

**pHoenix Electrode Company
Sodium Ion Electrodes
Instruction Manual**

GENERAL INSTRUCTIONS

The pHoenix Electrode Company Sodium Ion Electrodes are used to quickly, simply, accurately, and economically measure sodium ion concentrations in aqueous solutions.

Required Equipment

- 1) A pH/mV meter or an ion meter, either line operated or portable.
- 2) Semi-logarithmic 4-cycle graph paper for preparing calibration curves when using the meter in the mV mode.
- 3) A magnetic stirrer.
- 4) pHoenix Electrode Company Sodium Ion Combination Glass Electrode, Catalog No. NA71502, or the pHoenix Electrode Company Sodium Ion Combination Epoxy Electrode, Catalog No. NA71508.
- 5) pHoenix Electrode Company Filling Solution, Catalog No. R001041, for both the NA71502 and NA71508 electrodes.

Required Solutions

- 1) Deionized or distilled water for solution and standard preparation.
- 2) pHoenix Electrode Company Ionic Strength Adjuster (ISA), 4M $\text{NH}_4\text{Cl}/4\text{M } \text{NH}_4\text{OH}$, Catalog No. NA0IS01. To prepare, add 214 grams of reagent grade ammonium chloride (NH_4Cl) to a 1000 ml volumetric flask about half full of distilled water. Add 270 ml of concentrated ammonium hydroxide (NH_4OH) under a hood, swirl to dissolve, allow to cool and dilute to the mark with distilled water. Cap the flask and invert several times to mix the solution.
- 3) pHoenix Electrode Company Sodium Electrode Storage Solution, 5 M NaCl, Catalog No. NA0ES01. To prepare, add 29.2 grams of reagent grade sodium chloride (NaCl) to 100ml of distilled water. To each 100 ml storage solution, add 2 ml of ISA. ELECTRODES MUST NOT BE STORED IN DISTILLED WATER OR AIR.

- 4) Dilute Electrode Rinse Solution. To prepare, add 20 ml of ISA to a one liter volumetric flask and dilute to the mark with distilled water. Use this solution to rinse the electrode between measurements. DO NOT RINSE WITH DISTILLED WATER.
- 5) pHOenix Electrode Company Sodium Standard, 0.1M NaCl, Catalog No. NA0AS01. To prepare, half fill a 1 liter volumetric flask with distilled water and add 5.84 grams of reagent grade NaCl. Swirl the flask gently to dissolve the solid. Fill the flask to the mark with distilled water. Cap the flask and invert several times to mix the solution.
- 6) pHOenix Electrode Company Sodium Standard, 1000 ppm Na⁺, Catalog No. NA0AS02. To prepare, half fill a 1 liter volumetric flask with distilled water and add 2.542 grams of reagent grade NaCl. Swirl the flask to dissolve the solid. Fill the flask to the mark with distilled water.
- 7) pHOenix Electrode Company Sodium Standard, 100 ppm Na⁺. To prepare, half fill a 1 liter volumetric flask with distilled water and add 0.254 grams of reagent grade NaCl. Swirl the flask to dissolve the solid. Fill the flask to the mark with distilled water.

GENERAL PREPARATION

Electrode Preparation

Remove the rubber cap covering the electrode tip and the rubber insert covering the filling hole of the reference electrode. Fill the combination 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. Connect the electrode to the proper terminal(s) of the meter as recommended by the meter manufacturer. Soak the sodium electrode tip overnight in the electrode storage solution.

Electrode Slope Check (with standard pH/mV meter). (check the electrode each day)

- 1) To a 150 ml beaker, add 100 ml of distilled water and 2 ml of ISA. Place the beaker on a magnetic stirrer and begin stirring at a constant rate. After assuring that the meter is in the mV mode, lower the electrode tip into the solution.
- 2) Using a pipet, add 1 ml of 0.1M or 1000 ppm sodium standard to the beaker. When the reading is stable, record the millivolt reading.

- 3) Using a pipet, add 10 ml of the same sodium standard used above to the beaker. When the reading has stabilized, record the millivolt reading.
- 4) Determine the difference between the two readings. A difference of 56 ± 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.

