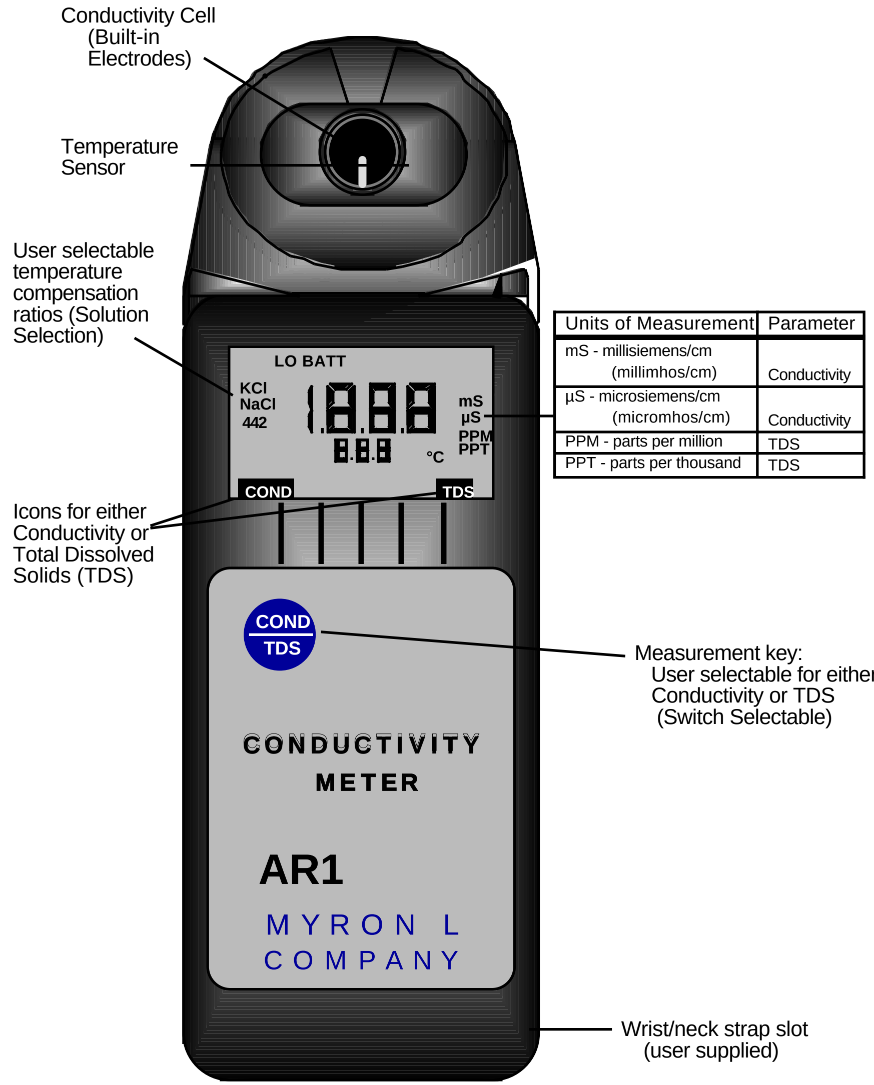
TechPro™ Operation Manual

Model AR1

MYRON L
COMPANY

10-02 (WEB-EG)

Instrument Illustration



Units of Measurement	Parameter
mS - millisiemens/cm (millimhos/cm)	Conductivity
µS - microsiemens/cm (micromhos/cm)	Conductivity
PPM - parts per million	TDS
PPT - parts per thousand	TDS

For detailed explanations, see Table of Contents

CE

1-12-99

FEATURES and SPECIFICATIONS

A. Features

- Superior resolution 3 1/2 digit LCD
- Accuracy of ±1% of full scale
- All electrodes are internal for maximum protection
- Latest electrode cell technology
- Water resistant
- Autoranging Conductivity/TDS
- Easy calibration
- User selectable Conductivity/TDS modes
- 3 “User Selectable” solution conversions (tempcos)
- Temperature Accuracy of ±1° C/F

