ISE-8900 and ISE 8902

Water Hardness Electrodes

OMEGA®

An OMEGA Technologies Company

Operator's Manual

OMEGA®

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Notes

1 General Instructions

1.1 Introduction

The OMEGA® Water Hardness Electrodes are used to quickly, simply, accurately, and economically measure water hardness (total calcium plus magnesium) in aqueous solutions.

1.2 Required Equipment

1. A pH/mV meter or an ion meter, either line operated or portable.
2. Semi-logarithmic, four-cycle graph paper for preparing calibration curves when using the meter in the mV mode.
3. A magnetic stirrer.
4. The OMEGA® Water Hardness Electrode, Catalog No. ISE-8900 (reference electrode necessary), or the OMEGA Water Hardness Combination Glass Electrode, Catalog No. ISE-8902.
5. The OMEGA® Single Junction Reference Electrode (for use with the ISE-8900) with OMEGA® Filling Solution, Catalog No. PHFS-KCl, in the reference junction.

1.3 Required Solutions

1. Deionized or distilled water for solution and standard preparation.
2. ISE-8900-S1 Water Hardness Standard, 0.1 M $CaCl_2$. To prepare this standard, add 14.7 grams of reagent-grade calcium chloride ($CaCl_2 \cdot 2H_2O$) to a one-liter volumetric flask about half full of distilled water. Swirl the flask to dissolve the solid and fill to the mark with distilled water. Cap the flask and invert several times to mix the solution.
3. ISE-8900-S2 Water Hardness Standard, 1000 ppm Ca^{+2}. To prepare this standard, add 3.67 grams of reagent-grade calcium chloride ($CaCl_2 \cdot 2H_2O$) to a 1 liter volumetric flask about half full of distilled water. Swirl the flask to dissolve the solid and fill to the mark with distilled water. Cap the flask and invert several times to mix the solution.
4. ISE-8900-S3 Water Hardness Standard, 100 ppm Ca^{+2} as $CaCO_3$. To prepare a 100-ppm stock solution, add 0.15 gram of reagent-grade calcium chloride ($CaCl_2 \cdot 2H_2O$) to a one-liter volumetric flask about half full of distilled water. Swirl the flask to dissolve the solid and fill to the mark with distilled water. Cap the flask and invert several times to mix the solution.
5. ISE-8900-R1 Ionic Strength Adjuster, 4 M KCl. To prepare the ISA, add 298 grams of reagent-grade potassium chloride (KCl) to a 1000-mL volumetric flask about half full of distilled water. Swirl the flask to dissolve the solid and fill to the mark with distilled water. Cap the flask and invert several times to mix the solution.

6. Acid pH Adjustment Solution, 1 M HCl. To prepare a 1 M HCl solution, add 86 mL of concentrated hydrochloric acid to a one-liter volumetric flask containing about 500–600 mL of deionized water, swirl the flask to mix the contents, and add water to the mark. Cap the flask and upend it several times to thoroughly mix the contents.
7. Alkaline pH Adjustment Solution, 1 M NaOH. To prepare a 1 M NaOH solution, add 40 grams of sodium hydroxide pellets to a one-liter volumetric flask containing about 500–600 mL of deionized water, swirl the flask to dissolve the solid, and add water to the mark. Cap the flask and upend it several times to thoroughly mix the contents.

2

General Presentation

2.1 Electrode Preparation

Remove the rubber cap(s) covering the electrode tip(s) and the rubber insert covering the filling hole of the reference electrode. Fill the combination electrode or the reference electrode with the filling solution shipped with the electrode to a level just below the fill hole. No preparation is required with a sealed reference electrode. Gently shake the electrode downward in the same manner as a clinical thermometer to remove any air bubbles that might be trapped behind the water hardness membrane.

Prior to first usage or after long-term storage, immerse the water hardness membrane in water hardness standard for 30 minutes. The electrode is now ready for use. Connect the electrode(s) to the proper terminal(s) as recommended by the meter manufacturer.

2.2 Electrode Slope Check With a pH/mV meter

Check electrodes each day.

To a 150-mL beaker, add 100 mL of distilled water. Place the beaker on a magnetic stirrer and begin stirring at a constant rate. After ensuring that the meter is in the mV mode, lower the electrode tip(s) into the solution. If drifting or instability is observed, see the Troubleshooting section.

