APPLICATION NOTE – CONDUCTIVITY

CONSORT bvba, parklaan 36, B2300 Turnhout, Belgium
tel:+32/14/411279 • fax:+32/14/429179 • e-mail: support@consort.be

What is Conductivity?

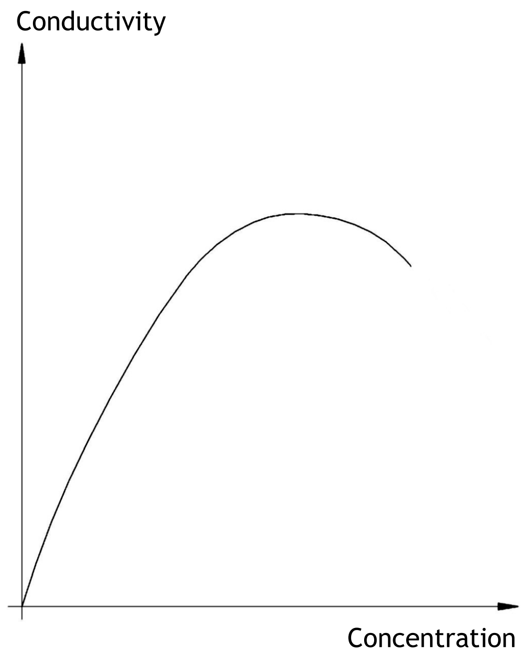
Conductivity, or specifically Electrolytic Conductivity (EC), is defined as the ability of a substance to conduct electric current. It is the reciprocal of the more commonly encountered term, resistivity. All substances possess conductivity to some degree, but the amount varies widely, ranging from extremely low (insulators such as benzene, glass) to very high (silver, copper, and metals in general). Most industrial interest is in the conductivity measurement of liquids, which generally consists of ionic compounds dissolved in water. These solutions have conductivities approximately midway between insulators and metallic conductors. This conductivity can be measured quite easily by electronic means, and this offers a simple test which can tell much about the quality of the water, or the make-up of the solution. A broad line of conductivity equipment is available to measure liquids ranging from ultra pure water (low conductivity) to concentrated chemical streams (high).

Units of Conductivity

The units of measurement used to describe conductivity and resistivity are quite fundamental and are frequently misused. Once the units are known, various waters can be quantitatively described.

The basic unit of resistance is the familiar ohm (). Conductance is the reciprocal of resistance, and its basic unit is the siemens (S). In discussions of bulk material, it is convenient to talk of its specific conductance, now commonly called its conductivity. This is the conductance as measured between the opposite faces of a 1 cm cube of the material. This measurement has units of S/cm. The units S/cm and mS/cm are most commonly used to describe the conductivity of aqueous solutions. The corresponding terms for specific resistance (or resistivity) are .cm, M.cm and k.cm.

Users of ultra pure water prefer to use resistivity units of M.cm, because measurement in these units tend to spread the scale out in the range of interest. These same users frequently use k.cm when dealing with less pure water such as tap water. Others, however, use the units of S/cm and mS/cm when dealing with any stream from quite pure to very concentrated chemical solutions. In these applications, the use of conductivity has the advantage of an almost direct relationship with impurities, especially at low concentration. Hence, a rising conductivity reading shows increasing impurities, or a generally increasing concentration in the case of a chemical stream (with some exceptions in concentrated solutions).



Some conductometers can measure total dissolved solids (TDS) and salinity of sea water. Due to ionic interactions within a solution, the salt concentration cannot easily be related to conductivity. Whilst a TDS measurement is referred to a solution of pure NaCl, salinity is the ratio between the total salt content (g) and the total weight of the sea water (kg) at 15°C. Hence salinity is expressed in ppt (parts per thousand) or g/kg. An automatic temperature compensation is required for highest accuracy.

Conductivity Electrodes

Conductivity is measured by an electrode consisting of two platinum plates to which an alternating potential is applied. The corresponding current is proportional to the conductivity of the ionic solution in which the cell is dipped. Since the conductivity of a solution varies with temperature, the measurements are always related to a reference temperature (25°C). The specific conductivity is expressed by the equation:

$$G = C \times (L/A) \ / \ (1 + \alpha(t - t_r))$$

in which:

- the specific conductivity G is referred to t_r °C.
- the absolute conductivity at t °C is given by C.
- the cell constant is determined by L/A where L is the length of the liquid column between the plates and A is the area of the plates.
- the temperature coefficient α of a solution is the change in conductivity versus the change of temperature.

All meters compensate temperature by using the world-wide accepted non-linear function for natural waters (EN27888). Some instruments can store individual temperature curves for each solution to match special requirements of research applications.