B. General Specifications

Display	3 1/2 Digit LCD
Dimensions (LxWxH)	7.7x2.7x2.5 in. 196x68x64 mm
Weight	10.1oz./290g
Case Material	ABS
Cond/TDS Cell Material	ABS
Cond/TDS Cell Capacity	0.2 oz./5 ml
Power	9V Alkaline Battery
Battery Life	>100 Hours/5000 Readings
Operating/Storage Temperature	32-132°F/0-55°C
Protection Ratings	IP64/NEMA 3

C. Specification Chart

AR1	Conductivity	TDS	Temperature
Ranges	0-1999 µS 2-19.99 mS in 3 autoranges	0-1999 ppm 2-19.99 ppt in 3 autoranges	0-71° C 32 - 160° F
Resolution	0.1 (<200 µS) 1 (<2000 µS) 0.01 (>2 mS)	0.1 (<200 ppm) 1 (<2000 ppm) 0.01 (>2 ppt)	0.1° C/F
Accuracy	±1% of Full Scale		±1.0° C/F
Auto Temperature Compensation	0-71° C 32 - 160° F		
Conductivity or TDS Ratios	KCl, NaCl or 442™		

D. Warranty/Service

The Myron L AR1 has a limited two year warranty. If an instrument fails to operate properly, see Troubleshooting Chart, pg. 13. The battery is user-replaceable. For other service, return the instrument prepaid to the Myron L Company.

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If, in the opinion of the factory, failure was due to materials or workmanship, repair or replacement will be made without charge. A reasonable service charge will be made for diagnosis or repairs due to normal wear, abuse or tampering. This warranty is limited to the repair or replacement of the AR1 only. The Myron L Company assumes no other responsibility or liability.

E. TechPro™ Series Models

TechPro Series Models	pH1	AR1	ARH1
Parameters	pH & Temperature	Conductivity or TDS, & Temperature	Conductivity or TDS, pH & Temperature

Additional information available on our web site at:
www.myronl.com

CE

TABLE OF CONTENTS

I. INTRODUCTION

Thank you for selecting the TechPro™ Series, Model AR1, one of the Myron L Company's latest in a new line of digital instruments utilizing advanced circuitry. This circuitry makes it very accurate and easy to use (see pages 2 & 3 for Features and Specifications on this and other models). For your convenience, on the bottom side of your AR1 is a brief set of instructions.

Special note ...... Conductivity/TDS require mathematical correction to 25°C values (ref. Temperature Compensation, pg. 15).

On the left side of the AR1 liquid crystal display is shown an indicator of the salt solution characteristic used to model temperature compensation (tempco) of conductivity or its TDS conversion. The indicator can be KCl, NaCl or 442. Internal selection affects the temperature correction of conductivity, and the calculation of TDS from compensated conductivity (ref. Conductivity Conversion to TDS, pg. 17).

The selection can affect the reported conductivity of hot or cold solutions, and will change the reported TDS of a solution. Generally, using KCl for conductivity and 442™ (Natural Water characteristic) for TDS will reflect present industry practice for standardization. NaCl may also be selected for either conductivity or TDS as is needed.

Your instrument, as shipped from the factory, is set for conductivity with the KCl tempco. However, if you are measuring natural waters and wish to have maximum accuracy, you may want to change it to the 442 tempco setting. To change the Tempco or to read in TDS/ppm, see Solution Selection on pg. 8.

II. RULES of OPERATION

A. Operation

Using the instrument is simple:

- Rinse the Conductivity cell with test solution 3 times and Refill.
- Pressing COND/TDS key starts a 20 second timer.
- Note the value displayed. It's that simple!

B. Characteristics of the Key

- Your AR1 is designed to provide quick, easy, accurate measurements by simply pressing one key.

C. Operation of the Key (See Instrument Illustration on page 1)

1. Measurement Keys in General

The measurement key turns on the instrument in the mode selected. The mode is shown at the bottom of the display, and the measurement units appear at the right.

2. COND/TDS Key

This key is used with solution in the Conductivity Cell.

