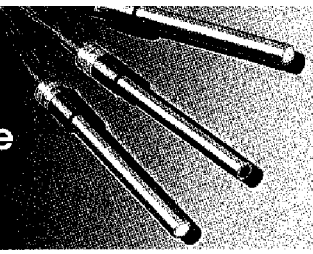
IOTRODE™
Ion-Selective Electrode Applications



Bulletin No. 000116

Fluoride In Water

INTRODUCTION

Fluoride analysis in water was one of the first widely accepted measurement techniques by ion selective electrodes. By adding buffer solution to the sample, practically all possible interferences are cancelled.

EQUIPMENT

Meter:

pH/Millivolt meter. Readability of 1 mV required; 0.1 mV preferred. Specific ion meters will provide direct readout of final answer or concentration factor. Consult manual for millivolt measurement instructions.

Electrodes:

1. Iotrode™ AB100 Fluoride Electrode
2. Reference electrode (Double Junction Type)
   Iotrode AB450 (Ag/AgCl internal) or
   Iotrode AB455 (Calomel internal)

Glassware:

1. 1 ml, 2 ml, and 10 ml pipets
2. 150 ml beakers, plastic
3. 100 ml graduated cylinders
4. 100 ml, 1000 ml volumetric flasks
5. Magnetic stirrer and stirbars or glass stirring rods

REAGENTS

1. **100 ppm Standard Fluoride Solution:** Weigh out 0.221 grams anhydrous NaF into a one liter volumetric flask. Dilute to mark with deionized water.

2. **Fluoride Sample Buffer:** Weigh out 4.5 grams of CDTA (cyclohexane -1,2 diamine -N,N,N',N'-tetra-acetic acid) into a one liter flask. Add 58 grams NaCl, 57 ml glacial acetic acid and 500 ml deionized water. While stirring, slowly add 120 ml of 5M NaOH and continue stirring until all solids have dissolved. Using a pH electrode and meter, slowly add 5M NaOH until the solution pH reaches 5.0-5.5. Approximately 30 ml NaOH will be needed. Remove pH electrode and allow solution to cool to room temperature. Dilute to one liter with deionized water. Store in polyethylene bottle.

Reference Electrode Outer Junction Filling Solution: 10 grams KNO_3 diluted to 100 ml with deionized water.

ELECTRODE SET-UP

Plug the sensing electrode into the G.E. or Glass jack of the meter. Fill the inner and outer chambers of the reference electrode with appropriate solutions. Plug the reference electrode into the REF or Reference jack of the meter. Technique Hints:

1. Stirring: Electrode response is improved if samples and standardizing solutions are stirred at a fixed rate during measurements. If magnetic stirring is not available, stir solution one minute with a clean glass stirring rod before measuring.
2. Temperature: The slope of the sensing electrode and the absolute potential of the reference electrode are temperature dependent. Therefore, samples and standardizing solutions should be at the same temperature.
3. Cleaning Electrodes: Rinse both electrodes with a fresh portion of deionized water and blot dry with tissue between all measurements.

ELECTRODE CALIBRATION

The primary criteria for electrode performance verification is the span test. If 55 millivolts or greater change is observed for a decade change in concentration, the performance is considered satisfactory.

1. Put 50 ml deionized water and 50 ml fluoride buffer solution into a 150 ml beaker. Place the pH meter into the M.V. mode. Place electrodes in the solution to a minimum depth of one inch.

2. Pipet 1 ml of 100 ppm fluoride standard into the solution. Stir thoroughly. Read stable electrode potential in millivolts and record value as E1.

3. Add 10 ml of 100 ppm fluoride standard and stir thoroughly. Read stable electrode potential in millivolts and record as E2. Calculate S by E2-E1. Assume S value as the slope of the electrode.

NOTE: If the slope value is below 55 mV, check electrode set-up and repolish sensing electrode.

PROCEDURE

Sample Preparation: Dilute sample 1:1 with fluoride buffer solution.

