Technical Data Book: Chapter 6—Density

API TECHNICAL REPORT TDB-6
FIRST EDITION, JANUARY 2026



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SCOPE

Technical Report TDB-6 provides procedures for calculating vapor and liquid densities for pure components, petroleum fractions and mixtures that are common in refinery applications. Methods to estimate the volume shrinkage when blending of light hydrocarbons into crude oil are also presented. Both computer algorithms and figures are presented for estimation of these properties. An estimate of the accuracy and range of application for each method is presented.

Any references to other chapters within this document refer to the corresponding Technical Data Book Chapter which is published as API Technical Report TDB-x, where x is the chapter number.

6-0 Introduction

This chapter presents methods for the calculation of the density of liquid and gas systems. Density (or "absolute density" or "true density") is defined as the *mass* of a substance contained in a unit volume at a specified temperature and pressure, and is given the symbol ρ. The methods of calculation, which will be described separately for liquid and gas systems, are primarily for use in heat and material balance calculations and equipment design. In general, these methods are not meant to be used in custody transfer calculations.

Liquid Systems

The density of liquids is frequently expressed in grams per milliliter (g/mL), which is identical to grams per cubic centimeter (g/cm^3), or in pounds per cubic foot (lb/ft^3). The exact numerical relationship between the two units is (3a):

$$1\ g/mL\ (or\ g/cm^3) = 62.42796\ lb/ft^3$$

The conversion factors in (3a) or in Chapter 1 (with fewer significant figures) can be used to express density in a variety of units.

Specific gravity is the density of a liquid relative to that of water at stipulated conditions of temperature and pressure, commonly at 60 °F and 1 atm:

Specific gravity, (*t* °F) / (60 °F) =

$$SG = \frac{Density\ of\ substance\ at\ t\ °\mathrm{F}}{Density\ of\ water\ at\ 60\ °\mathrm{F}} \qquad (6\text{-}0.1)$$

The density of water at 60 °F and 1 atm (14.696 psia) is given in (1a) as 0.999016 g/mL.

Petroleum fractions are generally characterized by two parameters, an average boiling point and an average density or gravity, which is expressed as either the specific gravity at 60 °F/60