Precautions:

- While filling cell cup ensure no air bubbles cling on the cell wall.
- If the proper solution is not selected (KCl, NaCl or 442) refer to Why Solution Selection is Available, pg. 8.

Solution to be tested is introduced into the conductivity cell and a press of COND/TDS displays conductivity or Total Dissolved Solids (TDS) with units on the right. On the left is shown the solution type selected for conductivity. An overrange condition will show only [- - - -].

III. AFTER USING the AR1

Rinse out the cell cup with clean water. Do not scrub the cell. For oily films, squirt in a foaming non-abrasive cleaner, and rinse. Even if a very active chemical discolors the electrodes, this does not affect the accuracy; leave it alone (ref. Cleaning Cell Cup, pg. 12).

IV. THE SPECIFIC RECOMMENDED MEASURING PROCEDURES

If the proper solution is not selected (KCl, NaCl or 442), see Solution Selection, Pg. 8.

***NOTE**: After sampling high concentration solutions or temperature extremes, more rinsing may be required.*

Measuring Conductivity/Total Dissolved Solids (TDS)

1. Rinse cell cup 3 times with sample to be measured. (This conditions the temperature compensation network and prepares the cell).
2. Refill cell cup with sample.
3. Press COND/TDS.
4. Take reading. A display of [- - - -] indicates an overrange condition.

V. SOLUTION SELECTION

A. Why Solution Selection is Available

Conductivity and TDS require temperature correction to 25°C values (ref. Standardized to 25°C, pg. 15). Selection determines the temperature correction of conductivity and calculation of TDS from compensated conductivity (ref. Conductivity Conversion to TDS, pg. 17).

B. The 3 Solution Types

On the left side of the display is the salt solution characteristic used to model temperature compensation of conductivity and its TDS conversion. Generally, using KCl for conductivity and 442 (Natural Water characteristic) for TDS will reflect present industry practice for standardization. Your instrument as shipped from the factory is set for conductivity with the KCl tempco. If you are measuring natural waters and wish to have maximum accuracy, it may be better to change it to the 442 setting. However, selecting NaCl for either conductivity or TDS may best reflect your specific specialized needs (ref. Solution Characteristics, pg. 17).

C. Procedure to Select a Solution

NOTE: Check display to see if solution displayed (KCl, NaCl or 442) is already the type desired. If not:

1. **Dry Instrument THOROUGHLY**.

2. Remove the 4 bottom screws and carefully open Instrument.

3. Locate dip switch labeled "TEMP COMP" on the right side of the circuit board. Switch positions are 1-4 (left to right).

4. Set switch numbers **1** and **2** to the desired position.
   Note: Factory setting is for KCl - both switches UP or ON.

5. Carefully turn instrument over and press the COND/TDS key. The correct icon "KCl", NaCl" or "442" should be shown on the left side of the display.

6. Replace bottom, ensuring the sealing gasket is installed in the groove of the top half of case. Tighten screws securely. (Do NOT overtighten)

7. Recalibrate as necessary. See Calibration, pg. 9.

D. Procedure to Select the Units of Measurement
i.e., µS to ppm

1. **Dry Instrument THOROUGHLY**.

2. Remove the 4 bottom screws and open Instrument.

3. Locate dip switch labeled "TEMP COMP" located on the right side of the circuit board. Switch positions are 1-4 (left to right).

4. Set switch number **3** to the desired position - COND or TDS.
   Note: Factory setting is for COND - DOWN or OFF.

5. Carefully turn instrument over and press the COND/TDS key. The correct icon "µS" or "PPM" should be shown on the right side of the display.

6. Replace bottom, ensuring the sealing gasket is installed in the groove of the top half of case. Tighten screws securely. (Do NOT overtighten)

7. Recalibrate as necessary. See Calibration Procedures, pg. 10.

In the first five sections, you have learned all you need to make accurate measurements. The following sections contain calibration, advanced operations, and technical information.

VI. CALIBRATION

A. Calibration Intervals

Generally, calibration is recommended about once per month with Conductivity or TDS solutions.

