

IOTRODE™

Ion-Selective Electrode Applications

Bulletin No. 000114

Total Cyanide Analysis in Cadmium/Cyanide Bath

INTRODUCTION

Total cyanide may be measured directly with an Iotron Cyanide electrode in cadmium/cyanide baths. The measurement is based on the stability of the cadmium-cyanide complex. As cyanide concentrations may vary widely, the following procedure should be used as a general guide.

EQUIPMENT

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

Electrodes:
Measuring Electrode: Iotrode AB-160 Cyanide ISE.
Reference Electrodes—Double Junction—Refillable
Calomel — RD-101 Removable Sleeve
RD-201 Non-Removable Sleeve
Ag/AgCl — RD-301 Removable Sleeve
RD-401 Non-Removable Sleeve

Glassware:

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

REAGENTS

- 1. Ionic Strength Adjustor (ISA):** 0.1M NaOH. Prepare solution by diluting 4 grams NaOH to one liter with deionized water.
- 2. Cyanide Standard, 1000 ppm:** Weigh out 2.50 grams KCN into a 1000 ml volumetric flask. Add 100 ml ISA and 500 ml of deionized water to dissolve solid. Dilute to mark with deionized water. Store standard in dark plastic bottle with appropriate warning labels. Prepare fresh standard weekly.

CAUTION: Do not allow cyanide solutions to become acidic. HCN gas evolved from acid cyanide solution is highly toxic, whether inhaled or absorbed through the skin.

Reference Electrode Outer Junction Filling Solution:
Weigh out 10 grams KNO_3 and dissolve in 100 ml of deionized water.

ELECTRODE SET-UP

If the electrode is being used for the first time, please follow the instructions for polishing the membrane surface. 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 criterion 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 100 ml deionized water and 2 ml ISA 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 1000 ppm cyanide standard into the solution. Stir thoroughly. Read stable electrode potential in millivolts and record value as E1.
3. Add 10 ml of 1000 ppm cyanide 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 plating solution with ISA to a cyanide concentration range of 10⁻²M (260 ppm) -10⁻⁴M (2.6 ppm) cyanide. Record volumes of both solutions to compute dilution factor.

Sample Standardization: Add 100 ml of prepared 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 1000 ppm cyanide 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 ΔDE is less than 8mV, **dilute the prepared sample 1:10** with ISA and remeasure. Be sure to account for this additional dilution when computing final answer.

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

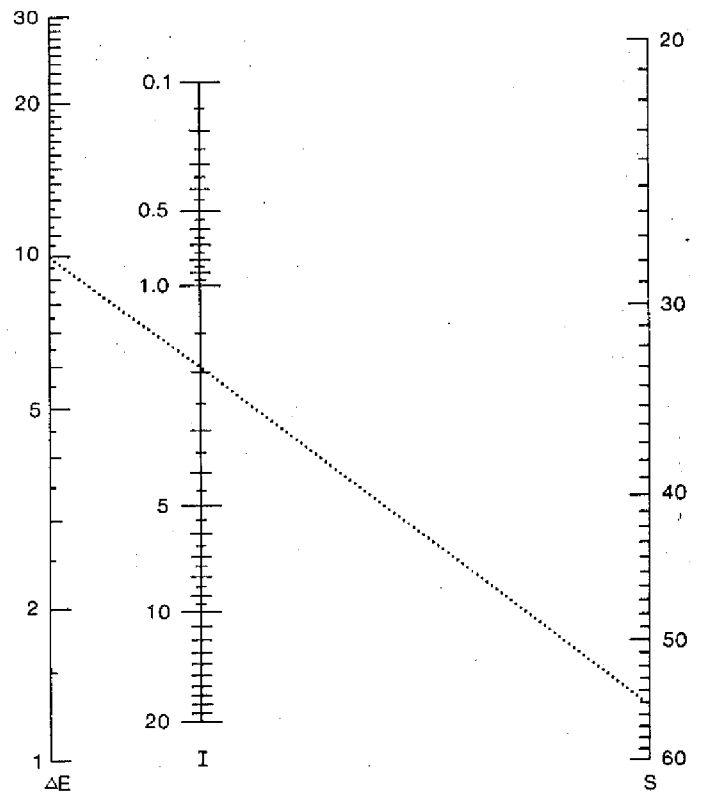
Δ E = Change in potential (see procedure section)

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.

$$\text{Concentration of Sample} = \frac{(I) (C^*)}{V_s}$$

The concentration of Sample 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)

$$\begin{aligned} \text{Sample Concentration} &= \frac{(2.0) (1000 \text{ ppm})}{100 \text{ ml}} \\ &= 20 \text{ ppm} \end{aligned}$$