Using a pipet, add 1 mL of 0.1 M, 1000-ppm, or 100-ppm (as calcium carbonate) standard and 2 mL of ISA to the beaker. When the reading is stable, record the millivolt reading.

Using a pipet, add 10 mL of the same calcium standard used above to the beaker. When the reading has stabilized, record the millivolt reading.

Determine the difference between the two readings. A difference of 25±2 mV indicates correct electrode operation, assuming the solution temperature is between 20 and 25°C. See the Troubleshooting section if the potential change is not within this range.

Slope is defined as the change in potential observed when the concentration changes by a factor of 10.

2.3 Electrode Slope Check With an Ion Meter

Check electrodes each day.

Prepare two standard calcium solutions whose concentrations vary by tenfold. Use either the 0.1 M Ca^{+2}, 1000 ppm Ca^{+2}, or the 100 ppm Ca^{+2} (as calcium carbonate) standard stock solutions. Use the serial dilution method for this preparation.

To a 150-mL beaker, add 100 mL of the lower value standard and 2 mL of ISA. Place the beaker on the magnetic stirrer and begin stirring at a constant rate. Lower the electrode tip(s) into the solution. Ensure that the meter is in the concentration mode.

Adjust the meter to the concentration of the standard and fix the value in the memory according to the meter manufacturer's instructions.

Rinse the electrode(s) with distilled water and blot dry.

To a 150-mL beaker, add 100 mL of the higher value standard and 2 mL of ISA. Place the beaker on the magnetic stirrer and begin stirring at a constant rate. Lower the electrode tip(s) into the solution.

Adjust the meter to the concentration of the standard and fix the value in the memory.

Read the electrode slope according to the meter manufacturer's instructions. Correct electrode operation is indicated by a slope of 90–100%. See the Troubleshooting section if the slope is not within this range.

3 Measurement

3.1 Measuring Hints

The sensing membrane is normally subject to water uptake and might appear milky. This has no effect on performance. All samples and standards should be at the same temperature for precise measurement, preferably ambient temperature.

Constant, but not violent, stirring is necessary for accurate measurement. Magnetic stirrers can generate sufficient heat to change the solution temperature. To counteract this effect, place a piece of insulating material, such as a styrofoam sheet, between the stirrer and beaker.

Always rinse the electrode tip(s) with distilled water and blot dry with a fresh tissue between readings to prevent solution carryover. Do not wipe or rub the sensing membrane.

Check the electrode for air bubbles adhering to the membrane surface after immersion in solution. Agitate the electrode gently to remove the air bubbles.

A slow or sluggish electrode response may indicate surface contamination of the membrane. Soak the electrode tip in distilled water for about five minutes to clean the membrane. Rinse the membrane and soak in diluted standard solution for about five minutes to restore performance.

When measuring samples with high ionic strength, prepare standards with compositions similar to that of the sample. Dilute concentrated samples (over 0.1 M) before measurement. Recalibrate every few hours for routine measurement.

3.2 Sample Requirements

Make sure that the samples and standards are at the same temperature. An error of approximately 4% will be introduced for a 1°C difference in temperature at the 1.0×10^{-3} M level. Temperature should be less than 40°C.

All samples and standards must be aqueous. They must not contain organic solvents.

Adjust the sample solution to between pH 5–10 with NaOH or HCl. Interferences found in Table 1 should be absent.

Table 1. Concentration of Possible Interferences Causing a 10% Error at Various Levels of Calcium and/or Magnesium

Interferences (mole/liter)	10^{-2} M	10^{-3} M	10^{-4} M
Zn^{+2}	3.0×10^{-4}	3.0×10^{-5}	3.0×10^{-6}
Ba^{+2}	6.0×10^{-3}	6.0×10^{-4}	6.0×10^{-5}
K^{+1}	3.0×10^{-1}	1.0×10^{-1}	3.0×10^{-2}
Na^{+1}	8.0×10^{-2}	3.0×10^{-2}	8.0×10^{-3}
Ni^{+2}	1.0×10^{-3}	1.0×10^{-4}	1.0×10^{-5}
Cu^{+2}	3.0×10^{-4}	3.0×10^{-5}	3.0×10^{-6}
Fe^{+2}	6.0×10^{-4}	6.0×10^{-5}	6.0×10^{-6}
Sr^{+2}	4.0×10^{-3}	4.0×10^{-4}	4.0×10^{-5}

3.3 Units of Measurement

Water hardness concentrations are measured in units of parts per million as calcium, parts per million as $CaCO_3$, grains of hardness, moles per liter, or any other convenient concentration unit. Table 2 indicates some of the concentration units.