B. Rules for Calibration in the AR1

1. Calibration Steps

The calibration is accomplished by a Calibration Control located under the respective cap plug located on the bottom of the instrument.
After pressing the COND/TDS key, the reading is changed/adjusted to match the known standard value.

2. Calibration Limits

In Conductivity or TDS, the inability to calibrate may indicate improper or contaminated calibration solution, or a damaged conductivity cell.

C. Calibration Procedures

a. Rinse conductivity cell three times with proper standard (KCl, NaCl or 442) (ref. Conductivity/TDS Standard Solutions, pg. 14).

b. Refill conductivity cell with same standard solution.

c. Press COND/TDS key. If reading is acceptable, end procedure. If reading is unacceptable, continue.

d. Remove cap plug labeled COND CAL on bottom of Instrument.

e. Refill conductivity cell with same standard solution.

f. While pressing the COND/TDS key, adjust COND CAL Control with finger until the display agrees with the value on the standard solution bottle.

g. Repeat steps b. & c. to verify the setting.

h. Replace bottom cap plug securely to maintain water resistance. The COND/TDS Calibration procedure is now complete.

VII. CALIBRATION INTERVALS

There is no simple answer as to how often one should calibrate an instrument. The AR1 is designed to not require frequent recalibration. The most common sources of error were eliminated in the design, and there are simple electromechanical adjustments. Still, to ensure specified accuracy, any instrument has to be checked against chemical standards occasionally.

A. Suggested Intervals

On the average, we expect calibration need only be checked monthly. Measuring some solutions will require more frequent intervals.

B. Calibration Tracking Records

To minimize your calibration effort, keep records. If adjustments you are making are minimal for your application, you can check less often. Changes in conductivity calibration should be recorded in percent.

Calibration is purposely limited in the AR1 to approximately ±8% for the conductivity cell because more than that indicates damage, not drift.

C. Conductivity or TDS Practices to Maintain Calibration

1. Clean oily films or organic material from the cell electrodes with foaming cleaner or mild acid. Do not scrub inside the cell.

2. Calibrate with solutions close to the measurements you make. Readings are compensated for temperature based on the type of solution. If you choose to measure tap water with a KCl compensation, which is often done (ref. Temperature Compensation, pg. 15), and you calibrate with 442 solution because it is handy, the further away from 25°C you are, the more error you have. Your records of calibration changes will reflect temperature changes more than the instrument's accuracy.

3. Rinse out the cell with pure water after making measurements. Allowing crystals to form in the cell contaminates future samples.

VIII. CHANGING from CENTIGRADE to FAHRENHEIT

(Note: °F to °C is the reverse)

1. **Dry Instrument THOROUGHLY.**

2. Remove the 4 bottom screws and carefully open Instrument.

3. Locate dip switch labeled "TEMP COMP" on the right side of the circuit board. Note: Factory setting is degrees "C".

4. Set switch number **4** to the down position.

5. Carefully turn instrument over and press the COND/TDS key. The displayed reading will be in Fahrenheit "°F".

6. Replace bottom, ensuring the sealing gasket is installed in the groove of the top half of case. Tighten screws securely.

IX. CARE and MAINTENANCE

The AR1 should be rinsed with clean water after each use. Solvents should be avoided. Shock damage from a fall may cause instrument failure.

A. Temperature Extremes

Solutions in excess of 160°F/71°C should not be placed in the cell cup area; this may cause damage. Care should be exercised not to exceed rated operating temperature. Leaving the AR1 in a vehicle or storage shed on a hot day can easily subject the instrument to over 150°F. This will void the warranty.

B. Battery Replacement (LO BATT)

Dry Instrument THOROUGHLY. Remove the four bottom screws. Open instrument. Carefully detach battery from circuit board. Replace with 9 volt alkaline battery. Replace bottom, ensuring the sealing gasket is installed in the groove of the top half of case. Tighten screws evenly and securely. (Do NOT overtighten)

C. Cleaning Cell Cup

The cell cup should be kept as clean as possible. Flushing with clean water following use will prevent buildup on electrodes. However, if very dirty samples — particularly scaling types — are allowed to dry in the cell cup, a film will form. This film reduces accuracy. When there are visible films of oil, dirt, or scale in the cell cup or on the electrodes, use a foaming non-abrasive household cleaner. Rinse out the cleaner, and your AR1 is ready for accurate measurements.

