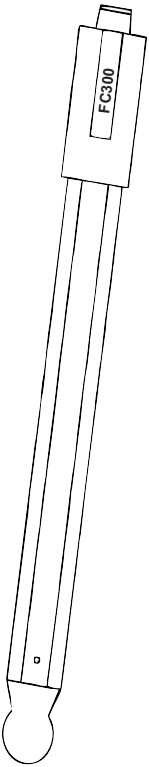

Instruction Manual

FC300
Combination Sodium Electrode

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Table of contents

I. Introduction

The Hanna Instruments FC300 Sodium electrode is a glass combination ion selective electrode designed for the measurement of sodium ions in aqueous solutions such as water, food, beverages, wine, beer and soil.

The electrode utilizes a special glass membrane that is selective to sodium ions. The internal reference electrolyte chamber is refillable.

II. Specifications

Type	Glass combination ISE with Ag/AgCl reference
Ion Measured	Sodium (Na^+)
Measurement range	1M to 1X 10^{-5}M 22990 to .23 ppm
Interference	Ratio of interfering ion to Na^+ must be below .0001 for H^+ 1 for K^+ Note: other monovalent cations may also increase sodium readings.
Operating Temperature	0-80 °C
Operating pH	9.75-14 pH
Dimensions	12 mm (OD) x 120 mm insertion (0.47" x 4.72")
Connection	BNC Plug
Wetted Materials	glass, ceramic

III. Theory of Operation

The FC300 sodium electrode is a potentiometric device used for the rapid determination of free sodium ions in water, soft drinks, beer, wine, and soils. The electrode functions as a sensor or ionic conductor.

The FC300 is a combination electrode that does not require a separate reference electrode to complete its electrolytic circuit. The selective glass membrane blown on the tip of the sensor exchanges ions with the sample solution which produces a voltage on the surface of the membrane.

This creates a charge imbalance between the test solution and internal cell of the sensor. This exchange on the external surface produces a voltage that changes in response to the sample's ion activity. When the ionic strength of the sample is fixed, and hydrogen ions are eliminated, the voltage is proportional to the concentration of sodium ions in solution.

The sensor follows the Nernst Equation:

$E = Ea + 2.3\ RT/nF \log A\ ion$

E = observed potential

Ea = Reference and fixed internal voltages

R = gas constant (8.314 J/K Mol)

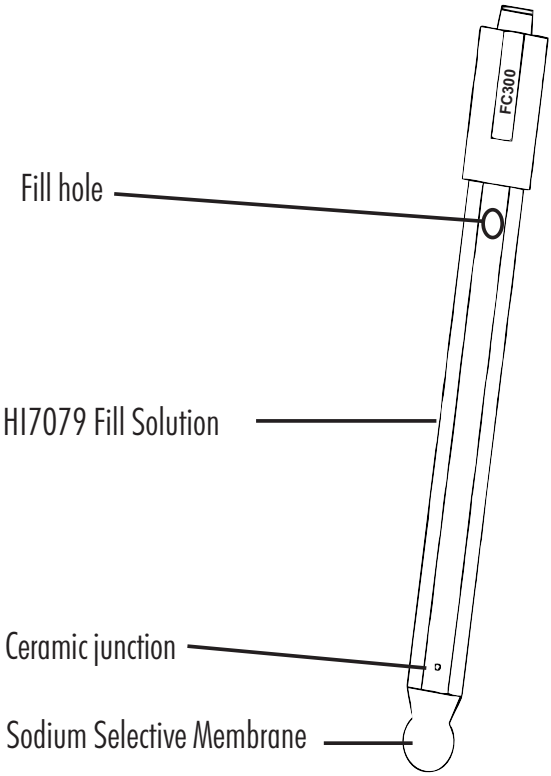
n = Charge on ion (equivalents/mol) (1^+)

$A\ ion$ = ion activity in sample

T = absolute temperature in K

F = Faraday constant (9.648 x 104 C/equivalent)

IV. Design elements of the FC300 electrodes



V. Equipment required:

- Hanna Instruments FC300 combination electrode with HI7079 fill solution.
- Hanna Instruments 931100 portable waterproof Sodium meter that reads out in units of g/L NaCl.
- Hanna Instruments 931101 portable waterproof Sodium meter that reads out in units of mg/L, g/L Na^+, pNa
- Hanna Instruments 931102 portable waterproof Sodium meter that reads out in units of g/L or % NaCl
- Hanna Instruments HI5222 pH/ISE/mV meter or other suitable ion or pH/mV meter. (Note: log/linear graph paper is useful if an ISE (ion) meter is not available).
- Hanna Instruments HI180 magnetic stirrer or equivalent with stirring bars (HI731320). (Note: isolate beakers from stirrer motor heat by placing insulating material such as foam or cork between them).
- Hanna Instruments HI76404 electrode holder or equivalent.
- Plastic beakers (HI740036P) or other suitable measurement vessel.

