IBT ***Bulletin***

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Specific Gravity Measurement

Specific gravity is a measurement of liquid density which is often used as a measurement of a solution concentration. When a solid chemical is dissolved in water, it makes the solution heavier than water and increases the density of the solution. The relative density of the solution against the density of water is defined as the specific gravity of the solution. In other word, specific gravity of a solution is the ratio of the density of the solution to the density of the water. Since the density of the water is 1.0 (g/cc) at 20° C., the density and the specific gravity of a solution are the same at that temperature. The terms specific gravity and density of a solution often are used interchangeably.

How to measure solution density:
The density of a solution is defined as the number of grams per cc of solution. In the laboratory, the grams weigh of the solution is measured with an analytical balance in a flask of precise volume at 20°C. This apparently is not practical in the field. Instead, the density or specific gravity of a solution is often measured indirectly by measuring different physical properties of the solution and calibrated against standard solutions. Since the properties used for the measurement are different, the results are therefore highly dependent on the method used and the standard solution used for calibration. The results from one method may not be the same as the results from the other method on the same solution.

Following are the most commonly used methods for the measurement of liquid specific gravity.

Hydrometric measurement with a glass hydrometer:
Hydrometer is a device consists of a bulb with an elongated stem. It is usually constructed with glass or plastic. When the device is dropped into the solution, the device will sink halfway into the solution with the stem extended above the solution. How far the stem extends above the solution depends on the density of the solution. The denser the solution the higher the bulb will float toward the surface of the solution and the higher the stem will extended into the air. The specific gravity of the solution can be read from the scale on the stem at the meniscus (surface) of the solution. When using a hydrometer, it is important that the device be floating freely and does not stick to the side of the solution container. When reading the result, the eye level should be at the solution level. The temperature of the solution should be at 20°C for accuracy. Since the method is based on the buoyant density of the solution, which is manifested by the movement of all molecular particles in the solution, the method measures the total dissolved solid.

Conductivity:
Conductivity of a solution is measurement of its ability to conduct electrical current flowing across two electrical plates of opposite charge. When a chemical is dissolved, some will possess an ionic charge.

The charged particles will facilitate the flow of electrons from one plate (anode) to the other (cathode). The higher the concentration of the ionic charge, the faster the flow of the current. The electrical current is measured in amperes which is some times converted to specific gravity values based on a specific calibration solution. Since conductivity measures only the ionic particles such as sodium or chloride, and is insensitive to non-ionic chemicals such as glucose, conductivity measures only the charged particles in the solution.

Conductivity measurement by itself is often used as a relative indicator of solution concentration. It is usually quite accurate for solutions at low concentration levels. For concentrated solutions, however, it is much less sensitive to variation in solution concentration. The accuracy also decline at high concentration since the conductivity measurement is not linear with the increase in solution concentration.

Light refractometric measurement:

When light passes through a dense media, it bend (refract). The degree of refraction correlates to the density of the solution. The density of a solution, therefore, can be measured with a refractometer.

Refractometer is a light scope constructed with multi-element glass lenses. It requires only two drops of the sample and takes less than a minute to read the results. The test is performed by placing two drops of the liquid sample on the prism and covering with a clear plastic cover. Pointing the scope against a light source and looking through the scope, a clearly visible boundary line appears on the scope, separating a clear and blue field caused by light refraction. The specific gravity value can be read at the boundary line from the scale printed on the screen. Since the refractometer is a precision optical instrument, very accurate and consistent result can be obtained. When equipped with a temperature compensation mechanism, the solution temperature can very from 50 - 86°F without affecting the test result. Refractometric measurement is the best for routine measurement of the concentration of sodium bicarbonate solution.

Osmometric measurement:

Osmometic pressure is the pressure of the gas phase or vapor of a solution. When a chemical is dissolved in the water, it changes the osmotic pressure of the water. That causes the solution to boil at a higher temperature (boiling point) or to freeze at a lower temperature (freezing point) than water. By measuring the freezing point or the boiling point of a solution the concentration of a solution can be estimated. The test is commonly performed in clinical laboratories for the measurement of plasma, urine or sweat concentration. Because it requires a sophisticated instrument, it is rarely used in the field for routine measurement of solution concentration.

How to estimate the specific gravity of a solution?

On average, most chemical when dissolved in water will increase the solution volume equal to about one half of the weight of the solid. For example, when 10 grams of salt is dissolved in 100 cc of water, the resulting solution will have a volume of 105 cc. The solution then will have a specific gravity or a density of 110/105 or 1.048. This is just an estimate. The true specific gravity may vary as much as 50 to 100 % higher or lower than the estimated value. In many application, however, such as daily monitoring of the consistency of sodium bicarbonate solution preparation, the apparent specific gravity measured with a given method would be sufficient without having to convert to a true specific gravity value as long as the apparent specific gravity is first calibrated with a known concentration of the specific solution.

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