OAKTON® TECH TIPS

Practical Considerations for Conductivity and Total Dissolved Solids Measurement

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When using a meter to measure either the ppm or total dissolved solids (TDS), or the conductivity of a liquid, you need to periodically calibrate the meter using a calibration standard solution. There are special considerations to be given to each type of calibration:

- Conductivity calibrations are transferrable from one type of solution to another.
- ppm total dissolved solids (TDS) calibrations are very specific to one type of dissolved solids solution. These calibrations MUST NOT be transferred from one type of dissolved solids solution to the next. Doing this will result in serious measurement errors.

Although the basis for testing ppm of TDS is the conductivity of the solutions, don't assume that these measurements have the same transferability to different types of solutions. **It is always necessary to calibrate all total dissolved solids meters with a parts per million TDS standard calibration solution that contains the same types of salts or mixture of salts as the solution to be tested.** Failure to do this will result in serious errors in the measurement of total dissolved solids. This is because total dissolved solids meters are calibrated by correlating the conductivity of the solution to the ppm dissolved solids, and this correlation varies considerably from one type of dissolved solids to the next.

In the table Figure 1, there are a number of standard curves which correlate the parts per million of total dissolved solids to the conductivity of these solutions. Note that there is a great deal of variation in the slopes of these curves. According to Figure 1, if a meter detects a conductivity of 6000 micromhos and is calibrated to read out 1030 parts per million of sodium hydroxide (NaOH) as shown in the curve, the meter would not be able to accurately detect parts per million contents of sodium chloride (NaCl) in solution. The correct ppm NaCl indication for the detected conductivity of 6000 micromhos would be 3200 ppm, as shown in Fig. 1, but the meter would only indicate 1030 ppm, which is clearly unacceptable. This shows that it is incorrect to use a meter that has been calibrated for ppm NaOH indications for a ppm NaCl indication.

A similar conclusion can be made for all types of dissolved solids. Most pre-formulated parts per million total dissolved solids standard calibrated solutions are formulated with either sodium chloride (NaCl), potassium chloride (KCl) or the 442 (40% sodium sulfate, 40% sodium bicarbonate and 20% sodium chloride) natural water formulation.

In some cases, a KCl solution is made to a specific conductivity value, and then the ppm values for NaCl, KCl and/or a 442 formulation are referenced on the bottle giving the user the option to calibrate to any one of these. A conductivity value is also usually given.

If your test solution's major dissolved solids components are the same as any of these, you may want to choose the pre-made formulation that best approximates your test solution. Generally, NaCl is used for brines and the 442 formulation is used for general water and waste water, rinse water, boilers and cooling towers, lakes, streams and wells.

Alternatively, if the contents of the ppm standard calibration solution used for calibration are known and if there are figures such as Fig. 1 or tables such as Tables 1, 2 and 3 available, you can cross reference the calibration standard solution's "conductivity to ppm total dissolved solids" curve to the curves for other types of dissolved solids solutions. Other curves and tables are available in various reference books.

