RESISTIVITY MEASUREMENT

In working with water systems, our primary interest is in the concentrations of dissolved ionic materials. Unfortunately, these concentrations can only be determined with reasonable accuracy by slow and cumbersome chemical analysis. For simple analysis and monitoring we often use the conductivity characteristics of the water solutions to determine the chemical concentrations. However, there are pitfalls in these techniques which should be understood to avoid assigning more significance to the measurement data than is justified.

With solutions of known characteristics, either simple compounds or mixtures of known proportions, such as dialysate, conductivity measurement can accurately reflect the concentration. Generally the instruments are temperature-compensated to match the characteristics of the solution being tested, so that all readings are normalized to 25°C, regardless of the temperature at which measurements are made.

The problem encountered in analyzing water supplies by conductivity measurement is that the dissolved materials are a mixture of varying proportions with different conductivity and temperature coefficient characteristics. For example, sodium chloride is almost twice as conductive as calcium carbonate, sodium hydroxide is three times as conductive as sodium chloride, and hydrochloric acid is almost twice as conductive as sodium hydroxide. A further complication is that temperature coefficients of conductivity vary from 0.5% to 3.0% per C° for different materials commonly found in water.

The conclusion to be drawn from this discussion is that a simple conversion from conductivity to TDS (total dissolved solids) is at best an approximation and should be considered to be supplementary information to a laboratory analysis of the water. It can be very useful information, however, if we use it to monitor for changes or to compare the readings before and after some form of water treatment.

The measurement of conductivity is, in theory, a simple process. A voltage is applied between two electrodes in a solution and the current is measured. The results are expressed as mhos, or reciprocal ohms, according to the equation:

$$\text{Conductivity} = \text{current (I)} / \text{voltage (E)}$$

Standard electrode configurations are used so that the results may be normalized to mhos per centimeter, defined as the conductance of one cubic centimeter of the material measured between opposite faces of a cube. More often the units of milli or micro-mhos per centimeter are used for dilute solutions. These characteristics are also expressed as resistivity, which is the reciprocal relationship and has units of ohm-centimeters.

Tech Note 107

The measurements are normally made with alternating current to avoid polarization or electrode plating, and utilize non-corrosive electrode material, such as gold or platinum plated stainless steel or carbon, depending upon the conductivity or resistivity range of measurement.

Of particular interest in reverse osmosis systems is the ratio of the input and output resistivities, as this is a measure of the performance of the equipment. For convenience, this ratio is expressed as percent rejection, according to the following relationship:

Assume: Conductivity is proportional to TDS.

Percent of ions = 100 (TDS out / TDS in)
passed by RO unit.

Then:

Percent rejection = 100 (1-TDS out / TDS in)

$$= 100 \left(1 - \frac{\text{Conductivity of product}}{\text{Conductivity of input}}\right)$$

The Dot Two Water Quality Monitor is configured to monitor this characteristic, using specially designed electrodes in the input and product water paths. This provides a very simple but effective means of monitoring the performance of an RO unit. The supplemental capability of measuring either input or product resistivity directly can offer considerable help in trouble-shooting problems or in maintaining surveillance over the water source characteristics.