2.47105 acres
- 1 square mile = 640 acres
- 1 km^2 = 100 hectares
- The **Darcy** is not a true geometric area unit; it represents permeability but is dimensionally equivalent to area.
- 1 Darcy = 9.86923×10^{-9} cm^2 = 9.86923×10^{-13} m^2
- Often used in permeability with fluid viscosity and pressure gradient:

$$q = \frac{kA}{\mu L}\Delta P$$

where k has units of area (e.g., m^2 or D).

30.4 Volumes

Volume units vary widely depending on context. SI uses cubic meters (m^3), but engineers often work with barrels (bbl), gallons (gal), and cubic feet (ft^3). Table 30.4 has common conversions:

From	To	Multiply by	Inverse (To → From)
gallon	in^3	**231**	0.004329
ft^3	in^3	**1728**	0.000578704
gallon	ft^3	0.133680556	7.48052
ft^3	gallons	7.48052	0.133681
ft^3	liters	28.3168	0.0353147
ft^3	m^3	0.0283168	35.3147
in^3	gallons	0.004329	231.000
bbl	gallons	**42**	0.0238095
bbl	ft^3	5.614583	0.178107
bbl	m^3	0.158987	6.28981
acre-ft	bbl	7758.367	0.000128909
acre-ft	m^3	1233.48	0.000810519
acre-ft	ft^3	**43560**	2.2957e-5
m^3	ft^3	35.3147	0.0283168
m^3	gallons	264.172	0.00378541
m^3	bbl	6.28981	0.158987
liter	ft^3	0.0353147	28.3168
liter	gallons	0.264172	3.78541
liter	bbl	0.00628981	158.987

Table 30.4: Volume unit conversions including oilfield and SI units (bold = exact)

These conversions are particularly important for estimating fluid volumes in place or produced, and for comparing laboratory PVT data with field-scale measurements.

30.5 Pressure

Pressure is the force applied normal to the surface of an object per unit area over which that force is distributed. SI uses pascals (Pa), where 1 Pa = 1 N/m^2 but kPa and MPa are more common. In oilfield units, we use psi (pounds per square inch). Other units you may encounter:

From	**To**	**Multiply by**	**Inverse (To → From)**
atm	mm Hg (0°C)	**760**	0.00131579
atm	Pa	**101325**	9.86923e-6
atm	psi	14.6959	0.0680459
atm	bar	1.01325	0.986923
atm	ft H_2O (4°C)	33.9	0.029497
mm Hg (0°C)	atm	0.00131579	**760**
mm Hg (0°C)	Pa	133.322	0.00750062
mm Hg (0°C)	psi	0.0193368	51.7149
bar	Pa	**100000**	1e-5
bar	atm	0.986923	1.01325
bar	psi	14.5038	0.0689476
psi	Pa	6894.76	1.45038e-4
psi	bar	0.0689476	14.5038
dyne/cm^2	Pa	0.1	10
dyne/cm^2	psi	1.45038e-6	689476
kgf/cm^2	N/cm^2	**9.80665**	0.101972
kgf/cm^2	Pa	98066.5	1.01972e-5
kgf/cm^2	kPa	98.0665	0.0101972
kgf/cm^2	MPa	0.0980665	10.1972
kgf/cm^2	psi	14.2233	0.0703069

Table 30.5: Pressure unit conversions (bold = exact by definition)

Standard pressure is a foundational reference in reservoir and gas engineering calculations, but its value can vary depending on context, regulatory jurisdiction, or convention. The most widely recognized value in scientific literature is 1 atmosphere (atm) = 101.325 kPa = 14.6959488 psia, derived from the pressure exerted by a 760 mm column of mercury at sea level. In oil and gas operations, however, 14.7 psia is often used as a convenient rounded approximation for standard pressure, particularly in U.S.-based workflows. The Texas Railroad Commission, in its Rule 3.79, defines standard pressure as 14.65 psia, which is also used in some regulatory and volumetric calculations within Texas. Louisiana uses 15.025 psia as standard pressure. This slight difference can lead to minor but important discrepancies in gas volume calculations, especially when converting surface volumes to reservoir conditions. Internationally, 1 bar = 100 kPa = 14.5038 psia is sometimes used as a standard pressure base, especially in European and metric contexts. Engineers must be vigilant in understanding and consistently applying the correct pressure base for any given dataset or calculation, as inconsistencies can lead to systematic errors in gas-in-place estimates, material balance evaluations, and reservoir simulation results.

Pressure can be psia (absolute) or psig (gauge). The former is, as implied the absolute pressure. The latter is the difference between the absolute pressure and atmospheric pressure. This difference arises from the typed of gauges that measure pressure, some of which measure a delta pressure with the atmosphere. Atmospheric pressure is (by definition) 0 psig. For even modest reservoir engineering pressures the difference becomes small but it is important to specify.

