⟨841⟩ SPECIFIC GRAVITY

Change to read:

▲Specific gravity is the term for the relative density of a substance when water is used as the reference. The measurement of specific gravity necessarily involves the measurement of the density of the sample at a specified temperature as well as the measurement of the density of water.

The density ρ (g/mL or g/cm^3) means the mass per unit volume, and the relative density means the ratio of the mass of a sample specimen to that of an equal volume of a standard substance. The relative density and specific gravity are unitless values.

The specific gravity ($d_t^{t'}$) means the ratio of the mass of the sample specimen at t' to that of an equal volume of water (H_2O) at t.▲ (USP 1-Aug-2020)Unless otherwise stated in the individual monograph, the specific gravity determination is applicable only to liquids and ▲▲ (USP 1-Aug-2020) is based on the ratio of the weight of a liquid in air at 25° to that of an equal volume of water at the same temperature ▲(i.e., d_{25}^{25}).▲ (USP 1-Aug-2020) Where a temperature is specified in the individual monograph, the specific gravity is the ratio of the weight of the liquid in air at the specified temperature to that of an equal volume of water at the same temperature. ▲If▲ (USP 1-Aug-2020) the substance is a solid at 25°, determine the specific gravity ▲above the melting point▲ (USP 1-Aug-2020) (at the temperature directed in the individual monograph, ▲if specified).▲ (USP 1-Aug-2020)

Unless otherwise stated in the individual monograph, the density is defined as the mass of a unit volume of the substance at 25°, expressed in kilograms per cubic meter or grams per cubic centimeter (1 kg/m^3 = 10^{-3} g/cm^3). Where the density is known, mass can be converted to volume, or volume converted to mass, by ▲using▲ (USP 1-Aug-2020) the formula, volume = mass/ density.

▲▲ (USP 1-Aug-2020)

Change to read:

METHOD I

Procedure

Select a ▲▲ (USP 1-Aug-2020)clean, dry pycnometer that has been previously calibrated by determining its weight and the weight of ▲the deaerated▲ (USP 1-Aug-2020) water contained in it at 25°. Adjust the temperature of the ▲sample▲ (USP 1-Aug-2020) liquid to about 20°, and fill the pycnometer with it. Adjust the temperature of the filled pycnometer to 25°, remove any excess liquid, and weigh. When the monograph specifies a temperature different from 25°, the filled pycnometers must be brought to the temperature of the balance before ▲weighing. The specific gravity ($d_t^{t'}$) can be calculated by use of the following equation:

$$d_t^{t'} = \frac{W_1 - W}{W_2 - W}$$

W_1 = mass of the pycnometer filled with the sample solution at t'
W = mass of the clean, dry pycnometer
W_2 = mass of the pycnometer filled with water at t

The density of water can be used to calculate the density of the sample of the specimen according to the following equation:

$$\rho_{s,t'} = d_t^{t'} \rho_{w,t}$$

$\rho_{s,t'}$ = density of the sample at t'
$\rho_{w,t}$ = density of water at t▲ (USP 1-Aug-2020)

Change to read:

METHOD II

The procedure ▲requires▲ (USP 1-Aug-2020) the use of the oscillating transducer density meter. The apparatus consists of the following:

- A U-shaped tube, usually of borosilicate glass, which contains the liquid to be examined
- A magneto-electrical or piezo-electrical excitation system that causes the tube to oscillate as a cantilever oscillator at a characteristic frequency depending on the density of the liquid to be examined
- A means of measuring the oscillation period (T), which may be converted by the apparatus to give a direct reading of density or used to calculate density by using the constants A and B described below
- A means to measure and/or control the temperature of the oscillating transducer containing the liquid to be tested

The oscillation period is a function of the spring constant (c) and the mass of the system:

$$T^2 = \{(M/c) + [(\rho \times V)/c]\} \times 4\pi^2$$

where ρ is the density of the liquid to be tested, *M* is the mass of the tube, and *V* is the volume of the filled tube.

Introduction of two constants $A = c/(4\pi^2 \times V)$ and $B = (M/V)$ leads to the classical equation for the oscillating transducer:

$$\rho = A \times T^2 - B$$

The specific gravity of the liquid is given by the formula:

$$\rho_{(L)}/\rho_{(W)}$$

where $\rho_{(L)}$ and $\rho_{(W)}$ are the densities of the liquid and water, respectively, both determined at 25°, unless otherwise directed in the individual monograph.

▲Samples with high viscosity will dampen the oscillations in the instrument and will introduce an error in the density measurement. Some oscillating transducer density meters are able to provide a correction to the density based on the viscosity of the sample. Samples with viscosities <10 mPa · s can be accurately measured without a density correction. Samples with viscosities >10 mPa · s must be measured with a density correction. If a density correction is not possible for a sample with >10 mPa · s viscosity, use *Method I.*▲ (USP 1-Aug-2020)

Calibration

The constants *A* and *B* are determined by operating the instrument with the U-shaped tube filled with two different samples of known density (e.g., degassed water and air). Perform the control measurements daily, using degassed water. The results displayed for the control measurement using degassed water ▲should▲ (USP 1-Aug-2020) not deviate from the reference value (ρ_{25} = 0.997043 g/cm^3) by more than its specified error. Precision is a function of the repeatability and stability of the oscillator frequency. Density meters are able to achieve measurements with an error on the order of 1×10^{-3} g/cm^3 to 1×10^{-5} g/cm^3 and a repeatability of 1×10^{-4} g/cm^3 to 1×10^{-6} g/cm^3. For example, an instrument specified to $\pm 1 \times 10^{-4}$ g/cm^3 must display 0.9970 ± 0.0001 g/cm^3 in order to be suitable for further measurement, otherwise a readjustment is necessary. Calibration with certified reference materials should be carried out regularly.

Procedure

▲Verify the viscosity of the sample to be analyzed. If the viscosity is >10 mPa · s and the oscillating transducer density meter is unable to provide a density correction based on the viscosity, use *Method I.*▲ (USP 1-Aug-2020)

Using the manufacturer's instructions, perform the measurements using the same procedure as for *Calibration*. If necessary, equilibrate the liquid▲▲ (USP 1-Aug-2020) at 25° before introduction into the tube to avoid the formation of bubbles and to reduce the time required for measurement. Factors affecting accuracy include the following:

- Temperature uniformity throughout the tube
- Nonlinearity over a range of density
- Parasitic resonant effects
- Viscosity, if the oscillating transducer density meters used do not provide automatic compensation of sample viscosity influence

▲The oscillating transducer density meter provides the reportable value of the sample density at the selected temperature. The specific gravity of the sample is calculated from this measured density according to the following equation:

$$d_t^{t'} = \frac{\rho_{s,t'}}{\rho_{w,t}}$$

$\rho_{s,t'}$ = density of the sample at t'
$\rho_{w,t}$ = density of water at t

[NOTE—The density of water used in the calculation of the specific gravity should be the accepted value of the density of water at *t* (e.g., at 25° use 0.9970 g/cm^3) rather than the value reported by the instrument.▲ (USP 1-Aug-2020)]