

Environmental Protection Agency

Method for Determination of Density and Specific Gravity of Liquids by Digital Density Meter

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1. Scope

- 1.1 The test method is used to determine the density or specific gravity of gasoline, diesel fuel, and chemicals at temperatures between 15 °C and 35 °C with vapor pressure below 600 mm.

2. Summary of Method

- 2.1 A volume (about 0.7 mL) of liquid is introduced into an oscillating tube and the change in frequency caused by the change in mass of the tube in respect to calibration data determine the density of the sample.

3. Significance

- 3.1 Density is a fundamental physical property that can be used in conjunction with other properties to characterize the light and heavy fractions of petroleum and its products.

4. Applicable Documents

- 4.1 ASTM D4052: Test Method for Density and Relative Density of Liquids by Digital Density Meter.
- 4.2 ASTM D5002: Test Method for Density and Relative Density of Crude Oil by Digital Density Meter.

5. Definitions

- 5.1 Density – the mass of a material per unit volume at a stated temperature.
- 5.2 Specific Gravity – the ratio of the density of a material at a stated temperature to the density of water at the same temperature. (see Step 13.1)
- 5.3 cSt = centiStokes – units of kinematic viscosity equal to 1×10^{-6} meter² / second.
- 5.4 Constant A – device constant for instrument with water in the tube (see Step13.1.2).
- 5.5 Constant B - device constant for instrument with dry air in the tube (see Step13.1.2).
- 5.6 "T-value" – period of oscillation of the tube and contents.
- 5.7 "Dev.B" – deviation of the constant B from the last calibration.

6. Interferences and/or Limitations

- 6.1 Vapor pressure must be below 600 mm Hg and viscosity must be less than 15,000 cSt at temperature of test.
- 6.2 Sample can not be so dark in color and clarity as to obscure air bubbles.

7. Safety

- 7.1 Use standard precautions when working with flammable liquids.
- 7.2 Work in ventilated area (under hood) and wear safety glasses.

8. Apparatus

- 8.1 Digital Density Analyzer, Anton Paar DMA 58.
- 8.2 Syringes 5 mL in volume with a luerlock adapter.

9. Reagents and Materials

- 9.1 Dry Air for calibration.
- 9.2 Cooled, freshly boiled deionized water for calibration.
- 9.3 Pentane, 99% pure, [109-66-0] for flush between diesel and gasoline samples.
- 9.4 Toluene [108-88-3] for Check Standard.
- 9.5 Acetone [67-64-1] to flush and dry tube after water calibration.
- 9.6 California Phase II gasoline for Control Fluid.
- 9.7 Micro-90 Cleaning Solution to clean tube.

10. Sampling

Flush the 5 mL syringe with the sample at least twice before taking the actual sample to be injected into the tube. Pass at least 3 ml of sample through the tube and continue injecting sample until no more bubbles are observed in the tube.

11. Calibration

- 11.1 Initial calibration of the digital density meter is performed at a temperature of 15 °F; 15.56 °F and 20 °F before use. After that, conduct a monthly calibration of each of these three temperatures. If any other temperature is requested, a calibration must also be performed at that temperature.
- 11.2 Calibration necessitates calculation of the values of A and B by the instrument for internal calculations from the period of oscillation (T) when the sample cell contains dry air and then cooled freshly boiled water. The instrument uses these constants to calculate density.
- 11.3 With dry air in the tube, press "F" and 100, then the "Enter" key. Allow the air in the tube to come to thermal equilibrium with the test temperature and record the T-value for air.
- 11.4 Press "F" and 101, then the "Enter" key. Inject a volume of cooled freshly boiled water into the sample tube using a 5 mL syringe. The sample in the tube must be free of the smallest gas bubbles. Allow the display to reach a steady reading and record the T-value for water.
- 11.5 In the record book, record the Dev.B, which the Densitometer automatically calculates.. The Dev.B value must be within ± 0.001 g per cm^3 of the previous calibration. If it is not within this tolerance, check the instrument and re-run the calibration.

12. Analytical Procedure

- 12.1 Flush the 5 mL syringe with the sample at least twice before taking the actual sample to be injected into the tube. Turn on the light and pass at least 3 ml through the tube and continue until no bubbles are observed in the tube.
- 12.2 Turn the light off immediately after sample introduction, because heat generated by the light can affect the measurement.
- 12.3 The results automatically print out after the optical period stabilizes.

Note: Time varies with sample

13. Calculations and Reporting

- 13.1 Calculating Densitometer: The recorded value is the final result.
- 13.2 Constants A and B comprise the spring constant of the oscillator, the mass of the empty tube and the volume of the sample involved in the oscillation. Constants A and B are therefore device constants for each individual oscillator and are calculated by the instrument for its internal use.
- 13.3 Specific Gravity is the ratio of the density of the material at a stated temperature to the density of water at that temperature and is unit-less.

Note: This is automatically calculated by the Densitometer.

- 13.4 API gravity is density at 60 °F and is equal to $(141 / \text{specific gravity}) - 131.5$ and is expressed in degrees as API °.

Note: This is automatically calculated by the Densitometer

- 13.5 The calculated results are printed by the Densitometer. These results are entered into the "Fuel Tests Data Base, New Gravity Table." The "Gravity by Date" form is printed, signed and placed in the secured file cabinet, with the traveler document.

14. Performance Criteria

- 14.1 The set temperature and the actual temperature must be within ± 0.01 °C.
- 14.2 The actual temperature can be adjusted to set temperature by pressing "F" then 390 and the "Enter" key.
- 14.3 An error of 0.1 °C can result in a change of one ten thousandth in the density value.
- 14.4 Toluene must be run before the first analysis of the day and the Density must be 0.8708 ± 0.0001 g/mL @ 15.56 °C. The results are recorded into the instrument log.
- 14.5 Control fluid must be run at 15.56 °C once a week. If the density differs more than ± 0.001 g/mL from the previous values, the tube must be cleaned with warm micro-90 solution and the density of air re-measured. If the density of air is not the same as it was on the last calibration, a new calibration must be run. The results are recorded into the instrument log.

TABLE 1
Density of Water

Temperature °C	Density g/mL	Temperature °C	Density g/mL	Temperature °C	Density g/mL
0.00.....	0.99987	21.00	0.99802	40.00.....	0.99224
4.00.....	1.00000	23.00	0.99756	50.00.....	0.98807
5.00.....	0.99999	24.00	0.99732	55.00.....	0.98573
10.00.....	0.99973	25.00	0.99707	60.00.....	0.98324
*15.00.....	0.99913	26.00	0.99681	65.00.....	0.98059
*15.56.....	0.99904	27.00	0.99654	70.00.....	0.97781
16.00.....	0.99897	28.00	0.99626	75.00.....	0.97489
17.00.....	0.99880	29.00	0.99597	80.00.....	0.97183
18.00.....	0.99862	30.00	0.99567	85.00.....	0.96865
19.00.....	0.99843	35.00	0.99406	90.00.....	0.96534
*20.00.....	0.99823	37.78	0.99307	100.00.....	0.95838

* used to calibrate Densitometer.

TABLE 2
Density of Toluene

15.00 °C	0.8713 g/mL
15.56 °C	0.8708 g/mL
20.00 °C	0.8667 g/mL