Electrode Slope Check (with ion meter)
(check electrode each day)

- 1) Prepare standard sodium solutions whose concentrations vary by tenfold. Use either the 0.1M NaCl or the 1000 ppm Na⁺ standard. Use the serial dilution method for this preparation.
- 2) 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 into the solution. Assure that the meter is in the concentration mode.
- 3) Adjust the meter to the concentration of the standard and fix the value in the memory according to the meter manufacturer's instructions.
- 4) Rinse the electrode with the electrode rinse solution and blot dry.
- 5) To a 150 ml beaker, add 100 ml of the higher value standard and 2 ml of ISA. Place the beaker on a magnetic stirrer and begin stirring at a constant rate. Lower the electrode tip into the solution.
- 6) Adjust the meter to the concentration of the standard and fix the value in the memory.
- 7) 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.

MEASUREMENT

Measuring Hints

All samples and standards should be at the same temperature for precise measurement, preferably ambient temperature. A difference of 1 degree C in temperature will result in about a 2% measurement error. The electrodes should not be used above 70°C.

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 styrofoam sheet or asbestos sheet, between the stirrer and the beaker.

Always rinse the electrode with electrode rinse solution from a wash bottle. Blot dry with a clean, dry tissue between readings to prevent solution carryover. Never use distilled water.

Store the electrode in electrode storage solution between measurements. Do not store in air or distilled water. Always soak new electrodes overnight in electrode storage solution prior to first use. When making low level sodium measurements, use a dilute sodium chloride storage solution, adjusting the pH by adding ISA, for a storage medium.

Plastic labware should be used for low level measurements.

All measurements should be made in basic solution. All samples and standards should be adjusted to a pH>9 with ISA.

For samples with high ionic strength, prepare standards whose composition is similar to the sample.

Always check to see that the membrane is free from air bubbles after immersion into standard or sample.

Sample Requirements

The sample measuring range is pH 9-12. Use the ISA recommended to adjust the pH for best accuracy. Make sure that the samples and standards are at the same temperature. The glass electrode sensing bulb will not be attacked by most organic solvents.

Units of Measurement

Sodium concentrations are measured in units of parts per million, equivalents per liter, moles per liter, or any other convenient concentration unit. Table 1 indicates some of the concentration units.

TABLE 1: Concentration Unit Conversion Factors

<u>ppm Na⁺</u>	<u>moles/liter Na⁺</u>
229.90	1.0 x 10 ⁻²
22.99	1.0 x 10 ⁻³
2.30	1.0 x 10 ⁻⁴

