

Correlating Conductivity to PPM of Total Dissolved Solids

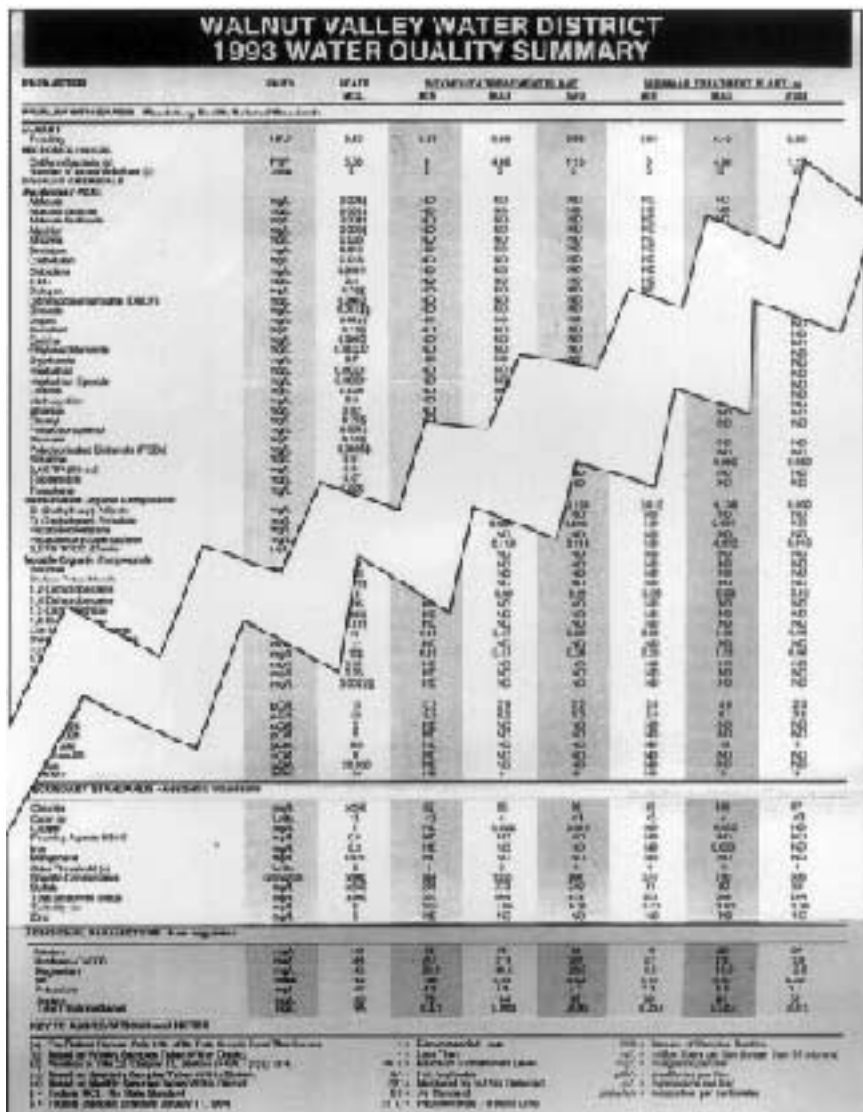
by Lori McPherson

Conductivity measurements are used often to approximate the total dissolved solids (ppm TDS) in water samples. A general correlation has been commonly used, which may or may not be accurate for any given sample. The true correlation will depend on the individual concentration of the different ions found in the sample. A solution of sodium chloride (sea water) may closely follow the standard correlation, while a sample of groundwater or water in a cooling tower may follow a significantly different correlation.

The Conductivity Measurement

The conductivity measurement itself is literally a measurement of a solution's ability to conduct electricity. It is directly affected by the number of dissolved ions in the solution. As the number of dissolved ions increases, the ability to conduct electricity also increases. The measurement value itself is generally considered to be a measurement of the actual number of ions contained in the sample, while in fact, this is only inferred.