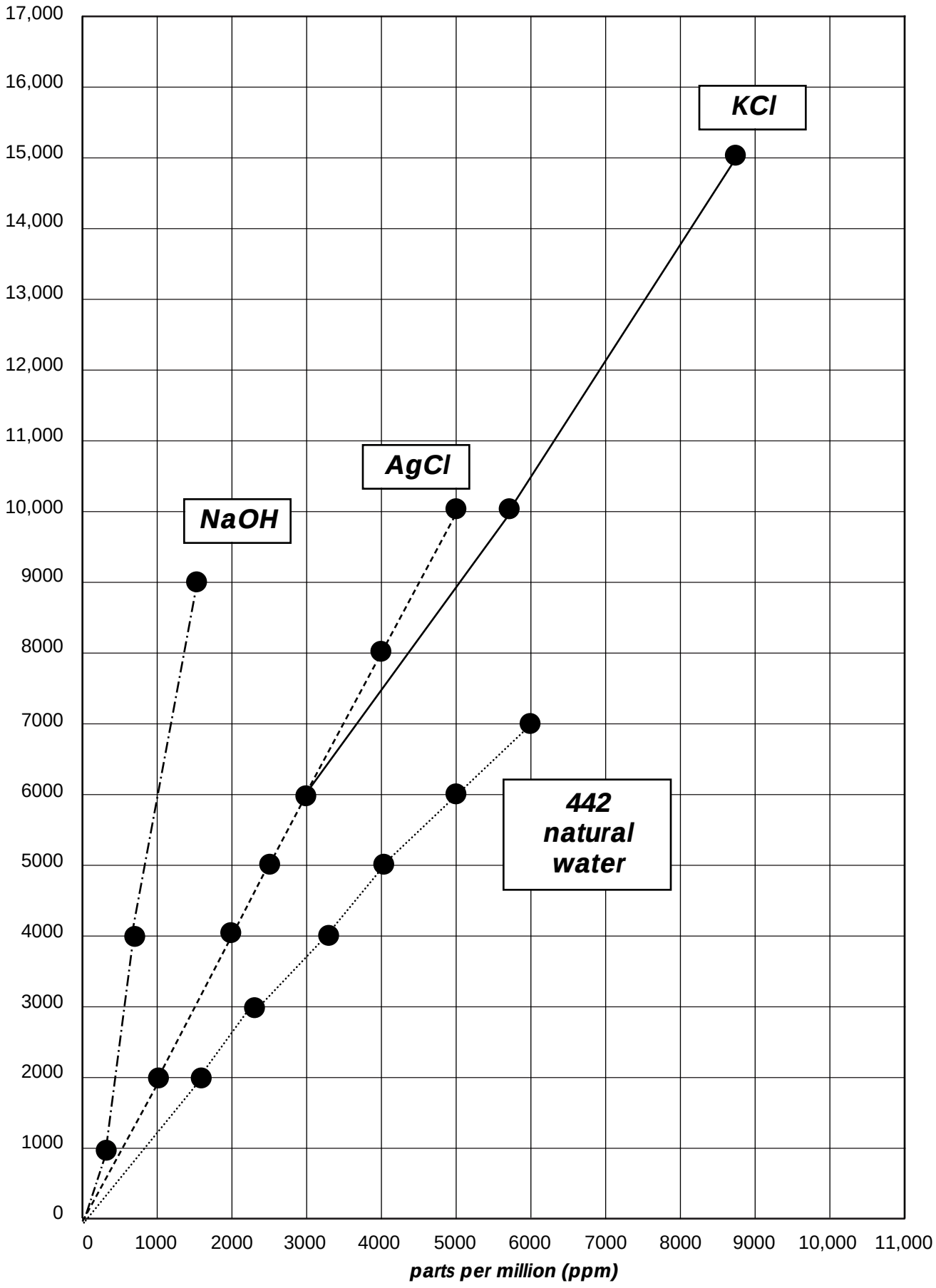
The previous discussion and references are based on standard conditions of temperature (25ºC). When measuring conductivity or total dissolved solids in nonstandard conditions, corrections for temperature variations must be taken into account before determining the final values of conductivity and total dissolved solids measurements. Otherwise, the measurements will not be correct.

Meters with temperature compensation overcome this problem, because they incorporate temperature sensing elements and temperature compensating circuitry into the meter so that the value displayed is corrected to a standard temperature. If your meter does not have temperature compensation, you need to use look-up tables or formulas to correct for the temperature effect, or to calibrate the meter using a calibration standard that has been brought to the same temperature as the test solution.

This discussion should prove useful to all users of conductivity and dissolved solids testing procedures. It is a "rule of thumb" guideline for using conductivity and dissolved solids testing equipment. Fine tuning of the standard curves and formulas for your specific application is recommended. We hope this discussion helps you to understand the process.

Fig. 1: Conductivity (µS) vs. ppm concentration

All data taken at 25°C and 1 ATM. Demonstrates how different materials have different Conducitivity to ppm ratios.