Measurement Procedure**Direct Measurement**

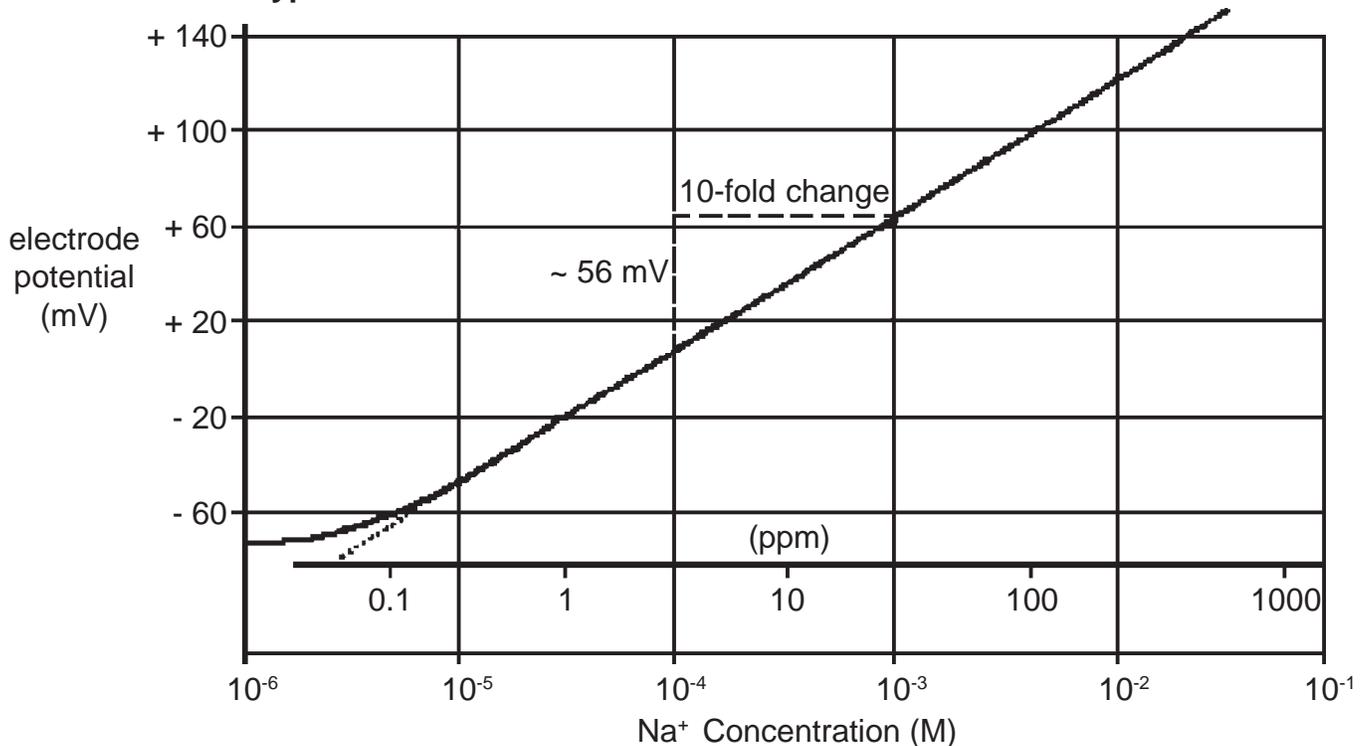
A simple procedure for measuring a large number of samples. A single meter reading is all that is required for each sample. The ionic strength of samples and standards should be made the same by adjustment with ISA for all sodium solutions. The temperature of both sample solution and of standard solutions should be the same.

Direct Measurement of Sodium (using a standard pH/mV meter)

- 1) By serial dilution of the 0.1 M or 1000 ppm standards, prepare 10⁻², 10⁻³, and 10⁻⁴M or 100 and 10 ppm sodium standards. Add 2 ml of ISA per 100 ml of standard. Prepare standards with a composition similar to the samples if the samples have an ionic strength above 0.1M.
- 2) Place the most dilute solution (10⁻⁴M or 10 ppm) on the magnetic stirrer and begin stirring at a constant rate. After assuring that the meter is in the mV mode, lower the electrode tip into the solution. When the reading has stabilized, record the mV reading.
- 3) Place the midrange solution (10⁻³M or 100 ppm) on the magnetic stirrer and begin stirring. After rinsing the electrode with electrode rinse solution, blot dry and immerse the electrode tip in the solution. When the reading has stabilized, record the mV reading.
- 4) Place the most concentrated solution (10⁻²M or 1000 ppm) on the magnetic stirrer and begin stirring. After rinsing the electrode with electrode rinse solution, blot dry and immerse the electrode tip 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.

Figure 1
Typical Sodium Electrode Calibration Curve



A calibration curve is constructed on semi-logarithmic graph paper when using a pH/mV meter in the millivolt mode. 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 are for the linear portion of the curve. The non-linear portion of the curve requires the use of low level procedures.

Extrapolate the curve down to about 5.0×10^{-5} M or 1 ppm. For measurements below this level, follow the instructions for low-level measurement.

- 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. After rinsing the electrode tip with sodium rinse solution, place the electrode tip in the solution. When the reading has stabilized, record the mV reading. Determine the concentration directly from the calibration curve.

- 7) The calibration should be checked every two hours. Assuming no change in ambient temperature, place the electrode tip in the mid-range standard. After the reading has stabilized, compare it to the original reading recorded in Step 3 above. A reading difference by more than 0.5 mV or a change in the ambient temperature will necessitate the repetition of Steps 2-5 above. A new calibration curve should be prepared daily.

Direct Measurement of Sodium (using an ion meter)

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

- 11) Immerse the electrode tip in the solution and wait for the reading to stabilize. Read the concentration directly from the meter display.
- 12) The calibration should be checked every two hours. Assuming no change in ambient temperature, place the electrode tip in the first sodium standard. After the reading has stabilized, compare it to the original reading recorded in Step 4 above. A reading difference by more than 0.5 mV or a change in the ambient temperature will necessitate the repetition of Steps 2-8 above. The meter should be recalibrated daily.