Table 2. Concentration Unit Conversion Factors

ppm Ca^{+2}	ppm $CaCO_3$	Moles/liter Ca^{+2}	Grains/gal
4.01	10.0	1.0×10^{-4}	0.6
10.00	24.9	2.5×10^{-4}	1.4
70.60	176.0	1.8×10^{-3}	10.0

4 Measurement Procedure

4.1 Direct Measurement

Direct measurement is a simple procedure for measuring a large number of samples. A single meter reading is all that is required for each sample. The temperature of both the sample solution and the standard solutions should be the same.

Total calcium plus magnesium ion concentration is determined using the OMEGA® Water Hardness Electrodes (ISE-8900 and ISE-8902). The OMEGA® Calcium Electrodes (ISE-8740 and ISE-8742) measure calcium, but not magnesium ion concentrations.

4.1.1 Direct Measurement of Water Hardness Using a pH/mV meter

1. By serial dilution of the 0.1 M, 1000-ppm, or 100-ppm standard, prepare 10^{-2}, 10^{-3}, and 10^{-4} M or 100-, 10- and 1-ppm standards. Measure out 100 mL of each standard into individual 150-mL beakers. Add 2 mL of ISA to every 100 mL of sample or standard.
2. Place the most dilute solution (1.0×10^{-4} M or 1 ppm) on the magnetic stirrer and begin stirring at a constant rate. After ensuring that the meter is in the mV mode, lower the electrode tip(s) into the solution. When the reading has stabilized, record the mV reading.
3. Place the mid-range solution (1.0×10^{-3} M or 10 ppm) on the magnetic stirrer and begin stirring. After rinsing the electrode(s) with distilled water, blot dry and immerse the electrode tip(s) in the solution. When the reading has stabilized, record the mV reading.
4. Place the most concentrated solution (1.0×10^{-2} M or 100 ppm) on the magnetic stirrer and begin stirring. After rinsing the electrode(s) with distilled water, blot dry and immerse the electrode tip(s) in the solution. When the reading has stabilized, record the mV reading.
5. Using the semi-logarithmic graph paper, plot the mV reading (linear axis) against the concentration (log axis). A typical calibration curve can be found in Figure 1.

   A calibration curve is constructed on semilogarithmic paper when using a pH/mV meter in the direct measurement procedure. The measured electrode potential in mV (linear axis) is plotted against the standard concentration (log axis). In the linear region of the curve, only three standards are necessary to determine a calibration curve. In the non-linear region, additional points must be measured. The direct measurement procedures given are for the linear portion of the curve. The non-linear portion of the curve requires the use of low level procedures.