VI. Solutions Required

Standards for Sodium Measurements: Select appropriate Hanna Instruments standard and ISA from the list below:

	Part Number
0.1 M sodium solution	HI4016-01
10 ppm sodium solution	HI4016-10
100 ppm sodium solution	HI4016-02
1000 ppm sodium solution	HI4016-03
30.0 g/L NaCl solution (500mL)	HI7081L
3.0 g/L NaCl solution (500mL)	HI7083L
0.3 g/L NaCl solution (500mL)	HI7085L
2.3 g/L sodium solution (500mL)	HI7080L
0.23 g/L sodium solution (500mL)	HI7087L
Reference Fill Solution (500mL)	HI7079
ISA (500mL)	HI4016-00 HI7090L
Storage Solution (500mL)	HI4016-45
Conditioning / Etchant solution	HI4016-46

Using volumetric pipettes and glassware make dilutions of the standard to bracket the concentration of the samples. Standards with concentrations less than 10^{-3}M (100 ppm) should be prepared fresh daily. Store solution in a tightly sealed bottle without ISA added. 10 mL of HI4016-00, or HI7090L should be added to each 100 mL sample of standard and samples just prior to measurement. This ISA buffers the pH of the sample or standard to about pH 9.8 thus removing hydrogen ion as an interference. It also provides samples and standards a constant ionic strength background that stabilizes the solutions activity coefficient and permits concentration to be measured directly.

VII. General Guidelines

- During measurement always operate electrode with the fill hole open.
- Verify protective cap has been removed.
- During normal use, fill solution will slowly drain out of the ceramic junction located on the side of the the electrode. Excessive loss (>2 cm drop within 24 hours) is not normal.
- Add fill solution daily to maintain a good head pressure. For optimum reference response, this level should be maintained and not be allowed to drop more than 2-3 cm (1-inch) below fill hole.
- Calibration standards and sample solutions should have the same ionic strength. ISA should be added to both samples and standards immediately before taking measurements.
- Calibration standards and sample solutions should be at the same temperature. Thermally insulate solution vessel from magnetic stirrer with cork or other insulating medium.
- Calibration standards and sample solutions should be stirred at the same rate using identical sized stir bars.
- Surface coating will effect the response. Inspect sensor before using.
- Rinse electrode with distilled or deionized water between samples and dab dry with lab wipe or other soft disposable absorbent toweling.
- Check calibration every 1-2 hours.

VIII. Electrode Preparation

Before using the electrode for the first time or if reactivating it after storage, the electrode should be conditioned, soaked in storage solution and then tested.

For a new sensor: Remove the protective shipping cap from the glass bulb and save for storage. Slide fill hole cover off opening to refill reference cavity with HI7079 fill solution. Leave open during measurement.

Condition/etch sodium sensitive membrane:

Warning: Use extreme care when handling condtioning solution. Protective gloves and eyeware should be worn. This procedure removes a thin layer of sensitive glass from the sodium membrane exposing a fresh surface. Pour a small quantity of Hanna Instruments HI4016-46 conditioning solution into a plastic container. Place the sensing membrane (round bulb at tip of sensor) into the solution for one minute. Discard conditioning solution after use, do not return to bottle. Rinse off sensor bulb in water and place into a small container of storage solution (HI4016-45). This solution provides optimum conditions to rehydrate the membrane surface and prepare it for sodium measurements. A minimum of one hour is recommended for rehydrating the sensing surface.

IX. Quick Check of Electrode Slope

- Connect sensors to pH/mV/ISE meter
- Place meter in mV mode.
- Place 100 mL of Deionized Water (DIW) into a beaker with 10 mL ISA and a stir bar.
- Place electrode into prepared sample.
- Add 1 mL of a standard (0.1 M or 1000 ppm standard) to beaker. Record the mV value when stable.
- Add an additional 10-mL of standard to the solution. Record the mV when reading has stabilized. This value should be more positive than the previous noted.
- Determine the difference between the two-mV values. An acceptable value for this slope is 56 $\pm$ 4 mV.

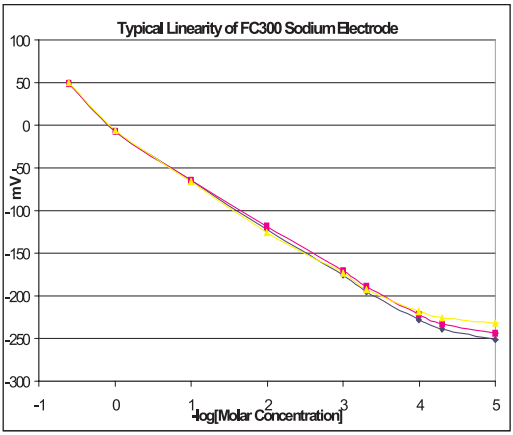
X. Corrective action

- Verify protective cap has been removed.
- Verify electrode is connected properly to meter and meter is powered.
- Verify dilute standards are freshly made and stored. Remake solutions if appropriate.
- If the sensor slope just misses the suggested slope window, soaking the sensor in the storage solution may solve the problem.
- A scratched sensing surface will have a slugish behavior. Use conditioning /etch procedure discussed in section VIII.
- If the membrane is damaged, the response becomes extremely sluggish, or the slope of the electrode has decreased significantly, and procedures above have not helped, the sensor should be replaced.