Low Level Sodium Determination (using a standard pH/mV meter)

This procedure is recommended for solutions with ionic strength less than $1.0 \times 10^{-2}M$ and a sodium concentration less than $1 \times 10^{-5}M$ or 1 ppm. If the solution is high in ionic strength, but low in sodium, use the same procedure, but prepare a calibration solution with a composition similar to the sample. Use plastic labware for low sodium measurements.

- 1) Using 20 ml of standard ISA, dilute to 100 ml with distilled water.
- 2) Dilute 20 ml of the outer chamber filling solution to 100 ml with distilled water and fill the reference electrode if using a double junction reference electrode.
- 3) Dilute 1 ml of the 0.1M standard to 100 ml to prepare a $1.0 \times 10^{-3}M$ standard solution for measurements in moles per liter. Dilute 10 ml of the 1000 ppm standard solution to 100 ml to prepare a 100 ppm standard solution for measurements in ppm. Add 1 ml of low level ISA to each 100 ml of standard. Standards should be prepared fresh daily.
- 4) To a 150 ml plastic beaker, add 100 ml of distilled water and 1 ml of low level ISA. Add NH_4OH , if necessary, to adjust the pH above 9. Place the beaker on the magnetic stirrer and begin stirring at a constant rate.
- 5) Place the electrode tip in the solution. Assure that the meter is in the mV mode.
- 6) Add increments of the $1.0 \times 10^{-3}M$ or 100 ppm standard as given in Table 2 below.
- 7) After the reading has stabilized, record the mV reading after each addition.

TABLE 2: Stepwise Calibration for Low Level Sodium Measurements

<u>Step</u>	<u>Added</u>		<u>Concentration</u>	
	<u>Pipet</u>	<u>Volume (ml)</u>	<u>M</u>	<u>ppm</u>
1	A	0.1	1.0×10^{-6}	0.10
2	A	0.1	2.0×10^{-6}	0.20
3	A	0.2	4.0×10^{-6}	0.40
4	A	0.2	6.0×10^{-6}	0.60
5	A	0.4	9.9×10^{-6}	0.99
6	B	2.0	2.9×10^{-5}	2.91
7	B	2.0	4.8×10^{-5}	4.76

Pipet A = 1 ml graduated pipet

Pipet B = 2 ml pipet

Solution = additions of 1.0×10^{-3} M or 100 ppm standard to 100 ml of distilled water and 1 ml of low level ISA.

- 8) On semi-logarithmic graph-paper, plot the millivolt reading (linear axis) against the concentration (log axis) as in Figure 1.
- 9) Rinse the electrode with electrode rinse solution and blot dry.
- 10) Measure out 100 ml of the sample into a 150 ml plastic beaker, add 1 ml of low level ISA, and place the beaker on the magnetic stirrer. Begin stirring. Adjust the pH, if necessary, to above 9. Lower the electrode tip into the solution. 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 two hours by repeating Steps 3-8.

Low Level Sodium Determination (using an ion meter)

Follow the procedure given for normal sodium determinations using an ion meter and the blank correction procedure. Use plastic labware for low level sodium measurement.

ELECTRODE CHARACTERISTICS

Reproducibility

Electrode measurements reproducible to $\pm 2\%$ can be obtained if the electrode is calibrated every hour. Factors such as temperature fluctuations, drift, and noise limit reproducibility. Reproducibility is independent of concentration within the electrode's operating range.

Interferences

Table 3 lists some common cations that, if present in high enough levels, will cause electrode interferences and measurement errors or electrode drift when using the sodium ion electrodes.

Most samples do not contain or contain very little of the cations shown in Table 3. The ammonium ion (NH_4^+), found in the recommended ISA, will not result in an error if all samples and standards have the same level of ISA present.

Electrode drift and slow response could indicate the presence of high interference from the ions listed. Soak the electrodes in electrode storage solution when this happens to restore proper response. See **Measuring Hints** section.

TABLE 3: Levels of Interfering Ions Resulting in a 10% Error at Specified Levels of Sodium.