X. TROUBLESHOOTING CHART

Symptom	Possible Cause	Corrective Action
No **display**, even though measurement key pressed.	Battery weak or not connected.	Check connections or replace battery. (ref. Battery Replacement, pg. 12).
Unstable **Conductivity** or **TDS** readings.	Film or deposits on electrodes.	Clean cell cup and electrodes. (ref. Cleaning Cell Cup, pg. 12)
Unable to calibrate **Conductivity** or **TDS**.	Film or deposits on electrodes.	Clean cell cup and electrodes (ref. Cleaning Cell Cup, pg. 12).

XI. ACCESSORIES

A. Conductivity/TDS Standard Solutions

Your AR1 has been factory calibrated with the appropriate Myron L Company NIST traceable standard solution. Most Myron L conductivity standard solution bottles show three values referenced at 25°C: Conductivity in microsiemens/micromhos and the ppm/TDS equivalents based on our 442 Natural Water™ and NaCl standards. All standards are within ±1.0% of reference solutions.

1. Potassium Chloride (KCl)

The concentrations of these reference solutions are calculated from data in the International Critical Tables, Vol. 6. The 1800 µS or 18,000 µS are the recommended standards. Order KCl-1800 or KCl-18,000.

2. 442 Natural Water™

442 Natural Water Standard Solutions are based on the following salt proportions: 40% sodium sulfate, 40% sodium bicarbonate, and 20% sodium chloride which represent the three predominant components "anions" in freshwater). This salt ratio has conductivity characteristics approximating fresh natural waters and was developed by the Myron L Company over three decades ago. It is used around the world for measuring both conductivity and TDS in drinking water, ground water, lakes, streams, etc. The 1500 ppm or 15,000 ppm are the recommended standards. Order 442-1500 or 442-15,000.

3. Sodium Chloride (NaCl)

This is especially useful in sea water mix applications, as sodium chloride is its major salt component. Most Myron L standard solution labels show the ppm NaCl equivalent to the conductivity and to ppm 442 values. The 14.0 mS is the recommended standard. Order NaCl-14.0.

B. Soft Protective Case

Padded Cordura® Nylon carrying case features a belt clip for hands-free mobility. Order Model: UCC

® Registered trade mark of DuPont

C. pH Buffer Solutions

For your Myron L pH instruments; pH buffers are available in pH values of 4, 7 and 10. Myron L Company buffer solutions are traceable to NIST certified pH references and are color-coded for instant identification. They are also mold inhibited and accurate to within ±0.01 pH units @ 25°C. Order 4, 7 or 10 buffer.

XII. TEMPERATURE COMPENSATION (Tempco) of Aqueous Solutions

Electrical conductivity indicates solution concentration and ionization of the dissolved material. Since temperature greatly affects ionization, conductivity measurements are temperature dependent and are normally corrected to read what they would be at 25°C.

A. Standardized to 25°C

Conductivity is very accurately measured in the AR1 by a method that ignores fill level, electrolysis, electrode characteristics, etc., and uses a unique circuit to perform temperature compensation. In simpler instruments, conductivity values are usually assigned an average correction similar to KCl solutions for correction to 25°C. The correction to an equivalent KCl solution is a standard set by chemists. It standardizes the measurements and allows calibration with precise KCl solutions recognized for stability. In the AR1, this correction can be set to either KCl, NaCl or 442 to best match your applications.