Signet Conversion Chart

Conductivity Micromhos-cm @ 25°C	Resistivity Ohms-cm @25°C	Dissolved Solids Parts per Million (ppm)	Approximate Grams Gallon (GPG) as $CaCO^2$
0.056	18,000,000	0.0277	0.00164
0.059	17,000,000	0.0294	0.00170
0.063	16,000,000	0.0313	0.00181
0.067	15,000,000	0.0333	0.00193
0.072	14,000,000	0.0357	0.00211
0.077	13,000,000	0.038	0.00222
0.084	12,000,000	0.0417	0.00240
0.091	11,000,000	0.0455	0.00263
0.100	10,000,000	0.0500	0.00292
0.111	9,000,000	0.0556	0.00322
0.125	8,000,000	0.0625	0.00358
0.143	7,000,000	0.0714	0.00415
0.167	6,000,000	0.0833	0.00485
0.200	5,000,000	0.100	0.00585
0.250	4,000,000	0.125	0.00731
0.333	3,000,000	0.167	0.00971
0.500	2,000,000	0.250	0.0146
1.00	1,000,000	0.500	0.0292
1.11	900,000	0.556	0.0322
1.25	800,000	0.625	0.0368
1.43	700,000	0.714	0.0415
1.67	600,000	0.833	0.0485
2.00	500,000	1.00	0.0585
2.50	400,000	1.25	0.0731
3.33	300,000	1.67	0.0971
5.00	200,000	2.50	0.146
10.0	100,000	5.00	0.292
11.1	90,000	5.58	0.322
12.5	80,000	6.25	0.368
14.3	70,000	7.14	0.415
16.7	60,000	8.33	0.485
20.0	50,000	10.0	0.585
25.0	40,000	12.5	0.731
33.3	30,000	16.7	0.971
50.0	20,000	25.0	1.46
100.0	10,000	50.0	2.92
111	9,000	55.6	3.22
125	8,000	62.5	3.68
143	7,000	71.4	4.15
167	6,000	83.3	4.85
200	5,000	100	5.85
250	4,000	125	7.31
333	3,000	167	9.71
500	2,000	250	14.6
1,000	1,000	500	29.2
1,110	900	556	32.2
1,250	800	625	36.8
1,430	700	714	41.5
1,670	600	833	48.5
2,000	500	1,000	58.5
2,500	400	1,250	73.1
3,330	300	1,670	97.1
5,000	200	2,500	146
10,000	100	5,00	292

