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Using Electrical Conductivity and Total Dissolved Solids Meters to Field Test Water Quality

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Water contains dissolved minerals, which are commonly referred to as total dissolved solids (TDS) or sometimes as total dissolved salts. The amount of TDS depends on the water's location and source. Some of the TDS can be toxic if present at concentrations beyond recommended levels.

The standard method for measuring TDS is evaporating all the water from a 0.1-liter sample and weighing the residual minerals left in the vessel. However, collecting a sample and conducting a standard laboratory analysis or sending the sample to a water quality testing facility can be time-consuming.

An electrical conductivity (EC) or TDS meter is a quick method to estimate TDS. Water conducts electricity due to the presence of minerals (ions), so the more dissolved minerals, the more conductive the water becomes. Pure (distilled) water is a poor conductor of electricity, because it contains very few dissolved minerals.

The units for TDS are usually expressed as milligrams per liter (mg/L), which is the same as parts per million (ppm). Some TDS meters also show parts per thousand (ppt), which is equal to 1,000 ppm.

The EC is a proxy measurement to determine the TDS in water. Some of the confusion with using EC is that it can be expressed in different units. The units might be referenced as micromhos per centimeter (µmhos/cm) and millimhos per centimeter (mmhos/cm) or microSeimens per centimeter (µS/cm) and milliSeimens per centimeter (mS/cm). All these units present the same information just expressed differently. For example, 1 mmho/cm = 1 mS/cm = 1,000 µmhos/cm = 1,000 µS/cm.

Most EC meters can change modes to read salinity in grams per liter, EC in µS and TDS in mg/Lor ppt. The meter calculates an estimate of TDS by multiplying the EC reading with a conversion factor. The chart below presents the conversion factor, which increases with increase in conductivity.

To ensure an accurate reading, EC meters must be calibrated regularly. The accuracy of the EC meter should be checked with a calibration solution prior to sampling. Calibrate each time batteries are changed or after the meter has been dropped on a hard surface.

Use a manufacturer-supplied calibration solution to calibrate the instrument, but you can make your own calibration solution using table salt (NaCl) following the instructions below.

Electrical Conductivity				Approximate TDS	Conversion Factor[1]
µmhos/cm	mmhos/cm	µS/cm	mS/cm	mg/l or ppm	
100	0.1	100	0.1	50	0.50
500	0.5	500	0.5	300	0.60
1,000	1.0	1,000	1.0	650	0.65
1,500	1.5	1,500	1.5	1,050	0.70
2,000	2.0	2,000	2.0	1,450	0.72
2,500	2.5	2,500	2.5	1,850	0.74
3,000	3.0	3,000	3.0	2,250	0.75
3,500	3.5	3,500	3.5	2,650	0.76
4,000	4.0	4,000	4.0	3,050	0.77
4,500	4.5	4,500	4.5	3,500	0.78
5,000	5.0	5,000	5.0	3,950	0.79
6,000	6.0	6,000	6.0	4,740	0.79
6,500	6.5	6,500	6.5	5,135	0.79
7,000	7.0	7,000	7.0	5,600	0.80
8,000	7.5	7,500	7.5	6,075	0.81
10,000	10.0	10,000	10.0	8,200	0.82

[1] Conversion factor is for natural waters

Making Table Salt (NaCl) Calibration Mixtures to Check EC and/or TDS Meters

What you need:

- Table salt
- ¼ teaspoon measuring spoon
- A measuring cup
- A mixing container that holds at least 4 cups of water and rinsed with distilled water
- 1 gallon distilled water
- An EC meter

A ¼ teaspoon measuring spoon has a volume of about 1.25 milliliters (ml). A leveled ¼ teaspoon of salt weighs about 1.7 grams or 1,700 milligrams. One cup of water equals 0.236 liters or 236 milliliters, and 4 cups equals 0.94 liters. Make a calibration solution with a TDS of around 2,600 mg/L because livestock can have adverse effects at this level and beyond.

Add table salt to the ¼ teaspoon and level it off with a straight edge. Add the salt to the mixing container. Set the measuring cup on a level surface and add 4 cups of distilled water to the container. Mix until the salt is dissolved, and let it rest for about 5 minutes.

The salinity of this solution will be about 1.8 grams per liter, and the EC can be from 3,200 to 3,600 µS/cm, depending on the quality of the table salt. Now, change the conversion factor on the EC meter to 0.76 for 2,650 mg/L TDS of natural water (see chart above). Set the mode on the EC meter to measure TDS. Insert the probe into the water and swirl gently. The reading on the EC meter should be between 2,400 and 2,700 mg/L. If the meter reads in parts per thousand (ppt), it should show 2.4 to 2.7. Make a new mixture each time you check the accuracy of the EC meter.

Notice on the chart that the conversion factor doesn't change much above 2,700 mg/L, so the calibrated EC meter now will provide reliable readings for natural water concentrations that are greater than 2,700 mg/L (ppm).

Field Testing

Once your meter is calibrated, you are ready to begin testing.

1. Select the area of concern to sample, such as where livestock are drinking.
2. Collect the sample in a clean plastic or glass container.
3. Rinse the container several times using the water to be sampled.
4. Fill the container, making sure to collect water from the surface and deeper depths. Collect the sample using a scooping motion collecting water from the surface followed by deeper depths. Field test water using an EC or TDS meter.

Submit a sample for laboratory analysis if EC is equal to or greater than 6,000 µmhos/cm or TDS is equal to or greater than 4,500 ppm.

Follow the NDSU Extension Livestock Water Testing Guidelines for the sample submittal. See www.ndsu.edu/agriculture/ag-hub/ag-topics/livestock/water/testing-livestock-water-quality-critical-during-drought/livestock for more information.

This publication was originally authored by Miranda Meehan and Tom Scherer, retired NDSU Extension agricultural engineer.

For more information on this and other topics, see www.ndsu.edu/extension

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