<u>Interference</u>	<u>$1.0 \times 10^{-4} \text{M}$</u>	<u>$1.0 \times 10^{-3} \text{M}$</u>	<u>$1.0 \times 10^{-2} \text{M}$</u>
Li^{+1}	$5 \times 10^{-4} \text{M}$	$5 \times 10^{-3} \text{M}$	$5 \times 10^{-2} \text{M}$
K^{+1}	$1 \times 10^{-2} \text{M}$	$1 \times 10^{-1} \text{M}$	1M
Rb^{+1}	$3 \times 10^{-1} \text{M}$	3M	—
NH_4^{+1}	$3 \times 10^{-1} \text{M}$	3M	—
Ag^{+1}	$3 \times 10^{-9} \text{M}$	$3 \times 10^{-8} \text{M}$	$3 \times 10^{-7} \text{M}$
Tl^{+1}	$5 \times 10^{-2} \text{M}$	$5 \times 10^{-1} \text{M}$	—
<u>Interference</u>	<u>1 ppm</u>	<u>10ppm</u>	<u>100ppm</u>
Li^{+1}	1.5ppm	15ppm	150ppm
K^{+1}	17ppm	170ppm	1700ppm
Rb^{+1}	$1.1 \times 10^4 \text{ppm}$	$1.1 \times 10^5 \text{ppm}$	—
NH_4^{+1}	$1.8 \times 10^3 \text{ppm}$	$1.8 \times 10^4 \text{ppm}$	—
Ag^{+1}	.0001ppm	.001ppm	.01ppm
Tl^{+1}	$4.5 \times 10^3 \text{ppm}$	$4.5 \times 10^4 \text{ppm}$	—

Temperature Influences

Samples and standards should be at the same temperature, since electrode potentials are influenced by changes in temperature. A 1 degree C difference in temperature results in a 2% error at the $10^{-3}M$ level. Because of the solubility equilibria on which the electrode depends, the absolute potential of the reference electrode changes slowly with temperature. The slope of the sodium electrode, as indicated by the factor "S" in the Nernst equation, also varies with temperature. Table 4 indicates the variation of theoretical slope with temperature.

Provided that temperature equilibria has occurred, the sodium ion electrodes can be used at temperatures from -5° to $70^{\circ}C$. Room temperature measurements are recommended, since measurements at temperatures markedly different from room temperature may require equilibrium times up to one hour. The electrode should not be used at temperatures above $70^{\circ}C$, since damage to the membrane may result.

TABLE 4: Temperature vs Values for the Electrode Slope

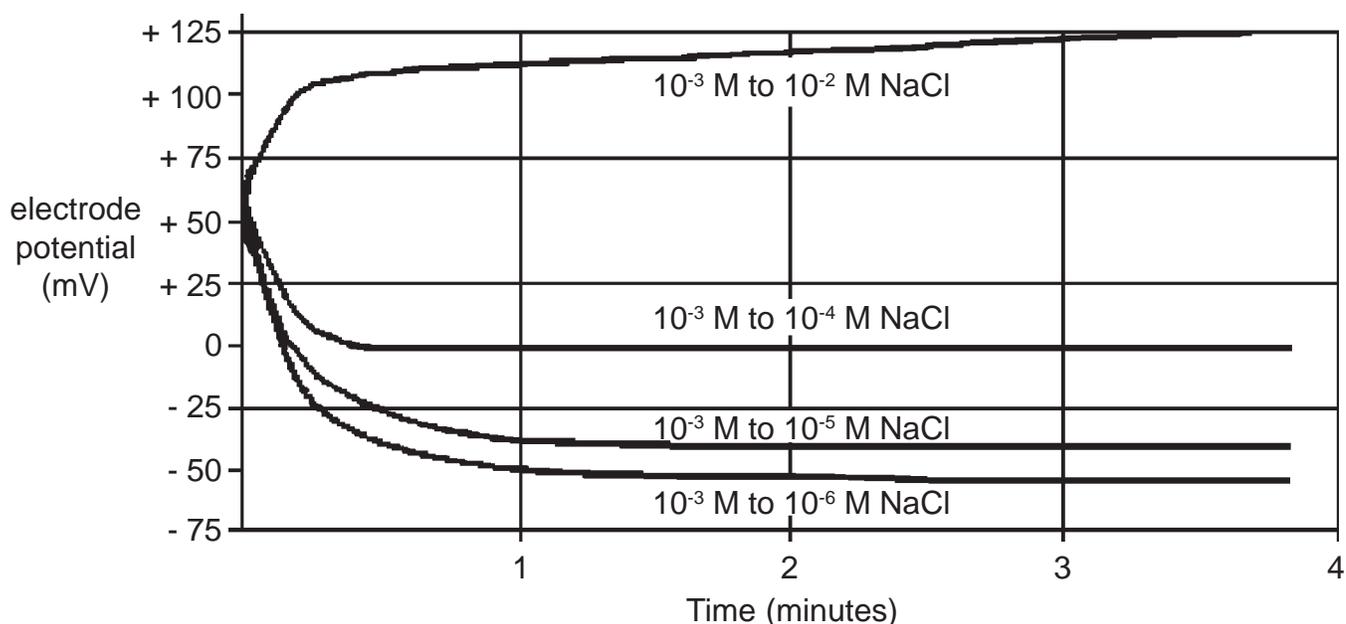
<u>Temperature ($^{\circ}C$)</u>	<u>"S" (slope)</u>
0	54.20
10	56.18
20	58.16
25	59.16
30	60.15
40	62.13
50	64.11