B. Tempco Variation

Most conductivity instruments use an approximation of the temperature characteristics of solutions, perhaps even assuming a constant value. The value for KCl is often quoted simply as 2%/°C. In fact, KCl tempco

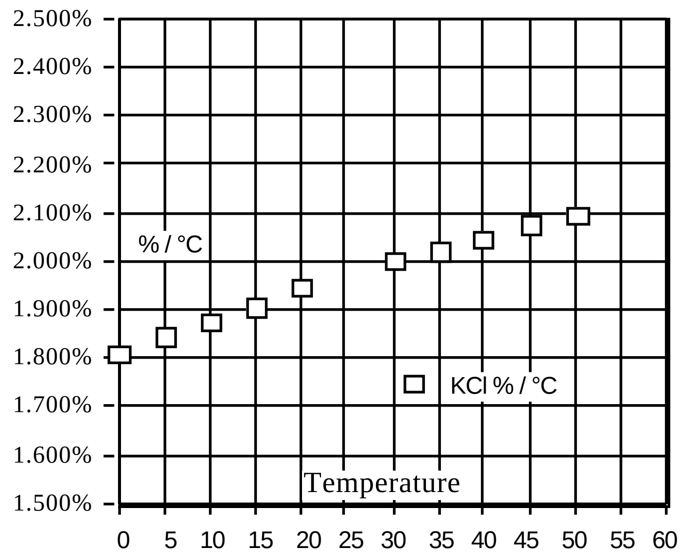

Chart 1

varies with concentration and temperature in a non-linear fashion. Other solutions have more variation still. The AR1 uses corrections that change with concentration and temperature instead of single average values.

C. An Example of 2 different solution selections and the resulting compensation:

How much error results from treating natural water as if it were KCl at 15°C?

A tap water solution should be compensated as 442 with a tempco of 1.68 %/°C, where the KCl value used would be 1.90 %/°C.

Suppose a measurement at 15°C (or 59°F) is 900 microsiemens of true uncompensated conductivity.

Using a 442 correction of 10 (degrees below 25) x 1.68% indicates the solution is reading 16.8% low. For correction, dividing by (.832) yields 1082 microsiemens as a compensated reading.

A KCl correction of 10 (degrees below 25) x 1.9% indicates the solution is reading 19% low. Dividing by (.81) yields 1111 microsiemens for a compensated reading. The difference is 29 out of 1082 = 2.7%.

D. A Chart of Comparative Error

In the range of 1000 µS, the error using KCl on a solution that should be compensated as NaCl or as 442, is shown in the graph below.

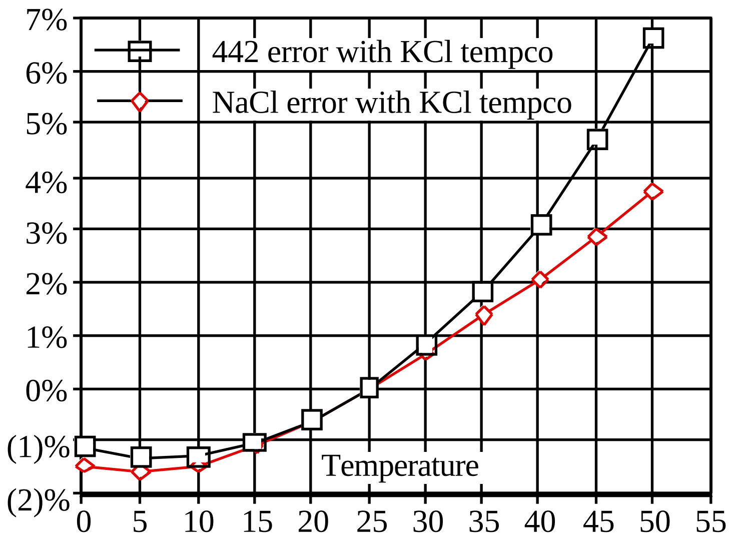

Chart 2

Users wanting to measure natural water based solutions to 1% would have to alter the internal compensation to the more suitable preloaded “442” values or stay close to 25°C. Some who have standardized to KCl based compensation may want to stick with it, regardless of increasing error as you get further from 25°C. The AR1 will provide the repeatability and convertibility of data needed for relative values for process control.