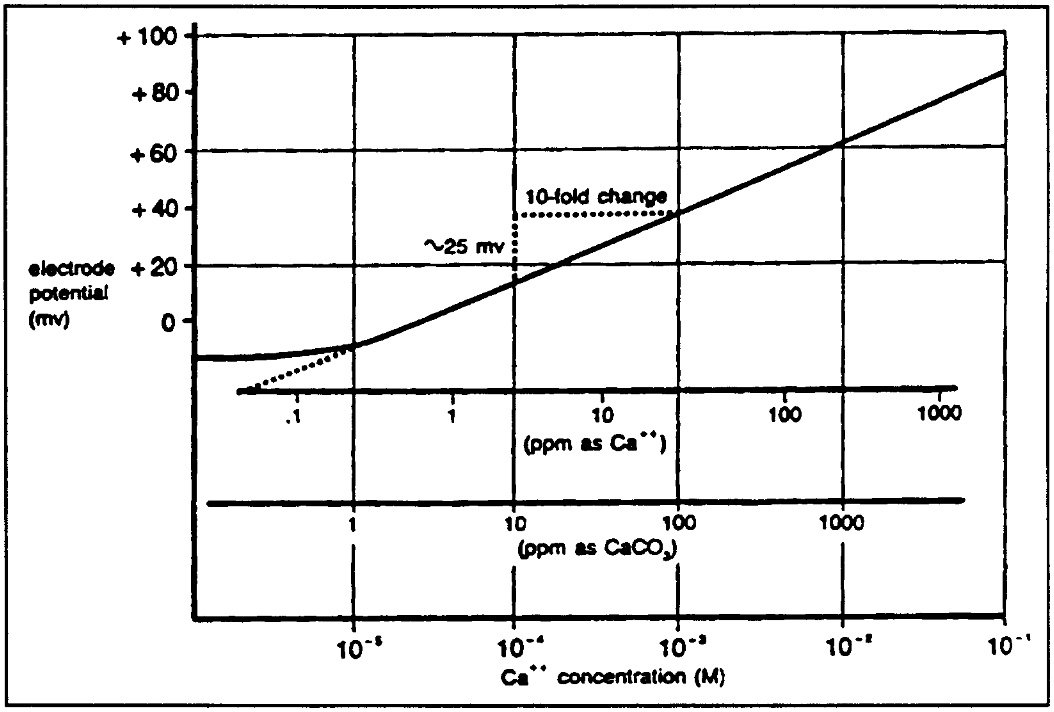

Figure 1. Typical Water Hardness Electrode Calibration Curve

6. To a clean, dry 150-mL beaker, add 100 mL of sample and 2 mL of ISA. Place the beaker on the magnetic stirrer and begin stirring. Place the electrode tip(s) in the solution. When the reading has stabilized, record the millivolt reading. Determine the concentration directly from the calibration curve.
7. The electrode(s) should be re-calibrated every one to two hours. Simply repeat Steps 2–5 above.

4.1.2 Direct Measurement of Water Hardness Using an Ion Meter

1. By serial dilution of the 0.1 M, 1000-ppm, or 100-ppm calcium standard, prepare two calcium standards with concentrations near the expected sample concentration. Measure out 100 mL of each standard into individual 150-mL beakers. Add 2 mL of ISA to each standard or sample.
2. Place the more dilute solution on the magnetic stirrer and begin stirring at a constant rate. Ensure that the meter is in the concentration mode.
3. Lower the electrode tip(s) into the solution.
4. Adjust the meter to the concentration of the calcium standard and fix the value in the memory according to the meter manufacturer's instructions after stabilization of the reading.
5. Rinse the electrode tip(s) with distilled water and blot dry.

6. Place the more concentrated solution on the magnetic stirrer and begin stirring at a constant rate.
7. Lower the electrode tip(s) into the solution.
8. Adjust the meter to the concentration of the calcium standard and fix the value in the memory according to the meter manufacturer's instructions after stabilization of the reading.
9. For low-level measurements, place the rinsed, dried electrode(s) into a solution containing 100 mL of distilled water and 2 mL of ISA. After stabilization, fix the blank value in the meter according to the meter manufacturer's instructions.
10. Place 100 mL of the sample and 2 mL of ISA in a 150-mL beaker, place it on the magnetic stirrer, and begin stirring.
11. Immerse the electrode tip(s) in the solution and wait for the reading to stabilize. Read the concentration directly from the meter display.
12. The electrode(s) should be re-calibrated every one to two hours. Simply repeat Steps 2–8 (9) above.

4.2 Low-Level Water Hardness Determination

4.2.1 Low-Level Water Hardness Determination Using a pH/mV Meter

This procedure is recommended for solutions with ionic strengths less than 1.0×10^{-2} M. If the solution is high in ionic strength, but low in calcium and magnesium, use the same procedure, but prepare a calibration solution with a composition similar to the sample.

1. Dilute 10 mL of the 0.1 M standard to 1000 mL to prepare a 1.0×10^{-3} M standard solution for measurements in moles per liter. Dilute 10 mL of the 1000-ppm or 1 mL of the 100-ppm standard to 1000 mL to prepare a 10-ppm standard solution for measurements in ppm.
2. Soak the water hardness electrode for at least one hour in 1.0×10^{-3} M or 100-ppm calcium standard solution.
3. To a 150-mL beaker, add 100 mL of distilled water. Place the beaker on the magnetic stirrer and begin stirring at a constant rate.
4. Place the electrode tip(s) in the solution. Ensure that the meter is in the mV mode.
5. Add increments of the 1.0×10^{-3} M or 10 ppm standard as given in Table 3 below.

