TC80 Total Chlorine Analyzer

ECD ELECTRO-CHEMICAL DEVICES

Introduction to Chlorine

- Chlorine, Cl_2, is a Diatomic Gaseous Element
- It is a strong oxidizer (wants electrons)
- The High Oxidation Potential makes it an efficient Sanitizer and Disinfectant.
- When combined with water it hydrolyzes to form hypochlorous acid and hypochlorite ion, depending on the pH.
  - HOCl
  - OCl^-

What is Total Chlorine?

- Total Chlorine is defined as the sum of the Free Chlorine and Combined Chlorine in the sample.
- Combined Chlorine is formed by the reaction of Free Chlorine with Organic Compounds, Ammonia or other nitrogen compounds.
- Two of the most common forms of Combined Chlorine are Monochloroamine (MCA) Dichloroamine (DCA)
- Total Chlorine is typically a regulatory measurement in wastewater to satisfy discharge requirements.

How is Chlorine Measured?

- DPD Method (N, N-diethyl-p-phenylenediamine sulfate)
- One of the most widely used testing methods for Free and Total Chlorine
- Forms a pink color with an intensity proportional to the chlorine concentration
- The testing can be automated or handheld measuring the intensity of the color formed
- FAS-DPD testing (pink to clear with addition of thiosulfate drops)
- DPD is not specific for chlorine it responds to most oxidizers

How is Chlorine Measured?

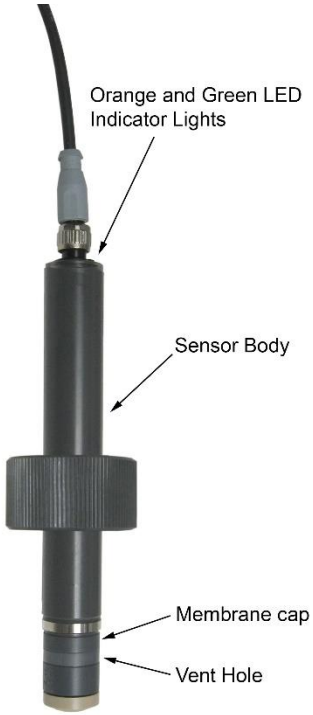
- Amperometric Analyzers
  - Measure current between two polarized electrodes
  - No Reagents are needed
- ECD Chlorine Analyzers
  - FC80 Free Chlorine
  - TC80 Total Chlorine
- Panel Mounted Plumb and Play design
  1. Constant Head Flow Controller
  2. pH Sensor in Flow Cell with sample port
  3. Chlorine Sensor in Flow Cell
  4. T80 Analyzer
  5. Spray Cleaner solenoid

How do they Work?

- The instrument applies a fixed voltage across the sensor referenced to the 316SS counter electrode.
- This polarization voltage generates a polarization current in the sensor.
- The current consumes all oxidants in the sensor and the sensor stabilizes at the “zero point current.”
- The initial polarization takes about 60 minutes.
- The Chlorine sensor is now ready to use.

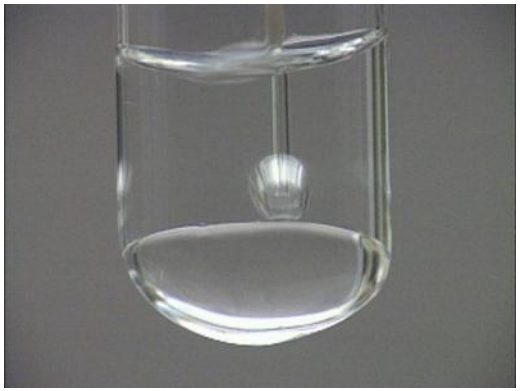
Total Chlorine Sensor

- Amperometric Design
  - Externally polarized by the analyzer
  - Gold Cathode
  - Silver-Silver Halide Anode
  - 316 SS Counter Electrode
  - Digital communication
- Replaceable Micro Porous Teflon Membrane
- Refillable Potassium Iodide Gel Electrolyte
- PVC outer body

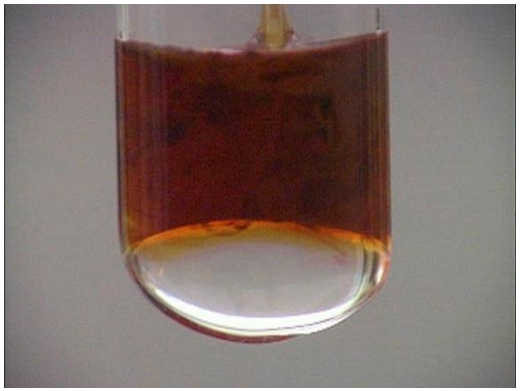


Total Chlorine Sensors

- The Micro Porous membrane allows all oxidizers to pass through.
- When an oxidizer diffuses through the membrane it oxidizes the iodide to iodine, reducing the Chlorine compound to Chloride
- Iodine is then reduced at the cathode back to iodide.
- Silver is oxidized off the anode in response to the chloride and iodide ions.
- The current flow from the oxidation and reduction reactions is proportional to the Total Chlorine concentration.



