Hydrometers Explained . . .

The hydrometer is an instrument which is constructed on the Archimedes principle that a solid body displaces its own weight of the liquid in which it floats. Hydrometers can be divided into two general classes; namely for liquids heavier than water and for liquids lighter than water. The base hydrometer scale is Specific Gravity, in which distilled water equals 1.000 as the initial point. Liquids lighter than water are scaled below 1.000 specific gravity and liquids heavier than water are scaled above 1.000 specific gravity.

Many other scales are commonly used, such as API, Brix, Baume, Plato, etc. All of which are convertible into specific gravity by formula.

Hydrometers are usually calibrated at 60°F/60°F. To determine the density of a liquid, the liquid should be at 60°F. If the temperature varies, the liquid will either contract or expand, depending upon the temperature. Therefore, the density fluctuates with the temperature. Where there is a variation from the standard 60°F, corrections must be applied to the hydrometer reading. To assure proper corrections, a separate accurate thermometer should be used, or a hydrometer in combination with a thermometer, which is sometimes referred to as a "thermohydrometer."

The correct method of reading a hydrometer follows:

A. Observe a point below the plane of the liquid surface. The surface should appear as an ellipse (Fig. 1).

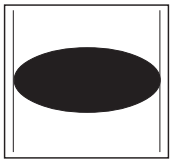
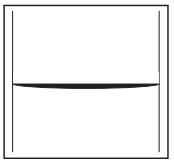
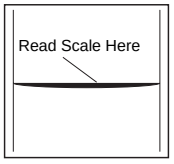


Fig. 1

B. The line of vision is raised until the surface, seen first as an ellipse, becomes a straight line (Fig. 2).



C. The point at which this line cuts the hydrometer scale is the reading of the instrument (Fig. 3).



If the liquid is not sufficiently clear for readings to be made in this manner, read from above the surface and estimate as accurately as possible the point to which the liquid rises on the hydrometer stem. Since hydrometers are calibrated to give correct indications when read at the principal surface of the liquid, correct the reading just taken at the upper edge of the meniscus by an amount equal to this height above the principal surface of the liquid. The amount of correction can be determined with the sufficient accuracy for most purposes by taking a few readings on the upper and lower meniscus in a clear liquid of the same character as that being tested and noting the differences.

Thermo-Hydrometer shown

GENERAL INFORMATION ON HYDROMETERS

ACCURACY OF HYDROMETER READINGS DEPEND ON:

1. CLEANLINESS OF THE HYDROMETER, HYDROMETER JAR AND THE LIQUID IN WHICH THE READINGS ARE TAKEN

For uniform and reproducible readings, the surface of the hydrometer and especially of the stem must be clean so that the liquid will rise uniformly and merge into an almost imperceptible film on the stem. The readiness with which this condition is fulfilled depends somewhat on the character of the liquid. Such liquids as mineral oils and strong alcoholic mixtures readily adhere to the stem. Weak aqueous solutions of sugar, salts, acids, and alcohol require scrupulous cleaning of the hydrometer stem. Before a test is made the hydrometer should be thoroughly washed, rinsed and dried by wiping with a clean, lint free cloth. The hydrometer jar should be thoroughly washed and rinsed before the clean test liquid is added.

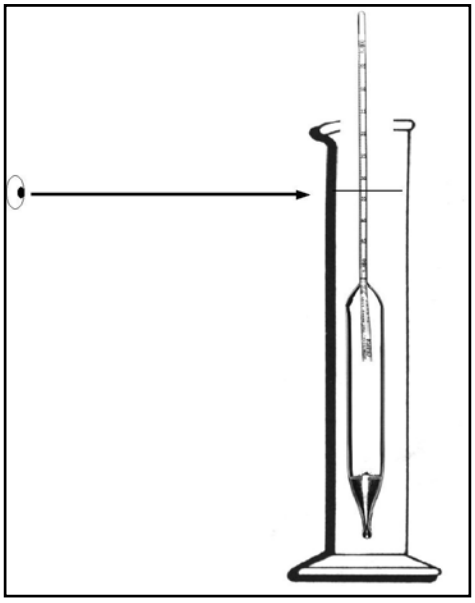
2. TEMPERATURE

The hydrometer and liquid should be at the temperature of the surrounding atmosphere to prevent changes in density during the testing. To ensure uniformity of density and temperature, the liquid should be completely stirred shortly before the observation is made. Stirring is accomplished with a perforated disk or spiral on the end of a rod long enough to reach the bottom of the container. Stirring from top to bottom disperses liquid layers of different densities and aids in attaining temperature uniformity. Readings should not be made until both liquid and hydrometer are free of air bubbles and are at rest. Temperature of the liquid should be determined by a precision thermometer and recorded along with the hydrometer reading. Thermometer ASTM 12F (-5/215F in 0.5 degree divisions) or ASTM 12C (-20/102C in 0.2 degree divisions) are thermometers designed specifically for this application and are recommended by most ASTM test methods.

3. PROPER IMMERSION

Use a hydrometer jar with an inside diameter of approximately 1" (25mm) ***greater*** than the outside diameter of the hydrometer. This will minimize any undue effect surface tension will have on the readings of the hydrometer. In general, a hydrometer jar of 50mm (inside diameter) by 375mm (inside height) is suitable for the majority of hydrometers.

Immerse the hydrometer slowly to a point slightly beyond that at which it floats naturally (not more than 2 scale divisions), then allow it to float freely. Take care that the hydrometer is not in contact with the sides of the hydrometer jar when reading.



4. READING THE MENISCUS PROPERLY

For most clear liquids, the scale reading is determined by the intersection of the horizontal plane, tangent to the bottom of the meniscus, on the stem scale. For opaque liquids, often the “top meniscus” is read. It is recommended that you check the requirements of the method you are following.

For drawings, discussion and general instruction on making accurate hydrometer readings, please refer to ASTM E-126 and ASTM D-1298.

Related documents which are informative on the use of hydrometers:

ASTM E-100 *Standard Specification for ASTM Hydrometers*

ASTM E-126 *Standard Test Method for Inspection and Verification of Hydrometers*

ASTM D-1298 *Standard Method for Density, Relative Density (Specific Gravity) or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method*

ASTM D-891 *Standard Test Methods for Specific Gravity, Apparent, of Liquid Industrial Chemicals*

BS-718 Available through ANSI (American National Standards Institute)