Table 3. Step-wise Calibration for Low-Level Water Hardness Measurements

Step	Pipet	Added Volume (mL)	Concentration M	Concentration ppm
1	A	0.1	1.0×10^{-6}	1.0×10^{-2}
2	A	0.1	2.0×10^{-6}	2.0×10^{-2}
3	A	0.2	4.0×10^{-6}	4.0×10^{-2}
4	A	0.2	6.0×10^{-6}	6.0×10^{-2}
5	A	0.4	9.9×10^{-6}	1.0×10^{-1}
6	B	2	2.9×10^{-5}	2.9×10^{-1}
7	B	2	4.8×10^{-5}	4.8×10^{-1}

Pipet A = 1 mL graduated pipet
Pipet B = 2 mL pipet
Solutions: Additions of 1.0×10^{-3} M or 10-ppm standard to 100 mL of distilled water.

6. After the reading has stabilized, record the mV reading after each addition.
7. On semi-logarithmic graph paper, plot the mV reading (linear axis) against the concentration (log axis) as in Figure 1.
8. Rinse the electrode(s) in distilled water and blot dry.
9. Measure out 100 mL of the sample into a 150-mL beaker and place the beaker on the magnetic stirrer. Begin stirring. Lower the electrode tip(s) into the solution.
10. After the reading has stabilized, record the mV reading and determine the concentration from the low level calibration curve.
11. Prepare a new low level calibration curve daily. Check the calibration curve every one to two hours by repeating Steps 3-7 above.

4.2.2 Low-Level Water Hardness Determination Using an Ion Meter

Follow the procedure given for normal water hardness determinations using an ion meter and the blank correction procedure.

5 Electrode Characteristics

5.1 Reproducibility

Direct electrode measurements reproducible to ±4% can be obtained if the electrode is calibrated every hour. Such factors as temperature fluctuations, drift, and noise will limit reproducibility. Reproducibility is independent of concentration within the electrode's operating range.

5.2 Interferences

Some common cations, if present in high enough levels (refer to Table 3), will cause electrode interferences and measurement errors or electrode drift when using the water hardness electrodes. Electrode drift and slow response could indicate the presence of high interferences from the ions listed. Soak the electrode in distilled water for five minutes, then for five minutes in calcium standard solution to restore proper response.

5.3 Complexation

Sulfate, bicarbonate, and carbonate are the most common species that complex calcium and/or magnesium ions. The level of calcium/magnesium ions, the level of the complexing ion, the pH of the solution, and the total ionic strength of the solution determine the extent of the complexation. Complexation reduces the free calcium/magnesium ion concentration, and since the electrode responds only to free calcium/magnesium ions, a false reading results.

5.4 Temperature Influences

Samples and standards should be at the same temperature, since electrode potentials are influenced by changes in temperature. A 1°C difference in temperature results in a 4% error at the 1.0×10^{-3} level.

Provided that temperature equilibria has occurred, the water hardness electrodes can be used at temperatures from 0–40°C. Room temperature measurements are recommended, since measurements at temperatures quite different from room temperature may require equilibrium times up to one hour. Table 4 indicates the variation of theoretical slope with temperature.

Table 4. Temperature vs. Value for the Electrode Slope

Temp (°C)	"S"
0	27.10
10	28.10
20	29.08
25	29.58
30	30.07
40	31.07

5.5 Electrode Response

Plotting the electrode mV potential against the calcium/magnesium concentration on semi-logarithmic paper results in a straight line with a slope of about 25 mV per decade. (Refer to Figure 1.)

The time needed to reach 99% of the stable electrode potential reading (the electrode response time) varies from one minute or less for calcium/magnesium concentration above 1.0 x 10^{-4} M to several minutes near the detection limit. (Refer to Figure 2.)