The conductivity measurement unit is the inverse of the resistivity measurement. Resistivity measures the solution's ability to resist electrical current flow, measured in ohms•cm. Conductivity is therefore mhos/cm, mhos being defined as ohms⁻¹. This unit has been renamed by the International Standards Organization (ISO) to the Siemen (S). Both mhos/cm and S/cm are considered correct terms.



In clean water (e.g., surface water, well water, etc.), the order of magnitude is in the range of 10⁻⁶ s/cm

or μs/cm. The solution's actual ability to conduct electricity is related to

both the concentration and specific conductivity of the ions in solution, and the temperature of the solution. Increased temperature provides increased activity or ionic movement, which enables more electricity to be carried through the solution from one electrode to another.

To correlate the electrical conductivity to the concentration of ions more correctly, the effect of temperature on the solution's ability to conduct electricity is subtracted from the actual conductivity. For example, a solution at 25 C may conduct 200 μ s. The same solution at 35 C would conduct 240 μ s. Since the primary purpose of the measurement is to correlate to the purity of the solution, the effect of temperature would be subtracted

(compensated), with a displayed, compensated value shown of 200 μ s. This provides a means of standardizing the conductivity reading to the concentration of ions at 25 C.

The Measurement of ppm TDS

Measuring a sample for ppm TDS is basically determined by completely drying the water from an extract quantity of the sample and weighing the remaining solids. The result, converted to mg/l, is the ppm of TDS. The complete procedure is shown in the figure on page 32.

First, the dish used to dry the sample must be completely dried and weighed (steps 1 thru 3). Second, suspended solid material is removed by filtering (steps 4 thru 7). A fixed volume (100 ml) of the filtrate is transferred to the

weighed dish, and the water evaporated from it (steps 7 thru 10). The final product is then weighed (step 11), with weight of the dish determined in step 3 subtracted to reveal the weight of only the soluble constituents. This weight, divided by the initial volume of the sample (100 ml), converted to mg/l is the ppm of TDS.

The Standard Correlation

The correlation between conductivity and ppm TDS is generally accepted as: **ppm TDS \cdot 2 = Conductivity (μ s)** where a 400 μ s solution would be correlated to contain 200 ppm TDS. This correlation is reasonable in applications involving sea water (sodium chloride based) but generally is incorrect for groundwater or well water. The conductivity factors of specific ions are shown in Table 1.

The actual correlation for a given sample will depend upon a weighted average of the ions contained in the sample. This may be difficult to determine quantitatively since the concentration and specific conductivity of each ion must be known. The true correlation can generally be obtained in an easier manner as described below.

Determining the Correlation Factor

In many areas, a water district or water utility will run both ppm TDS and electrical conductivity tests on a regular basis, and may even publish this information as shown in the tabulation from the Walnut Valley Water District in Southern California (Table 2). If this data has not been published, it may be available via a quick phone call to the appropriate water district.

In the "Secondary Standards" or "Aesthetic Standards" information provided for the water supply, two lines are important: the *specific conductance* and the *total dissolved solids*. By calculating the ratio between these numbers, the correlation factor for the water supply being used can be determined.

From the Walnut Valley data in Table 2, at the Weymouth Treatment Plant, the average values given are: Specific conductance = 997 mhos/cm. Total dissolved solids = 612 ppm. From this we would calculate our