Electrode Response

Plotting the electrode mV potential against the sodium concentration on semi-logarithmic paper results in a straight line with a slope of about 56 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 sodium concentrations above $1.0 \times 10^{-5}M$ to several minutes near the detection limit. Refer to Figure 2.

Figure 2
Typical Electrode Time Response to Step Changes in NaCl



Detection Limit

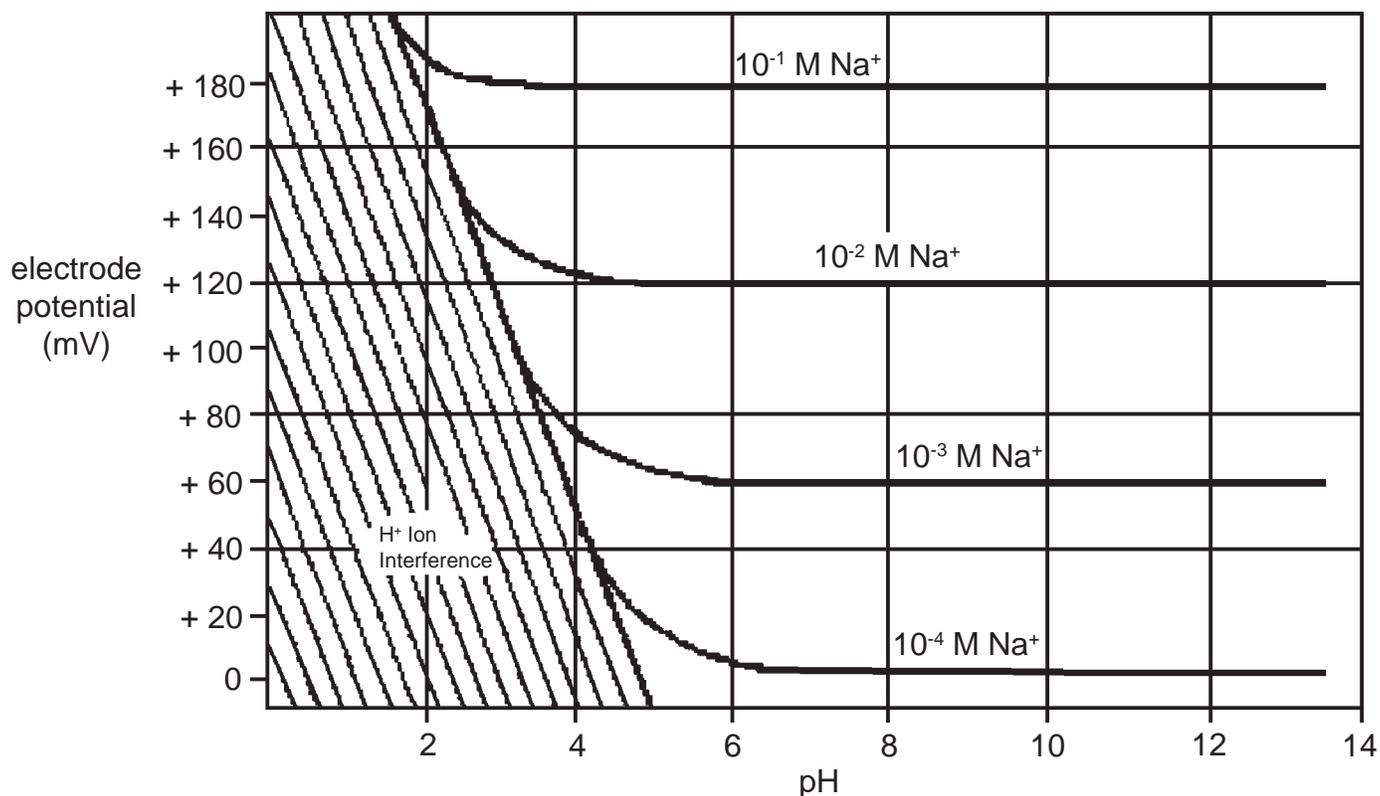
The upper limit of detection in pure sodium solutions is 1M. In the presence of other ions, the upper limit of detection is above 10^{-1} M sodium, but two factors influence this upper limit. Both the possibility of a liquid junction potential developing at the reference electrode and the salt extraction effect influence this upper limit. Some salts may extract into the electrode membrane at high salt concentrations, causing deviation from the theoretical response. Either dilute samples between 1M and 10^{-1} M or calibrate the electrode at 4 or 5 intermediate points.