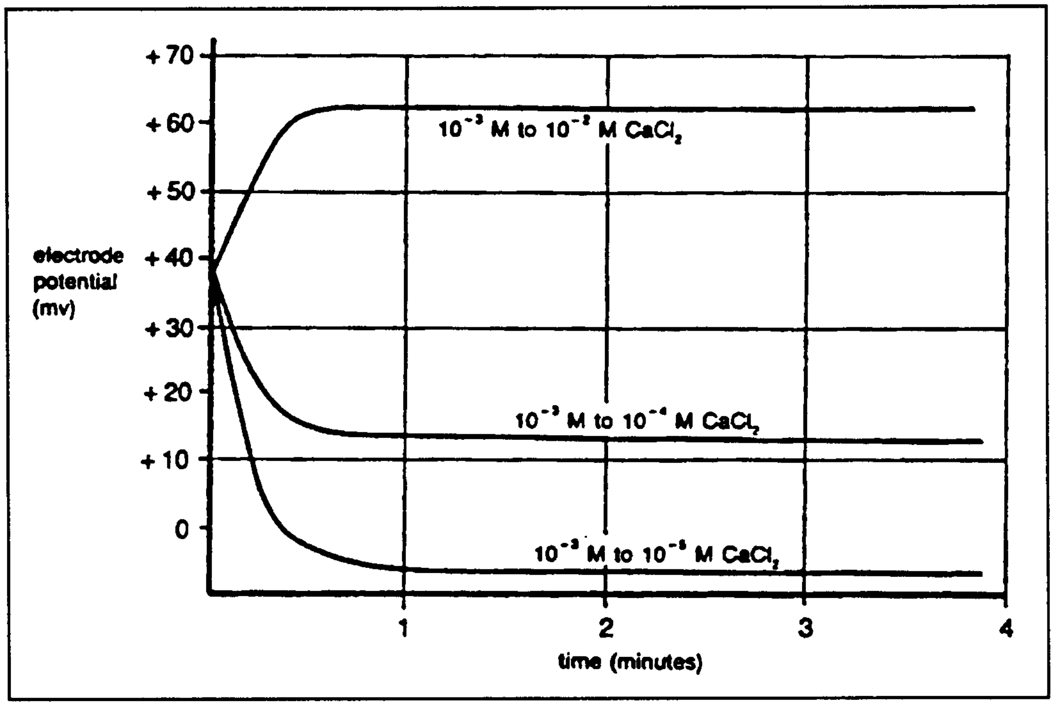

Figure 2. Typical Electrode Time Response to Step Changes in $CaCl_2$

5.6 Limits of Detection

The upper limit of detection is 1 M in pure calcium/magnesium chloride solutions. The upper limit of detection is above 1.0 x 10^{-1} M when other ions are present, but the possibility of a liquid junction potential developing at the reference electrode and the "salt extraction effect" are two limiting factors. Some salts may be extracted into the electrode membrane at high salt concentrations, causing deviation from theoretical response. Calibrate the electrode at four or five intermediate points or dilute the sample to measure samples between 1.0 x 10^{-1} M and 1 M.

The slight water solubility of the ion exchanger in the sensing module, which causes deviation from theoretical response, determines the lower limit of detection. The theoretical response at low levels of calcium/magnesium chloride compared to actual response was shown in Figure 1.

To avoid the formation of $CaSO_4$ and $MgSO_4$, the sulfate concentrations must be less than 5×10^{-4} M (50 ppm). To avoid the formation of $CaCO_3$ or the $CaHCO_3$ complex, the pH of the solution should be less than 7, and the total carbonate/bicarbonate concentration should be less than 3×10^{-3} M (280 ppm carbonate).

5.7 pH Effects

The water hardness electrode has an operating pH range of 5–10. Use at other pH values can adversely affect the membrane. Hydrogen ion interferes with measurements of low levels of calcium/magnesium. Hydroxide ion will complex calcium and/or magnesium ions.

5.8 Electrode Life

The water hardness electrode will last six months in normal laboratory use. On-line measurement might shorten operational lifetime to several months. In time, the response time will increase, and the calibration slope will decrease to the point at which calibration is difficult and electrode replacement is required.

5.9 Electrode Storage

The OMEGA® Water Hardness Electrodes may be stored in 1.0×10^{-2} M calcium standard for short periods of time. For storage over two weeks, rinse and dry the water hardness membrane and cover the tip with any protective cap shipped with the electrode(s). The reference portion of the combination electrode (or the outer chamber of the reference electrode) should be drained of filling solution, if refillable, and the rubber insert should be placed over the filling hole.

Notes

6 Electrode Theory and Operation

The OMEGA® Water Hardness Electrode consists of an electrode body containing an ion exchanger in a sensing module. This sensing module contains a liquid internal filling solution, in contact with a gelled organophilic membrane containing a calcium/magnesium selective ion exchanger.

