Conductivity (Specific Conductance)

Conductivity is a measure of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions; on their total concentration, mobility and valence; and on the temperature of measurement. Conductivity, also referred to as specific conductance, is the reciprocal of resistivity (specific resistance). For aqueous solutions, conductivity is usually measured in units of microsiemens (µS) per centimeter. An older unit for conductance is the mho, which is precisely equal to the Siemens; therefore, 1 µmho/cm = 1 µS/cm. Similarly, 1000 µmho = 1000 µS = 1 mmho = 1 mS = 0.001 S.

Conductivity standards may be manufactured from various salts or other ionic solutes. The choice of solute does not affect the use of the standard unless automatic temperature compensation is used. RICCA CHEMICAL COMPANY offers conductivity standards manufactured from Sodium Chloride (2200 series) or Potassium Chloride (5800 series).

Temperature Effects

Conductivity is very temperature dependent, increasing as the temperature increases. 25.0°C is the typical reference temperature for conductivity measurements in the United States, as the National Institute of Standards and Technology (NIST) reference standards for conductivity are certified at 25.0°C. For highest accuracy, we recommend that the temperature of standards and samples be adjusted to 25°C for measurements. When this is not possible, mathematical temperature corrections must be applied, resulting in reduced accuracy. However, these correction factors are themselves dependent on concentration and temperature. A temperature coefficient of approximately 2.12%/°C is suitable for dilute Sodium Chloride solutions near 25°C. For example, the change in conductivity at 20°C of a Sodium Chloride conductivity standard with a conductivity of 1000 µS/cm at 25°C is 1000 x -5°C x 0.0212/°C = -106 µS/cm, so the conductivity of the standard at 20°C is approximately 894 µS/cm. For Potassium Chloride solutions, the temperature coefficient is about 2%/°C, but varies significantly with temperature and concentration.

RICCA CHEMICAL COMPANY adjusts all standard and samples to 25.0°C for conductivity measurements.

Precision and Accuracy

The accuracy of RICCA CHEMICAL COMPANY conductivity standards is typically ±0.5%. This means that our conductivity standards are certified to be within 0.5% of the label value as compared to NIST standards at 25.0°C. The manufacturing specifications are somewhat tighter than this accuracy limit to ensure minimal lot-to-lot variation.

Limits on Range of Conductivity Standards

The electrical conductivity of pure water is about 0.055 µS/cm at 25°C. However, exposure to atmospheric gases, particularly Carbon Dioxide, causes the conductivity to increase, so that the conductivity of otherwise pure water in equilibrium with air is about 1.5 µS/cm at 25°C. For this reason, it is not possible to manufacture an aqueous conductivity standard with a certified conductivity lower than 5 µS/cm at 25°C.

Upper limits on conductivity standards are due to solubility limitations and ion pairing effects. Standards with conductivity up to 200 mS/cm can be manufactured from Sodium or Potassium Chloride. Standards with higher conductivity (up to 750 mS/cm) must be manufactured from corrosive materials such as Hydrochloric Acid.

Total Dissolved Solids (TDS)

Conductivity depends on the concentration of dissolved ionic substances and can thus be used to measured Total Dissolved Solids (TDS) concentration. However, equal concentrations of different ions give different conductivity readings. TDS measurements must therefore be referenced to a salt (usually Sodium Chloride, NaCl or Potassium Chloride, KCl) or to a proportionate mixture of salts (such as 442 or EPA/APHA). RICCA CHEMICAL COMPANY conductivity standards are labeled, where appropriate, with TDS concentrations on these four scales.

TDS concentrations as NaCl or KCl are useful for measurements in salt water. For fresh water measurements, other TDS scales are also used to better simulate the relative abundances of ions. The 442 scale simulates fresh water dissolved solids as a mixture of 4 parts Sodium Sulfate, 4 parts Sodium Bicarbonate, and 2 parts Sodium Chloride. The EPA/APHA fresh water TDS scale is based on the APHA 8010 E Synthetic Fresh Water formulations (also used in EPA “Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms”), and simulates fresh water dissolved solids as a mixture of 24 parts Sodium Bicarbonate, 15 parts Calcium Sulfate, 15 parts Magnesium Sulfate, and 1 part Potassium Chloride.

