# Practical Considerations for Conductivity/TDS Measurement

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 calibration solution should contain the same types of dissolved solids known to be given to each type of calibration:

Conductivity calibrations are transferable from one type of solution to another ppm 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.

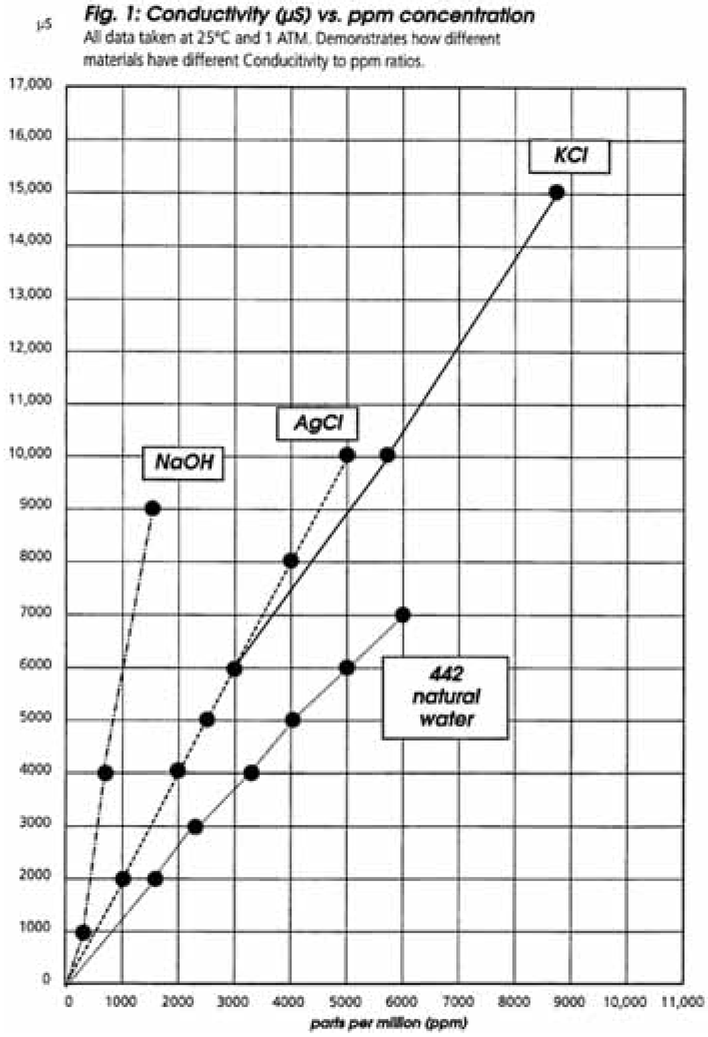
Although the basis for testing ppm of TDS is the Conductivity of the solutions, don't assume that these measurements have the same transferability to different types of solutions.

**It is always necessary to calibrate all TDS meters with a ppm (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 TDS. This is because TDS 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 table Figure 1, there are a number of standard curves which correlate the parts per million of TDS to the Conductivity of these solutions. Note that there is a great deal of variation in the slops of these curves. According to Figure 1, if a meter detects a Conductivity of 6000 µS/cm and is calibrated to read out 1030 ppm of sodium hydroxide ($NaOH$) as shown in the curve, the meter would not be able to accurately detect ppm contents of sodium chloride ($NaCl$) in solution. The correct ppm $NaCl$ indication for the detected Conductivity of 6000 µS/cm would be 3200 ppm, as shown in Figure 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.