30.6 Forces

In petroleum engineering, force units are fundamental for quantifying pressures, loads, and mechanical interactions in subsurface and surface operations. Whether designing wellbore casing to withstand formation stresses or analyzing fluid flow through porous media, accurate force measurements are critical to ensure safety and performance. In reservoir engineering specifically, force units like pounds-force (lbf) and newtons (N) appear in pressure gradients, capillary forces, and effective stress calculations that govern rock deformation, fluid displacement, and reservoir compaction.

From	**To**	**Multiply by**	**Inverse (To → From)**
lbf	N	**4.4482216**	0.2248089
lbf	kgf	0.45359237	2.20462
lbf	dyn	444822.16	2.24797e-6
kgf	N	**9.80665**	0.1019716
kgf	lbf	2.20462	0.45359237
N	lbf	0.2248089	**4.4482216**
N	kgf	0.1019716	**9.80665**
N	dyn	**1e5**	**1e-5**
dyn	N	**1e-5**	**1e5**
dyn	lbf	2.24797e-6	444822.16

Table 30.6: Force unit conversions (bold = exact by definition)

30.7 Temperature

Temperature is that physical quantity which quantitatively expresses the attribute of hotness or coldness due to kinetic energy of vibrating and colliding atoms and molecules making up a substance. Temperature conversions include:

Standard Reference Points

- $0\,°\mathrm{C} = 273.15$ K (SI definition of absolute zero)
- $0\,°\mathrm{F} = 459.67$ °R (Rankine scale absolute zero)
- 0 K $= -273.15\,°\mathrm{C}$ (absolute zero in Celsius)
- $60\,°\mathrm{F} = 519.67$ °R (typical standard temperature in Rankine)

Temperature Conversion Equations

$$\begin{aligned}
\text{Celsius to Kelvin:} \quad & K =^\circ C + 273.15 \\
\text{Kelvin to Celsius:} \quad & ℃ = K - 273.15
\end{aligned}$$

$$\begin{aligned}
\text{Fahrenheit to Rankine:} \quad & °R =^\circ F + 459.67 \\
\text{Rankine to Fahrenheit:} \quad & °F =^\circ R - 459.67
\end{aligned}$$

$$\begin{aligned}
\text{Fahrenheit to Celsius:} \quad & ℃ = \frac{5}{9}(°F - 32) \\
\text{Celsius to Fahrenheit:} \quad & °F = \frac{9}{5}(℃) + 32
\end{aligned}$$

$$\begin{aligned}
\text{Kelvin to Rankine:} \quad & °R = 1.8 \times K \\
\text{Rankine to Kelvin:} \quad & K = \frac{°R}{1.8}
\end{aligned}$$

Usage Notes

- **Kelvin (K)** is the SI unit for absolute temperature and **does not use a degree symbol**. Write temperatures as `273.15 K`, not `273.15°K`.
- **Rankine (°R)** is used in U.S. customary units as the absolute temperature scale, analogous to Kelvin but offset from `0°F`. It is common in gas law and thermodynamic calculations in the English system.

- **Celsius (°C)** and **Fahrenheit (°F)** are relative temperature scales commonly used for surface and field measurements. Celsius is standard in SI; Fahrenheit remains in wide use in North American operations.

- Petroleum and reservoir engineers often use **Celsius or Fahrenheit** for operational and environmental temperatures, while **Kelvin or Rankine** are required in **equations involving absolute temperature**, such as the ideal gas law and thermal expansion calculations.

Standard temperatures for different scientific applications vary from 0 °C to 21.2 °C. Most oilfield applications are 60 °F in the US or 15°C (59 °F). The standard density of water at 60 °F is 62.4 lb/ft^3. Crude oil and gas densities are typically expressed in API gravity or gas specific gravity and often need conversion for volumetric calculations. SPE uses slightly different standard conditions of temperature for the standard cubic foot and the standard cubic meter.

30.8 Density

Density is the ratio of substances mass to its volume and is usually abbreviated ρ. It is not to be confused with *specific gravity*.