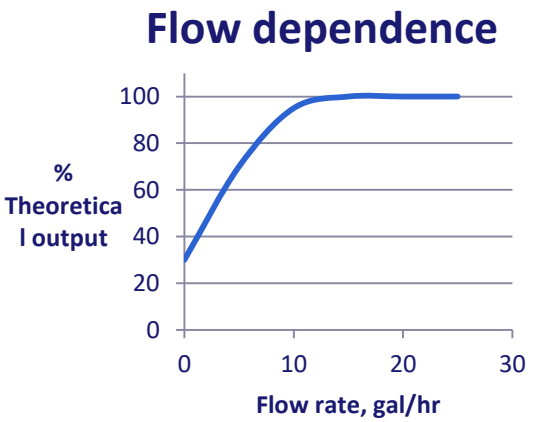
Potassium Iodide (KI)



KI plus Chlorine yields Iodine

Measurement Influences: Flow

- Flow Sensitivity
  - The Chlorine sensors consume chlorine depleting the area around the sensing tip
  - Flow replenishes the chlorine supply
  - Constant flow is required for a stable measurement
  - Low flow = Low reading
  - Chlorine readings are unchanged with flow rates above 0.5 ft./sec

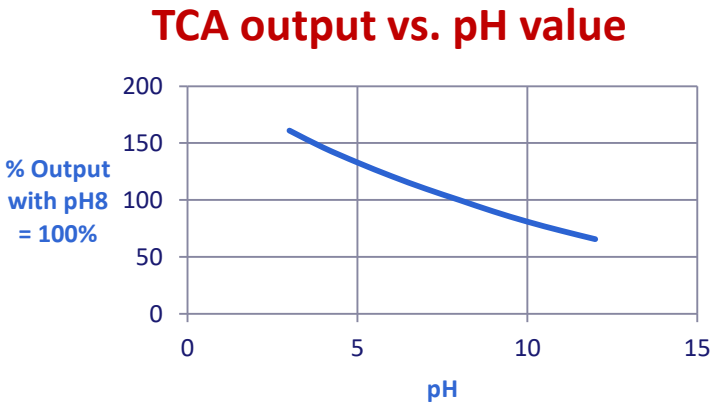


Constant Head Flow Controller

- The Constant Head Flow Controller (CHFC) eliminates the need for Pressure Regulators and Rotameters to control the flow by the sensor.
  - CHFC has ¼” ports
  - No small orifices to clog
- The unique overflow design maintains a constant flow at the sensor with incoming variations between 8 and 80 gal/hr.

Influences: pH Total Chlorine

- The Total chlorine concentration is not affected by the pH of the solution.
- The Total Chlorine sensor is affected by the pH of the solution, about -5% per pH unit
- The Total Chlorine concentration does not change with changes in pH but the output of the sensor increases as the pH gets lower.
- The sensor's equilibration time to pH changes is typically 3-5 minutes, T90 < 30 seconds



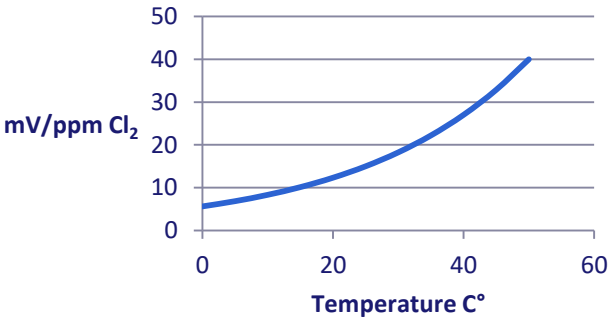
pH Sensor or Reagents?

- pH influences the output of the Total Chlorine sensor
- The pH must be controlled by adding reagents, typically acetic acid (vinegar) or
- The pH must be measured and used to calculate the interaction

Measurement Influences: Temperature

- Temperature Sensitivity
  - Output increases with temperature, 4-6 % per C°
  - Primarily due to the increased permeability of the membrane at higher temperatures
  - Output decreases with cooling.
- The TC80 Sensor has built in temperature compensation.
- The TC80 Sensor outputs a Temperature Compensated reading.

Temperature Dependence, 4%/C°



Measurement Influences: Coating

- Iron and Manganese precipitate from some waters after chlorination
- Bio-Films grow on most surfaces when little to No chlorine is present
- Mud and silt can settle out from some sample waters
- Regular cleaning is necessary
  - Manually with a squirt bottle and rag or
  - Automatically with the Spray Cleaning option
  - Period and duration controlled solenoid with 40+ psi water or air back flushes the system

Maintenance

- All Analytical Instrumentation requires regular Maintenance
- Weekly DPD verification of grab sample
  - The Handheld HCA1 Photometric meter is an easy to use accurate grab sampling device
- Verify pH is correct weekly, standardize the reading if more then 0.2 pH off
- Visually inspect for sedimentation or fouling in lines

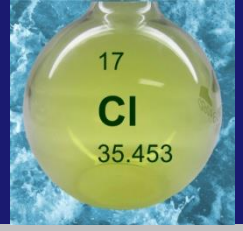
Maintenance

- TC80 replace electrolyte every 4-6 months and membrane cap yearly
- pH electrode replacement every 6-12 months depending on water quality.

Meet EPA Requirements?

- YES !!!!
- METHOD 334.0: DETERMINATION OF RESIDUAL CHLORINE IN DRINKING WATER USING AN ON-LINE CHLORINE ANALYZER
  - This method is for the analysis of residual chlorine (free or total) in drinking water. It is primarily intended to be used by drinking water utilities for compliance with daily monitoring requirements. This method allows the use of any type of on-line chlorine analyzer (e.g., amperometric, DPD, etc.) for compliance monitoring when used in conjunction with a grab sample reference method that is approved for drinking water compliance monitoring. This method is intended to be used when chlorine residuals (free or total) are in the range of 0.2 mg/L to 4 mg/L.

EPA
United States Environmental Protection Agency



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