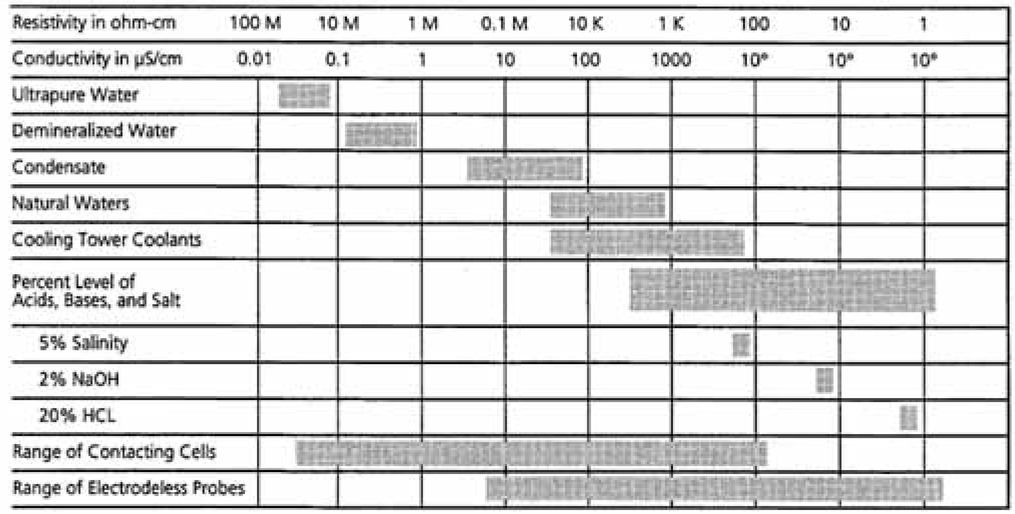
Fig. 1: Conductivity (µS) vs. ppm concentration
All data taken at 25°C and 1 ATM. Demonstrates how different materials have different Conducitivity to ppm ratios.




A similar conclusion can be made for all types of dissolved solids. Most pre-formulated ppm TDS standard 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 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.

## 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 | 1 | 2.2 | 6.2 | 4.1 | 6.6 | 11.7 | 8.8 | 6.8 | 10 | 6.4 | 4.2 |
| 0.0003 | 3 | 6.5 | 8.3 | 8.3 | 12 | 5.0 | 6.1 | 20 | 30 | 18 | 7.4 |
| 0.001 | 10 | 21.4 | 61.1 | 17 | 27 | 116 | 85.6 | 67 | 99 | 54 | 15.10.00 |
| 0.003 | 30 | 64 | 182 | 31 | 49 | 340 | 251 | 199 | 290 | 150 | 30.6 |
| 0.01 | 100 | 210 | 603 | 58 | 84 | 1140 | 805 | 657 | 630 | 450 | 63 |
| 0.03 | 300 | 617 | 1780 | 102 | 150 | 3390 | 2180 | 1950 | 1490 | 1200 | 114 |
| 0.1 | 1000 | 1990 | 5820 | 189 | 275 | 11100 | 6350 | 6380 | 2420 | 3600 | 209 |
| 0.3 | 3000 | 5690 | 16900 | 329 | 465 | 32200 | 15800 | 18900 | 5100 | 7900 | 368 |
| 1.0 | 10000 | 17600 | 53200 | 490 | 810 | 103000 | 48500 | 60000 | 11700 | 17200 | 640 |
| 3.0 | Rarely Used ↓ | 48600 | 144000 | 790 | 1110 | 283000 | 141000 | 172000 | 34700 | 32700 | 1120 |
| 5.0 | | 78300 | 223000 | 958 | 1115 | 432000 | 237000 | 275000 | 62000 | 42000 | 1230 |
| 10.0 | | 140000 | 358000 | 1115 | 1120 | 709000 | 427000 | 498000 | 118000 | 61000 | 1530 |
| 20.0 | | 226000 | 414000 | 968 | 4251 | 850000 | 709000 | 763000 | 232300 | Sat | 1600 |
| 30.0 | | Sat | 292000 | 725 | Sat | 732000 | 828000 | 861000 | 390000 | Sat | 1405 |
| 40.0 | | Sat | 191000 | 460 | Sat | Sat | 770000 | 820000 | NA | Sat | 1080 |
| 50.0 | | Sat | 150000 | 285 | Sat | Sat | 620000 | 717000 | NA | Sat | 740 |
| 75.0 | | Sat | Sat | Sat | Sat | Sat | 182000 | 340000 | 7.8 (0°C) | Sat | 168 |
| 100.0 | | Sat | Sat | — | <1 | Sat | 10000 | 50000 | 4 (0°C) | <1 | <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 |

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 Figure 1 or tables such as Tables 1 and 2 available, you can cross reference the calibration standard solution's "Conductivity to ppm TDS" 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 (25°C). When measuring Conductivity or TDS in non-standard conditions, corrections for temperature variations must be taken into account before determining the final values of Conductivity and TDS 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 a 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.