XI. Direct Calibration and Measurement

This method is a simple procedure for measuring many samples. A direct reading ISE meter (HI5222 or equivalent) determines concentration of the unknown by a direct reading after calibrating the meter with the standards. The meter is calibrated with two or more freshly made standards that are in the linear measurement range of the unknowns. More calibration points are required in nonlinear regions. Unknowns are read directly. At very low levels of sodium, special precautions must be employed for reproducible measurements. Water used for standards must be sodium free and sensors and glassware must be rinsed repeatedly with this water to prevent carry over. In the region where the electrode response appears curved, more calibration points are needed, and calibration will need to be repeated more frequently. A pH/mV meter in mV mode with semi log graph paper may also be used. Two or more freshly prepared standards that are in the measurement range of the unknowns are measured in mV mode on the meter.

These values are plotted on the semi-log paper and the points are connected to form a straight-line curve. When samples are measured, their mV values are converted to concentration by following the mV to the concentration axis on the semi-log plot.



Procedure

1) Follow sections VIII and IX to prepare sensors for measurement.

2) Follow section VI to prepare standards/ solution. Standards should bracket and fall within the range of interest. Ten mL HI4016-00 ISA, or 10 mL HI7090L ISA is added to 100 mL of both samples and standards. Add stir bar and mix before taking measurements.

3) Follow section VII; General Guidelines to optimize test set-up.

4) During calibration it is best to start with lower concentration samples first. Wait for a stable measurement before recording values. Slightly longer equilibrations are required at lower concentrations .

5) To prevent carry over and contamination of samples, rinse sensors with DIW and blot dry between samples.

XII. Other Measurement Techniques

Known Addition (for Na^+)

An unknown concentration can be determined by adding a known amount (volume and concentration) of measured ion to a known volume of the sample. This technique is called Known Addition. The method can use an ideal sensor slope, but actual determined slopes at the temperature of measurement should be used if known. This method is preprogrammed in the Hanna Instruments HI5222 pH/ISE/mV meter, which simplifies the method greatly.

Example: Sodium ion determination with known addition.

1. A 50 mL sample of unknown (Vsample) is placed in a clean plastic beaker with a FC300 sensor. Add 10 mL of ISA HI4016-00 or HI7090L (VISA) Mix well. and record the stable mV value. (mV 1)
2. 5 mL (Vstd) of 10^{-1}M (Cstd) standard is added to the beaker and the mV value increases. The unknown sodium concentration in the original sample (Csample) can then be determined by the following equation.

$$C_{sample} = \frac{C_{standard} V_{standard}}{(V_T)10^{\Delta E/S} - (V_{S'})} \left(\frac{V_{S'}}{V_{sample}} \right)$$

$$(V_{sample} + V_{standard} + V_{ISA}) = V_T$$

$$(V_{sample} + V_{ISA}) = V_{S'}$$

3. The procedure can be repeated with a second standard addition to verify slope and operation of the method.

XIII. pH

The FC300 electrodes are best used in pH from 9.5 to 14.00. The ratio of sodium to hydrogen ion should be greater than 10000. For example, if sodium is .05M, Hydrogen ion must be 0.000005M; 5.30 pH or greater. If sodium is .00001M, pH must be 7.00 pH. Samples that fall beyond this range must be adjusted with ISA. See Section VI.

XIV. Storage

The FC300 sodium electrodes may be stored in storage solution or in aqueous sodium solutions with ISA between sample measurements.

If the electrode will be used frequently and needs to be ready for use, take measures to prevent evaporation of fill solution. Top off fill solution, and replace the fill hole cover and protective cap with a few drops of storage solution over the sodium sensitive membrane. Store electrode upright. Before using, rinse off electrode and top off fill solution.

For long term storage, wash all salts from assembly with deionized water. Replace the fill hole cover and protective cap with a few drops of storage solution over the sodium sensitive membrane. Store in shipment box.

XV. Conversion Tables

	Multiply by
Moles/L (M) Na^+ to ppm Na^+ (mg/L)	22990
ppm Na^+ (mg/L) to M Na^+(Moles/L)	4.35×10^{-5}
ppm Na^+ (mg/L) to ppm NaCl (mg/L)	2.54197
ppm NaCl (mg/L) to ppm Na^+ (mg/L)	0.39339

WARRANTY

Hanna Instruments ISE series electrodes are warranted to be free of defects in material and workmanship for 6 months from date of purchase when used for their intended purpose and maintained according to instructions. If they fail to work when first used, contact your local Hanna Instruments Office. Damage due to accidents, misuse, misapplication, tampering or lack of prescribed maintenance is not covered.

Hanna Instruments reserves the right to modify the design, construction or appearance of its products without advance notice.

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