From	**To**	**Multiply by**	**Inverse (To → From)**
lbm/gal	lbm/ft^3	119.8264	0.008344
lbm/gal	kg/m^3	$119.8264 \times 0.0160185 = 1.91816$	0.52179
lbm/gal	g/cm^3	1.91816	0.52179
lbm/ft^3	lbm/gal	0.008344	119.8264
lbm/ft^3	kg/m^3	16.0185	0.062428
lbm/ft^3	g/cm^3	0.0160185	62.428
kg/m^3	lbm/ft^3	0.062428	16.0185
kg/m^3	lbm/gal	0.52179	1.91816
kg/m^3	g/cm^3	**0.001**	**1000**
g/cm^3	kg/m^3	**1000**	**0.001**
g/cm^3	lbm/ft^3	62.428	0.0160185
g/cm^3	lbm/gal	8.3454	0.11988

Table 30.7: Density unit conversions (bold = exact by definition)

30.9 Viscosity

Viscosity measures a fluid's rate-dependent resistance to flow. Viscosity of liquids is comparable to thickness; Honey has greater viscosity than water. It is a a force multiplied by a time divided by an area. Thus its SI units are newton-seconds per metre squared, or pascal-seconds. The oilfield unit is centipoise (cp) and other conversions include:

From	**To**	**Multiply by**	**Inverse (To → From)**
cP	Pa·s	**0.001**	**1000**
cP	P	**0.01**	**100**
P	cP	**100**	**0.01**
P	Pa·s	**0.1**	**10**
Pa·s	cP	**1000**	**0.001**
Pa·s	lbm/ft·s	0.67197	1.48816
Pa·s	lbm·s/ft^2	0.0208854	47.9581
lbm/ft·s	Pa·s	1.48816	0.67197
lbm/ft·s	lbm·s/ft^2	0.031081	32.171
lbm·s/ft^2	Pa·s	47.9581	0.0208854
cSt	cP	ρ (g/cm^3)	$1/\rho$

Table 30.8: Viscosity unit conversions (bold = exact by definition). Note: centistokes (cSt) is a kinematic viscosity and requires fluid density for conversion to dynamic viscosity.

Usage Notes

- **Centipoise (cP)** is the most commonly used unit for dynamic viscosity in oilfield applications. It is defined as $1\ \text{cP} = 1\ \text{mPa}\cdot\text{s} = 10^{-3}\ \text{Pa}\cdot\text{s}$.
- **Poise (P)** is a CGS unit where $1\ \text{P} = 0.1\ \text{Pa}\cdot\text{s}$.
- **Centistokes (cSt)** is a unit of *kinematic* viscosity and depends on fluid density. Use $\text{cP} = \text{cSt} \times \rho\ (\text{g/cm}^3)$ to convert to dynamic viscosity.
- **lbm/ft·s** and **lbm·s/ft^2** are used in some U.S. customary mechanical models and simulations.

Reservoir engineers normally encounter dynamic viscosity, but kinematic viscosity is also used in fluid dynamics and is simply the dynmic viscosity divided by the density, or:

$$\nu = \frac{\mu}{\rho},$$

30.10 Permeability

Permeability is absolutely fundamental to reservoir engineering and varies over many orders of magnitude. Permeability measures the ability for fluids (gas or liquid) to flow through porous media andis commonly symbolized as k.

From	**To**	**Multiply by**	**Inverse (To → From)**
D	mD	1000	0.001
D	cm^2	9.86923×10^{-9}	1.01325×10^{8}
D	m^2	9.86923×10^{-13}	1.01325×10^{12}
mD	D	0.001	1000
mD	m^2	9.86923×10^{-16}	1.01325×10^{15}
mD	cm^2	9.86923×10^{-12}	1.01325×10^{11}
m^2	D	1.01325×10^{12}	9.86923×10^{-13}
m^2	mD	1.01325×10^{15}	9.86923×10^{-16}
cm^2	D	1.01325×10^{8}	9.86923×10^{-9}
cm^2	mD	1.01325×10^{11}	9.86923×10^{-12}

Table 30.9: Permeability unit conversions (no exact definitions; D = darcy)

Usage Notes

- **1 darcy (D)** is a non-SI unit of permeability and is approximately equal to 9.86923×10^{-13} m^2 or 9.86923×10^{-9} cm^2.
- **1 millidarcy (mD)** $= 10^{-3}$ D $= 9.86923 \times 10^{-16}$ m^2, commonly used in reservoir engineering due to typical rock permeabilities.
- **Microdarcy (μD)** and **nanodarcy (nD)** are increasingly used for describing extremely low-permeability formations such as tight gas and shale reservoirs:
  - $1\,\mu\text{D} = 10^{-6}$ D $= 9.86923 \times 10^{-19}$ m^2
  - $1\,\text{nD} = 10^{-9}$ D $= 9.86923 \times 10^{-22}$ m^2

30.11 Time

Time is a fundamental quantity representing the progression of events from the past through the present to the future. In reservoir engineering, time is integral to modeling and interpreting dynamic reservoir behavior. It governs pressure transient analysis, production forecasting, material balance calculations, and reservoir simulation. Time units may range from seconds (for well testing) to years or decades (for field development planning and reserves estimation).