Sample Standardization: Add 100 ml of mixed buffer and sample solution to a 150 ml beaker. Place electrodes in the solution to a minimum depth of one inch. Read stable electrode potential in millivolts and record as E3.

Standard Addition: Pipet 1 ml of 100 ppm fluoride standard into the solution. Stir thoroughly. Read stable electrode potential in millivolts and record value as E4. Calculate ΔE by E4-E3.
NOTE: If ΔE is more than 30mV, **dilute standard** 1:10 with deionized water and divide final concentration by 10. If ΔE is less than 8mV, **dilute fresh sample** 1:10 with deionized water and multiply final concentration by 10.

CALCULATIONS

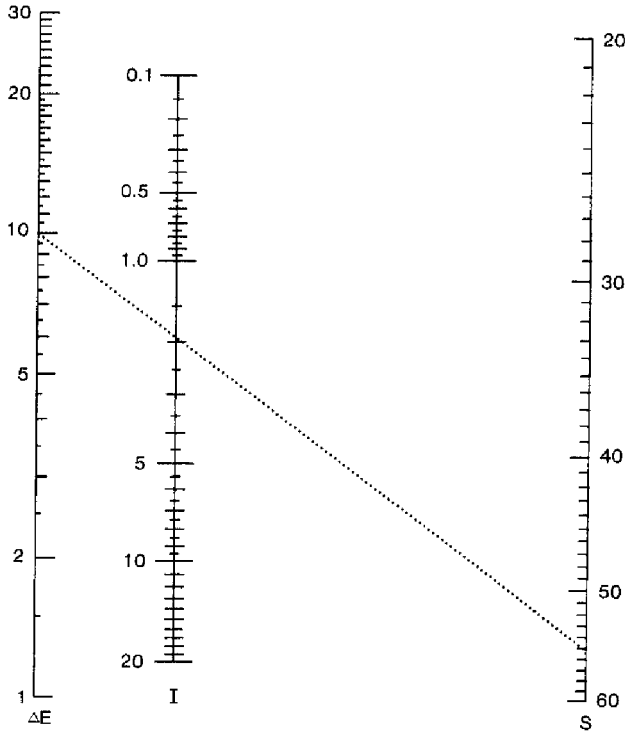
To perform the calculation for standard addition, the following factors are needed:

V_S = Sample Volume
V_a = Volume of standard added
C^* = Concentration of standard
ΔE = Change in potential (see procedure section)
S = Slope of the electrode (see electrode calibration section)

$$\text{Concentration of Sample} = \frac{C^* \left[\frac{V_a}{V_a + V_S} \right]}{\left[\text{antilog} \frac{\Delta E}{S} \right] - \left[\frac{V_S + V_a}{V_S} \right]}$$

Note: If the sample is diluted, multiply sample concentration by appropriate dilution factor.

Standard Addition Nomograph for use with Iotrode™ Electrodes



The standard addition nomograph method of calculation is valid when the increment of standard added to the sample is small compared to the volume. Therefore, if more than 1 ml of standard is added, please utilize the mathematical procedure above.

The following data must be known to utilize the nomograph: (See above for description of factors.)

ΔE, S, C^*, and V_S

Utilizing ΔE and S, draw a straight line to find I on the nomograph.

$$\text{Concentration of Standard} = \frac{(I)\,(C^*)}{V_S}$$

The concentration of Standard will be in the same units of concentration as C^*.

Example: ΔE = 10 mv
S = 55 mv
C^* = 1000 ppm
V_S = 100 ml
I = 2.0 (from Nomograph)

$$\text{Sample Concentration} = \frac{(2.0)\,(1000\ \text{ppm})}{100\ \text{ml}}$$

$$= 20\ \text{ppm}$$

REFERENCES:

APHA, 1971, Standard Methods for the Examination of Water and Wastewater, 13th edn., American Public Health Association, Washington, D.C., p. 168.