An electrode potential develops across the membrane when the membrane is in contact with a calcium/magnesium solution. Measurement of this potential against a constant reference potential with a digital pH/mV meter or with a specific ion meter depends on the level of free calcium and magnesium ion in solution.

The level of calcium and magnesium ions, corresponding to the measured potential, is described by the Nernst equation:

$$E = E_o + S \log X$$

where:

E = measured electrode potential
E_o = reference potential (a constant)
S = electrode slope (~26 mV/decade)
X = level of calcium and magnesium ions in solution

The activity (X) represents the effective concentration of the ions in solution. Total calcium/magnesium concentration (C_t) includes free calcium/magnesium ions, (C_f) plus bound or complexed calcium/magnesium ions (C_b). Since the water hardness electrodes only respond to free ion, the free ion concentration is:

$$C_f = C_t - C_b$$

The activity is related to the free ion concentration (C) by the activity coefficient (γ) by:

$$X = \gamma C_f$$

Activity coefficients vary, depending on total ionic strength (I) defined as:

$$I = 1/2 \Sigma C_x Z_x^2$$

where:

C_x = concentration of ion X
Z_x = charge on ion X
Σ = sum of all of the types of ions in the solution

In the case of high and constant ionic strength relative to the sensed ion concentration, the activity coefficient (γ) is constant and the activity (X) is directly proportional to the concentration.

To adjust the background ionic strength to a high and constant value, ionic strength adjustor (ISA) is added to samples and standards. The recommended ISA for water hardness is potassium chloride (KCl). Solutions other than this may be used as long as ions they contain do not interfere with the electrode's response to calcium/magnesium ions.

The reference electrode must also be considered. When two solutions of different composition are brought into contact with one another, liquid junction potentials arise. Millivolt potentials occur from the interdiffusion of ions into the two solutions. Electrode charge will be carried unequally across the solution boundary, resulting in a potential difference between the two solutions, since ions diffuse at different rates. When making measurements, it is important to remember that this potential be the same when the reference is in the standardizing solution, as well as in the sample solution, or the change in liquid junction potential will appear as an error in the measured electrode potential.

The composition of the liquid junction filling solution in the reference electrode is most important. The speed with which the positive and negative ions in the filling solution diffuse into the sample should be equitransferant. No junction potential can result if the rate at which positive and negative charge carried into the sample is equal.

7 Troubleshooting Guide

The goal of troubleshooting is the isolation of a problem through the checking of each of the system components in turn: the meter, the glassware, the electrode(s), the standards and reagents, the sample, and the technique.

7.1 Meter

The meter may be checked by following the instrument checkout procedure in the instruction manual.

7.2 Glassware

Clean glassware will drain clean. That is, when rinsed with distilled or deionized water, the water does not bead on the inside walls of the glassware.

7.3 Electrodes

The electrodes may be checked by using the procedure found in the sections on Electrode Slope Check.

1. Be sure to use distilled or deionized water when following the procedures given in Electrode Slope Check.
2. If the electrode fails to respond as expected, see the section Measuring Hints. Repeat the slope check.
3. If the electrode(s) still fail to respond as expected, substitute another water hardness electrode that is known to be in good working order for the questionable electrode. If the problem persists and you are using an electrode pair, try the same routine with a working reference electrode.
4. If the problem persists, the standards and/or reagents may be of poor quality, interferences in the sample may be present or the technique may be faulty. (Refer to the Standards and Reagents, Sample, and Technique sections.)
5. If another electrode is not available for test purposes, or if the electrode in use is suspect, review the instruction manual and be sure to:
    - Clean and rinse the electrode(s) thoroughly.
    - Prepare the electrode(s) properly.
    - Use the proper filling solution.
    - Adjust the pH of the solution according to the method being used for the analysis.
    - Measure correctly and accurately.
    - Review the Troubleshooting Hints.

7.4 Standards and Reagents

Whenever problems arise with the measuring procedure that has been used successfully in the past, be sure to check the standard and reagent solutions. If in doubt about the credibility of any of the solutions, prepare them again. Errors may result from contamination of the acid/base used to adjust the pH, incorrect dilution of standards, poor quality distilled/deionized water, or a simple mathematical miscalculation.

7.5 Sample

Look for possible interferences, complexing agents, or substances that could affect the response or physically damage the sensing electrode (or the reference electrode) if the electrode(s) work perfectly in the standard, but not in the sample.