Free sodium ion concentration down to 1.0×10^{-6} M or 0.1 ppm can be measured in basic solutions. For measurements below 10^{-5} M or 1 ppm, use plastic labware (and low level procedures) since a significant pickup of sodium may occur from glassware due to desorption from container walls.

pH Effects

The electrode response to sodium ions is greatly influenced by the pH of the solution. Hydrogen ion interferes with measurements of low level sodium ion measurements, although the electrode can be used over a wide pH range. See Figure 3.

Figure 3
Electrode Potential Behavior vs. Solution pH in Pure NaCl Solution at 25°C



The edge of the shaded area (the straight line) shown in Figure 3 indicates a minimum pH at which dilute sodium measurements can be made with less than 10% hydrogen ion interference.

The pH should be adjusted to a pH greater than 9 by the addition of ISA to all standards and samples for optimal results over the entire concentration range of sodium. Additional ammonium hydroxide may be necessary to adjust the pH to the desired level in some cases.

Electrode Storage

The pHOenix Electrode Company Sodium Ion Electrodes should be stored in the sodium electrode storage solution, never in air or in distilled water. A more dilute sodium chloride solution with pH adjusted through the use of ISA may be used for storage before low level measurements. For longer storage (longer than two weeks), rinse and dry the sensing glass and cover the glass tip with any protective cap shipped with the electrode. The reference portion of the combination electrode should be drained of filling solution, if refillable, and the rubber insert placed over the filling hole.

Electrode Life

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

ELECTRODE THEORY

Electrode Operation

The pHoenix Electrode Company Sodium Ion Electrodes are composed of a sodium-selective glass membrane bonded to a glass body. When the membrane is in contact with a solution containing sodium ions, an electrode potential develops across the membrane. This electrode potential is measured against a constant reference potential, using a standard pH/mV meter or an ion meter. The level of sodium ions, corresponding to the measured potential, is described by the Nernst equation.

$$E = E_0 + S \log X$$

where:

- E = measured electrode potential
- E_0 = reference potential (a constant)
- S = electrode slope (56 mV)
- X = level of sodium ions in solution

The activity, X, represents the effective concentration of the ions in solution. The activity is related to the free ion concentration, Cf, by the activity coefficient, γ , by:

$$X = \gamma C_f$$

Activity coefficients may vary, depending on the total ionic strength, I, determined as:

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

where:

- C_x = concentration of ion X
- Z_x = charge of ion
- 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 adjuster is added to samples and standards. The recommended ISA for sodium is an ammonium chloride/ammonium hydroxide buffer. Solutions other than this may be used as ionic strength adjusters as long as ions that they contain do not interfere with the electrode's response to sodium ions.

The reference electrode must also be considered. When two solutions of different compositions 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 solutions diffuse into the sample should be as nearly equal as possible, that is, the filling solution should be equitransferent. No junction potential can result if the rate at which positive and negative charge carried in the sample is equal.