Conductivity/Resistivity Spectrum

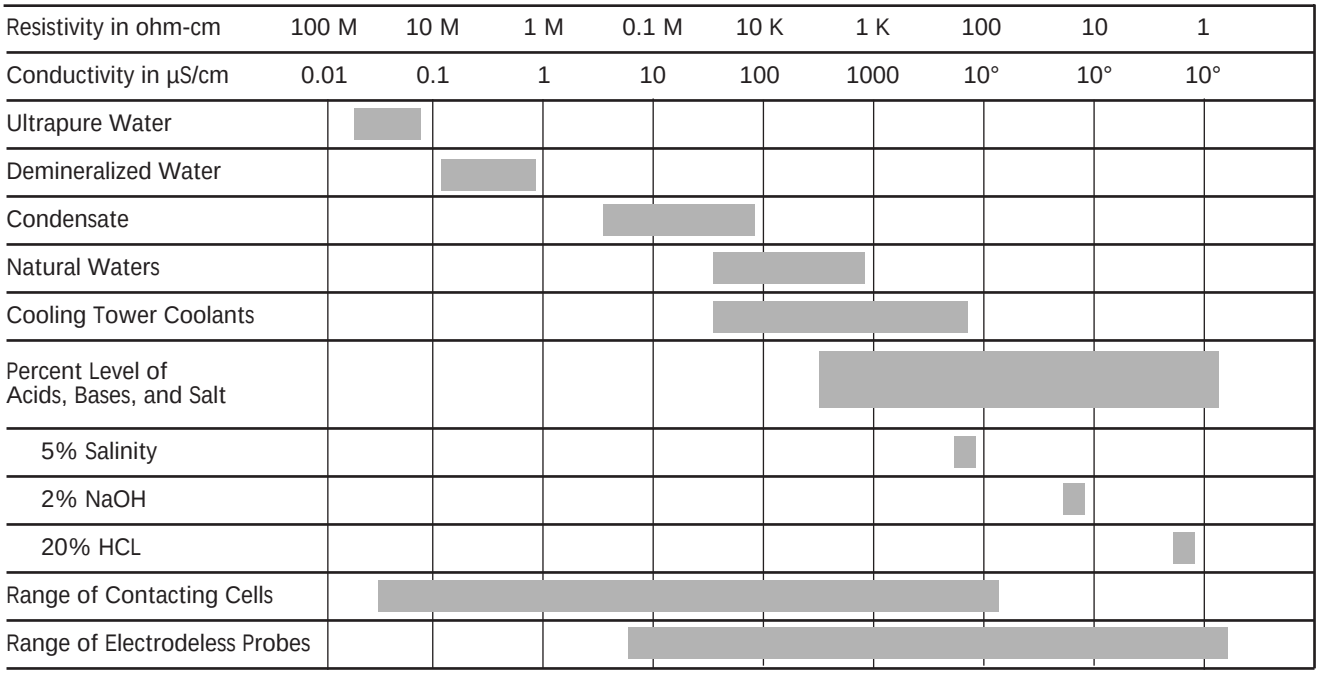


Table of Conductivity versus Concentration for Common Solutions

Conductivity (G) µSiem (µO/cm) at 25°C (77°F)

Weight %	ppm mg/litre	NaCl	NaOH	NH_4OH	NH_3	HCl	H_2SO_4	HNO_2	HF	SO_2	Acetic Acid
0.001 0.0003 0.001	1 3 10	2.2 6.5 21.4	6.2 8.3 61.1	4.1 8.3 17	6.6 12 27	11.7 5.0 116	8.8 6.1 85.6	6.8 20 67	10 30 99	6.4 18 54	4.2 7.4 15.10.00
0.003 0.01 0.03	30 100 300	64 210 617	182 603 1780	31 58 102	49 84 150	340 1140 3390	251 805 2180	199 657 1950	290 630 1490	150 450 1200	30.6 63 114
0.1 0.3 1.0	1000 3000 10000	1990 5690 17600	5820 16900 53200	189 329 490	275 465 810	11100 32200 103000	6350 15800 48500	6380 18900 60000	2420 5100 11700	3600 7900 17200	209 368 640
3.0 5.0 10.0	Rarely Used	48600 78300 140000	144000 223000 358000	790 958 1115	1110 1115 1120	283000 432000 709000	141000 237000 427000	172000 275000 498000	34700 62000 118000	32700 42000 61000	1120 1230 1530
20.0 30.0 40.0		226000 Sat Sat	414000 292000 191000	968 725 460	4251 Sat Sat	850000 732000 Sat	709000 828000 770000	763000 861000 820000	232300 390000 NA	Sat Sat Sat	1600 1405 1080
50.0 75.0 100.0		Sat Sat Sat	150000 Sat Sat	285 Sat —	Sat Sat <1	Sat Sat Sat	620000 182000 10000	717000 340000 50000	NA 7.8 (0°C) 4 (0°C)	Sat Sat <1	740 168 <1
Point of Maximum Solubility		26%	Abt 50%	13.6% (1 atm)	28% (1 atm)	37%	—	—	—	11.7% (1 atm)	
Point(s) of Maximum Conductivity		26%	16%	2.67%	5.5%	18.5%	31% 92.5%	31%	Abt 35%	11.7%	19%
Maximum Conductivity		244000	1120 412000	1120 (18°C)	(18°C)	830000 852000	139000	862000	NA	66000	1600