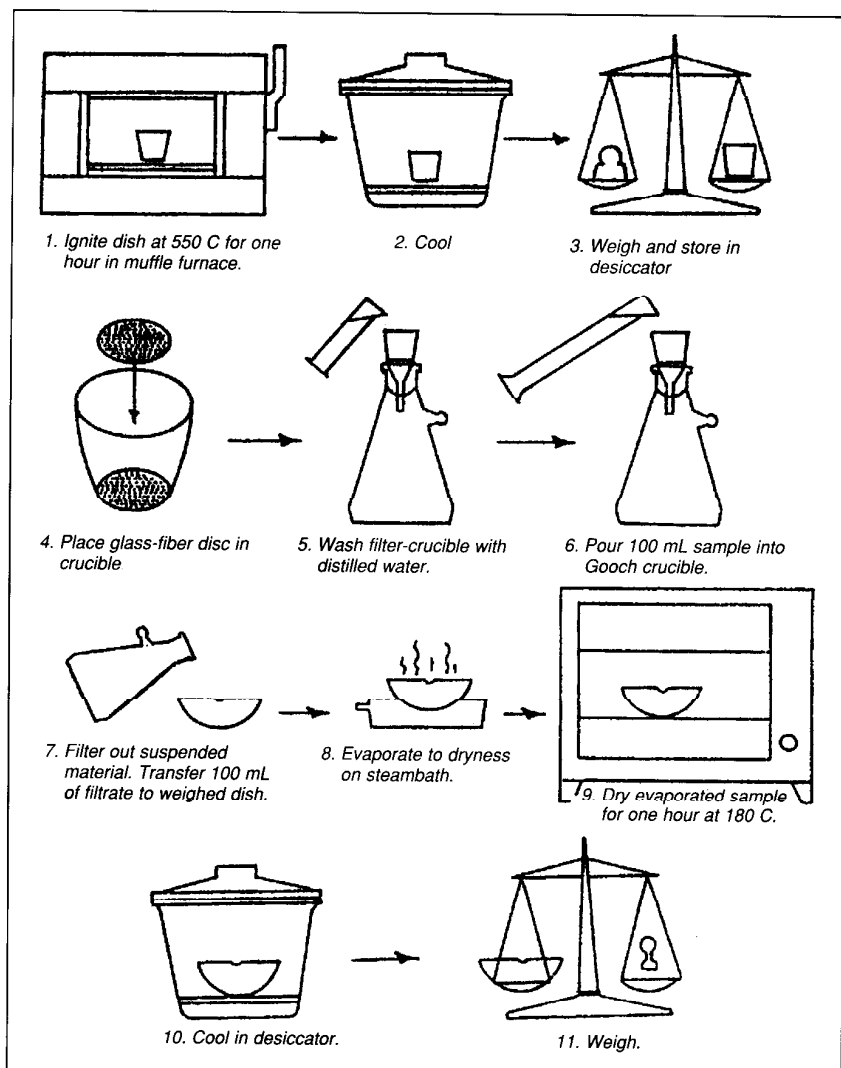


Table 1

Water Quality: Conductivity Factors of Ions Commonly Found in Water	
Ion	µS/cm per ppm
Bicarbonate	0.715
Calcium	2.60
Carbonate	2.82
Chloride	2.14
Magnesium	3.82
Nitrate	1.15
Potassium	1.84
Sodium	2.13
Sulfate	1.54

factor as:

$$\frac{997 \text{ mhos/cm}}{612 \text{ ppm}} = 1.63^1$$

At the Miramar Treatment Plant,

the average values given are:

Specific conductance = 506 mhos/cm
 Total dissolved solids = 284 ppm.

From this data we would calculate our factor as:

$$\frac{506 \text{ mhos/cm}}{284 \text{ ppm}} = 1.78^1$$

Both of these calculated values are significantly different than the 2.0 value that is generally recognized as a standard correlation. If water is supplied from both plants, an average of the two (approximately 1.7) could be used as a correlation factor.

Accurate on-line "measurement" of ppm TDS can then be programmed automatically with a conductivity instrument (or system) that features an adjustable factor between conductivity (mhos) and ppm TDS. With the appropriate factor programmed, a correlation error of nearly 15 percent can be

avoided.

If the water authority does not have such information available, a qualified laboratory can run such tests for a nominal fee. An average of several water samples, preferably taken at different times of the year, would provide more statistically favorable test data. ■

REFERENCE

1. Units for this factor are mhos/(cm ppm), but is generally referred to as simply the "ppm factor".

About the Author:

Lori L. McPherson is the Analytical Product Manager for George Fischer, Inc., of Tustin, California. She can be reached at (800) 532-6345.