TROUBLESHOOTING GUIDE

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

Meter

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

Glassware

Clean glassware is essential for good measurement. Be sure to wash the glassware well with a mild detergent and rinse very well with distilled or deionized water. Clean glassware will drain without leaving water droplets behind.

Electrodes

The electrodes may be checked by using the procedure found in the sections entitled **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 sections **Measuring Hints** and **Electrode Response**. Repeat the slope check.
3. If the electrode still fails to respond as expected, substitute another sodium ion 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 reagent may be of poor quality, interferences in the sample may be present or the technique may be faulty. See **Standards & Reagents**, **Sample**, and **Technique** sections below.
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 thoroughly.
 - Prepare the electrode properly.
 - Use the proper filling solution.
 - Adjust the pH and the ionic strength of the solution by the use of the proper ISA.
 - Measure correctly and accurately.
 - Review **TROUBLESHOOTING HINTS**.

Standards & 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 ISA, incorrect dilution of standards, poor quality distilled/deionized water, or a simple mathematical miscalculation.

Sample

Look for possible interferences, complexing agents, or substances which could affect the response or physically damage the sensing electrode (or the reference electrode) if the electrode works 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**.

Technique

Be sure that the electrode's limit of detection has not been exceeded.

Be sure that the analysis method is clearly understood and that Good Laboratory Practice has been followed.

Refer to the instruction manual again. Reread **GENERAL PREPARATION** and **ELECTRODE CHARACTERISTICS**.

If trouble still persists, call your pHOenix Electrode Company at 1-800-522-7920 and ask for the Technical Services Department.

TROUBLESHOOTING HINTS

Symptom	Possible Causes	Next Step
Out of Range Reading	defective meter	check meter with shorting strap (see meter instruction manual)
	defective electrode	check electrode operation
	electrode not plugged in properly	unplug electrode and reseal
	reference electrode not filled	be sure reference electrode is filled
	air bubble on membrane	remove air bubble by re-dipping electrode
	electrode not in solution	put electrode in solution
Noisy or Unstable Readings (readings continuously or rapidly changing)	defective meter	check meter with shorting strap
	air bubble on membrane	remove air bubble by re-dipping electrode
	ISA not used	use recommended ISA
	meter or stirrer not grounded	ground meter or stirrer
	defective electrode	replace electrode
	electrode exposed to interferences	soak overnight in electrode storage solution
Drift (reading slowly changing in one direction)	samples and standards at different temperatures	allow solutions to come to room temperature before measurement
	electrode exposed to interferences	soak overnight in electrode storage solution
	incorrect reference filling solution	use recommended filling solution
	pH too low	adjust pH
	ISA not used	use recommended ISA

Symptom	Possible Causes	Next Step
Low Slope or No Slope	standards contaminated or incorrectly made	prepare fresh standards
	ISA not used	use recommended ISA
	standard used as ISA	use ISA
	pH too low	adjust pH
	electrode exposed to interferences	soak overnight in electrode storage solution
	air bubble on membrane	remove bubble by re-dipping electrode
“Incorrect Answer” (but calibration is good)	incorrect scaling of semi-log paper	plot millivolts on the linear axis. On the log axis, be sure 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: $10^{-3}\text{M} = 23 \text{ ppm as Na}^+$
	sample pH too low	adjust pH above 9

SPECIFICATIONS

Concentration Range : Saturated to $1.0 \times 10^{-6}\text{M}$ (0.02 ppm)
pH Range : 5 to 12 (depending on Na^+ level)
Temperature Range : -5° to 70°C
Resistance : < 200 Mohm
Reproducibility : $\pm 2\%$
Size : 110 mm length
12 mm diameter
1 m cable length
Storage : store in 5M NaCl with added ISA

ORDERING INFORMATION

P/N	DESCRIPTION
NA71502	Sodium Ion Electrode, combination, glass body
NA71508	Sodium Ion Electrode, combination, epoxy body
NA0AS01	Sodium Standard, 0.1M NaCl
NA0AS02	Sodium Standard, 1000 ppm Na
R001041	Reference Electrode Filling Solution, .1M NH_4Cl , for both the NA71502 and NA71508 electrodes

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