Time Conversion Table

Unit	**Symbol**	**Equivalent in Seconds (s)**
Second	s	1
Minute	min	60 s
Hour	hr	3,600 s
Day	d	86,400 s
Year (365 days)	yr	31,536,000 s
Year (365.25 days)	yr	31,557,600 s

Table 30.10: Time conversion table for commonly used units in reservoir engineering

Notes

- For well testing and pressure transient analysis, time is often measured in seconds or hours.
- For reservoir simulation and forecasting, time is typically expressed in days, months, or years.
- When converting **days to years**, two common assumptions are used:
  - 365.25 days/year (accounts for leap years)
  - 365 days/year (simplified)
- When converting **days to months**, common approximations include:
  - $365.25/12 = 30.4375$ days/month
  - $365/12 = 30.4167$ days/month

- Always check consistency between time units and production rates (e.g., bbl/day vs. scf/month).

While widely believed, the conversion "Time is money" has no specific conversion factor.

30.12 Volumetric Flow Rate Conversion Table (to m^3/s)

Given the volume and time conversions, all of the standard volumetric flow rates whould be straightforward. Table 30.11 converts multiple flow rates to the SI standard of m^3/s.

Unit	**Equivalent in m^3/s**
1 barrel/day (bbl/day)	1.84013×10^{-6} m^3/s
1 m^3/hour (m^3/hr)	2.77778×10^{-4} m^3/s
1 m^3/day (m^3/day)	1.15741×10^{-5} m^3/s
1 cm^3/s (cc/s)	1.0×10^{-6} m^3/s
1 ft^3/minute (ft^3/min)	4.71947×10^{-4} m^3/s
1 gallon/minute (gpm, US)	6.30902×10^{-5} m^3/s
1 ft^3/second (ft^3/s)	0.0283168 m^3/s

Table 30.11: Volumetric flow rate conversions to m^3/s

30.13 Darcy's Law Unit Constants

The following constants are useful in Darcy's law applications and are used in definitions for dimensionless pressure, dimensionless time, dimensionless rate, etc. The Darcy unit conversion constants are central to flow calculations. These constants are based on the original definition of a darcy and adjusted for the units of flow rate, viscosity, pressure, and length.

- Base Darcy unit: $\frac{\text{cm}^3}{\text{s}} \cdot \frac{\text{cp}}{\text{cm}^2 \cdot (\text{atm/cm})} = 1$
- Wattenbarger : 6.3283×10^{-3}, `((rcf/day)·cp)/(ft`^{2}`·(psi/ft)·md)`
- Towler/Lee Eq. 6.16: 2.6368×10^{-4}, `((rcf/hr)·cp)/(ft`^{2}`·(psi/ft)·md)`

- Dake Eq. 9.7: 2.3114, `((rcf/yr)·cp)/(ft`^{2}`·(psi/ft)·md)`
- Towler Eq. 2.3: 1.12712×10^{-3}, `((RB/day)·cp)/(ft`^{2}`·(psi/ft)·md)`
- Towler Eq. 6.15: 7.08188×10^{-3}, 2π times previous
- Inverse: 141.205, same units

The number 141.2 is sufficiently useful as to be memorized. It is derived in Section XXXX' The following constants are used in definitions of dimensionless pressure, rate, and time.

30.14 Gas Engineering Constants

- Dake Eq. 1.25: $T_{sc}/p_{sc} = 35.37$ (degR/psia)
- Conversion for q_{res} from Q: 9.265 $\frac{\text{cm}^3/\text{s}\cdot\text{psia}}{\text{Mscf/day}\cdot\text{degR}}$
- Dake Eq. 8.5: 1422 $\frac{\text{psia}^2\cdot\text{md}\cdot\text{ft}}{\text{Mscf/day}\cdot\text{cp}\cdot\text{degR}}$

30.15 Mathematical and Physical Constants

- $\pi = 3.14159265358979\ldots$ (ratio of circumference to diameter of a circle)
- Euler-Mascheroni constant $\gamma = 0.57721566490153$
- $\exp(\gamma) = 1.78107241799020$
- $\exp(4/\exp(\gamma)) = 0.40453934810918$
- Earth's gravitational acceleration, g:
  - $g = 9.80665$ m/s^2 (SI)
  - $g = 32.174$ ft/s^2 (field units)
- Triple point of water:
  - $T = 273.16$ K
  - $T = 0.01$°C

  - $T = 491.69$ R
  - $T = 32.018$°F

- Universal gas constant, R:
  - $R = 8.3144621$ J/mol · K
  - $R = 8.3144621 \times 10^7$ erg/gmol · K
  - $R = 10.7316$ psi · ft^3/lb · mol · °R

- Maximum density of water (at 4°C):
  - 1000 kg/m^3
  - 1.000 g/cm^3
  - 62.43 lbm/ft^3

- Density of air at 1 atm and 60°F:
  - 1.225 kg/m^3
  - 0.0765 lbm/ft^3

These constants frequently appear in well test analysis (e.g., type curves, pressure-transient modeling).