Try to determine the composition of the samples prior to testing to eliminate a problem before it starts. (See Measuring Hints, Sample Requirements, and Interferences.)

7.6 Technique

Be sure that the electrode's limit of detection has not been exceeded. Be sure that the analysis method is clearly understood and is compatible with the sample.

Refer to the instruction manual again. Reread the General Preparation and Electrode Characteristics sections.

If trouble still persists, call OMEGA Engineering Inc. at (203) 359-1660.

7.7 Troubleshooting Hints

Symptom	Possible Causes	Next Step
Out of Range Reading	Defective meter	Check meter with shorting strap (see meter instruction manual)
	Electrode(s) not plugged in properly	Unplug electrode(s) and reseat
	Reference electrode not filled	Be sure reference electrode is filled
	Air bubble on membrane	Remove bubble by redipping electrode
	Electrodes not in solution	Put electrode(s) in solution

Symptom	Possible Causes	Next Step
"Incorrect Answer" (but calibration curve is good)	Incorrect scaling of semi-log paper	Plot millivolts on the linear axis. On the log axis, be sure that the concentration numbers within each decade are increasing with increasing concentration
	Incorrect sign	Be sure to note sign of millivolt number correctly
	Incorrect standards	Prepare fresh standards
	Wrong units used	Apply correct conversion factor: 1.0×10^{-3} M = 40 ppm Ca^{+2} = 100 ppm as $CaCO_3$
	Sample carryover	Rinse electrodes thoroughly between samples
Drift (reading slowly changing in one direction)	Samples/standards at different temperatures	Allow solutions to come to room temperature before measure
	Electrode exposed to interferences	Soak electrode in calcium standard
	Incorrect reference filling solution	Use recommended filling solution
	Incorrect pH	Adjust to pH 5–10 with NaOH or HCl
Low Slope or No Slope	Standards contaminated or incorrectly made	Prepare fresh standards
	Defective electrode	Check electrode operation
	Air bubbles on membrane	Remove bubbles by re-dipping electrode
	Electrode exposed to interferences	Soak electrode in calcium standard
	Standard used as ISA	Use ISA

Symptom	Possible Causes	Next Step
Noisy/Unstable Readings (readings continuously or randomly changing	Defective meter	Check meter with shorting strap
	Air bubble on membrane	Remove bubble by re-dipping electrode
	Meter or stirrer not grounded	Ground meter or stirrer
	Outer filling solution too low	Fill electrode to level just below fill hole
	Defective electrode	Replace electrode
	Electrode exposed to interferences	Soak electrode in water hardness standard

8 Specifications and Ordering Information

Specifications

Concentration Range:	1 M to 1 x 10^{-5} M
pH Range:	5–10
Temperature Range:	0–40°C
Resistance:	100 Ω ohms
Reproducibility:	±4%
Samples:	Aqueous solutions only; no organic solvents
Size:	110 mm length 12 mm diameter 1 m cable length
Storage:	Electrode should be stored in dilute water hardness standard

Specifications subject to change without notice

Ordering Information

Part Number	Description
ISE-8900	Water Hardness Electrode, mono (reference electrode necessary), PVC body
ISE-8902	Water Hardness Electrode, combination, glass body
PHE-3111	Reference Electrode, single junction, epoxy body, for use with the ISE-8900
ISE-8900-S1	Water Hardness Standard, 0.1 M $CaCl_2$
ISE-8900-S2	Water Hardness Standard, 1000-ppm Ca^{+2}
ISE-8900-S3	Water Hardness Standard, 100-ppm Ca^{+2} as $CaCO_3$
ISE-8900-R1	Water Hardness ISA (Ionic Strength Adjuster), 4 M KCl
PHFS-KCL	Reference Electrode Filling Solution and Combination Electrode Filling Solution, 4 M KCl (saturated with AgCl)
PHFS-4MKCL	Combination Electrode Filling Solution, 4 M KCl

Notes

Notes

WARRANTY/DISCLAIMER

OMEGA is glad to offer suggestions on the use of our various products. Nevertheless, OMEGA only warrants that the parts manufactured by it will be as specified and free of defects upon receipt by purchaser.

OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED.

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SPECIAL CONDITION: Should this equipment be used in or with any nuclear installation or activity, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the equipment in such a manner.

RETURN REQUESTS/INQUIRIES

BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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