E. Other Solutions

A salt solution like sea water or liquid fertilizer acts like NaCl. An internal correction for NaCl can be selected for greatest accuracy with such solutions. Many solutions are not at all similar to KCl, NaCl or 442. A sugar solution, or a silicate, or a calcium salt at a high or low temperature may require a value peculiar to the application to provide readings close to the true compensated conductivity.

Clearly, the solution characteristics should be chosen to truly represent the actual water under test for rated accuracy of ±1% of full scale. Many industrial applications have always been relative measurements seeking a number to indicate a certain setpoint or minimum concentration or trend. The AR1 gives the user the capability to take data in “KCl conductivity units” to compare to older published data, as in terms of NaCl or 442, or as may be appropriate.

XIII. CONDUCTIVITY CONVERSION to TOTAL DISSOLVED SOLIDS (TDS)

Electrical conductivity indicates solution concentration and ionization of the dissolved material. Since temperature greatly affects ionization, conductivity measurements are temperature dependent and are normally corrected to read what they would be at 25°C (ref. Temperature Compensation, pg. 15).

A. How it’s Done

Once the effect of temperature is removed, the compensated conductivity is a function of the concentration (TDS). Temperature compensation of the conductivity of a solution is performed automatically by the internal processor, using data derived from chemical tables. Any dissolved salt at a known temperature has a known ratio of conductivity to concentration. Tables of conversion ratios referenced to 25°C have been published by chemists for decades.

B. Solution Characteristics

Real world applications have to measure a wide range of materials and mixtures of electrolyte solutions. To solve this problem, industrial users commonly use the characteristics of a standard material as a model for their solution, like the KCl favored by chemists for its stability.

Users dealing with sea water, etc., use NaCl as the model for their concentration calculations. Users dealing with freshwater work with mixtures including sulfates, carbonates and chlorides, the three predominant components (anions) in freshwater that Myron L Company calls “natural water”. These are modeled in a mixture called “442” which the Myron L Company markets for use as a calibration standard, as it does standard KCl and NaCl solutions.

C. <u>When does it make a lot of difference?</u>

First, the accuracy of temperature compensation to 25°C determines the accuracy of any TDS conversion. Assume we have industrial process water to be pretreated by R.O. Assume it is 45°C and reads 1500 µS uncompensated.

1. If NaCl compensation is used, an instrument would report 1035 µS compensated, which corresponds to 510 ppm NaCl.

2. If 442 compensation is used, an instrument would report 1024 µS compensated, which corresponds to 713 ppm 442.

The difference in values is 40%.

In spite of such large error, some users will continue to take data in the NaCl mode because their previous data gathering and process monitoring was done with an older NaCl referenced device.

Those who want true TDS readings that will correspond to evaporated weight will select the correct solution type.

The AR1 contains circuitry for the 3 most commonly referenced compounds — KCl, NaCl and 442. In the LCD display, the solution type being used is shown on the left.

XIV. TEMPERATURE COMPENSATION (Tempco) and TDS DERIVATION

When making conductivity measurements, the Solution Selection determines the characteristic assumed as the instrument reports what a measured conductivity would be if it were at 25°C. The characteristic is represented by the tempco, expressed in %/°C. If a solution of 100 µS at 25°C increases to 122 µS at 35°C, then a 22% increase has happened over this change of 10°C. The solution is said to have a tempco of 2.2 %/°C.

Another solution would have a different tempco because of its ionization activity. And, that tempco may be a little different at a different concentration or temperature. This is why the AR1 uses mathematically generated models for known salt characteristics that vary with concentration and temperature.

The AR1 contains circuitry for characteristics of the 3 most commonly referenced compounds — KCl, NaCl and 442. In the display, the solution type being used is shown on the left.

XV. GLOSSARY

Anions - Negatively charged ions.
See Solution Characteristics, pg. 17.

Algorithm - A procedure for solving a mathematical problem.
See Temperature Compensation and TDS Derivation, pg. 18.

TDS - Total Dissolved Solids or the Total Conductive Ions in a solution. See Conductivity Conversion to TDS, pg. 17.

Tempco - Temperature Compensation
See Temperature Compensation, pg. 15.

For details on specific areas of interest refer to Table of Contents.

NOTES