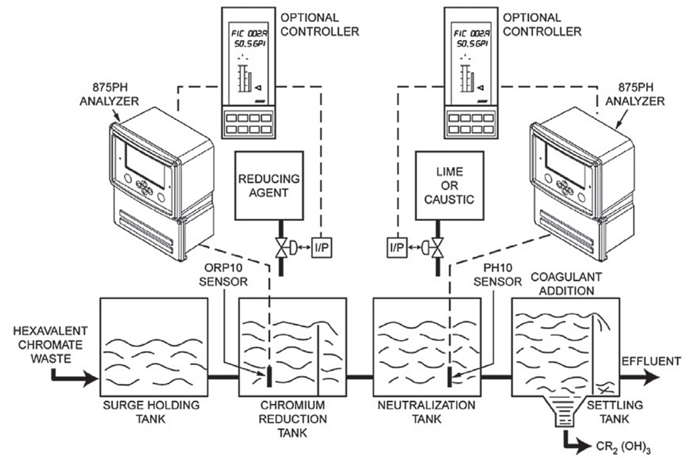
Foxboro® 875PH Series pH and ORP Electochemical Analyzers

Control and Monitoring in Chromate Waste Treatment



Summary

Foxboro analyzers and sensors can measure the most demanding pH applications. DolpHin™ sensors utilize a unique, glass formulation for high-temperature service. Their breakthrough performance comes in a robust, easy-to-use package. The innovative reference electrode is stabilized and protected from process contamination and clogging through a double junction design and an ion barrier.

Business Value

With more than 40 years experience in measurement, Foxboro offers the most complete line of instrumentation available. The proven reliability and robustness of the Foxboro 875PH Analyzers, DolpHin sensors, and accessories provides users with an online analysis package with a price/performance value that is hard to beat.

Foxboro® Analyzers and Sensors

The Foxboro 875PH intelligent analyzer and DolpHin™ sensors are a proven system for demanding pH measurement applications. The 875PH analyzer provides ease-of-use advantages such as two alarm relays, two 4-20 mA outputs, and an optional HART Communications Protocol for remote configuration. The Foxboro DolpHin pH sensors utilize a proprietary glass formulation for high temperature service, allowing use in applications with temperatures as high as 250°F (121°C).

Technical Challenge

Chromates used as corrosion inhibitors in the metal plating industry produce highly toxic waste solutions from plating and rinsing procedures. The toxic hexavalent chromate species can be neutralized into a less toxic insoluble trivalent form, which is capable of being precipitated as a hydroxide at a pH value of approximately 8.5. Three commonly used reducing agents are ferrous sulfate, sodium metabisulfite, and sulfur dioxide. Ferrous sulfate and sodium metabisulfite require a pH adjustment to approximately 2.5 pH for a rapid reduction to occur. However, sulfur dioxide gas forms sulfurous acid in solution and typically does not require additional acid additions. The chemical reactions for these reductions are shown in Table 1.

The Foxboro Solution

The pH and ORP (oxidation-reduction-potential) monitoring and control of reagent addition is easily accomplished using 875PH pH/ORP Electrochemical Analyzers and DolpHin Sensors, regardless of which reducing agent is utilized.

The 875PH pH/ORP Analyzer is one of a family of Foxboro Electrochemical Analyzers. The analyzer can be configured to read in units of pH or mV. Two analog outputs are standard; one output may be connected to a recording device, and the second to a controller for reagent additions.

Alternately, the alarm relays can be used to control pumps for reagent additions. Dual, independent, Form C dry alarm contacts, rated at 5 A at 250 V ac, 2 A at 30 V dc, nonincendive, are provided. The alarms can be configured to operate with a concentration dead band, or with timed actuation and delay. When the alarm is actuated, a reagent pump begins feeding reagent into the reaction vessel. The reagent neutralizes the hexavalent chromium, or adjusts the pH. When this time is completed, a second timer prevents the alarm from reactivating, thus allowing time for adequate mixing. The timers can be set for up to 99 minutes. After the sequence is completed, and the instrument is still in an alarm state, the feed timer and delay timer repeats the sequence again until the control value is reached. The relationship is shown in Figure 1.

The sensor choice is also very important in the neutralization process. The correct choice of process sensor materials and installation hardware greatly enhances reliability of the measurement. DolpHin pH and ORP sensors are available with compatible body, measuring and reference electrode parts, O-rings, and accessories for each step of the neutralization process. Gold ORP measuring electrodes have been found to be superior to platinum in chrome reduction procedures. Figure 2 illustrates the ORP potential observed during chromium reduction using sodium metabisulfite (SHE reference).

Selecting 875PH Analyzers, DolpHin sensors, and accessories provides users with an online analysis package with a price/performance value that is hard to beat.

Figure 1: On/Off Control Using “On-time” and “Off-time” Parameters

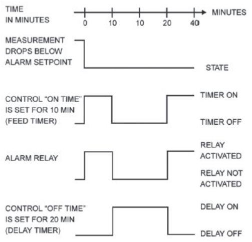


Figure 2: Chromium Reduction with Sodium Metabisulfite

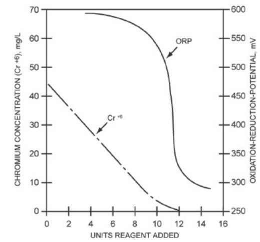


Table 1 – Neutralization Reactions of Chromium to Trivalent Form Using Different Reagents

Reagent and ORP (a)	Type of Reaction	Equation
Ferrous Sulfate +500 mV at pH 2	Hydrolysis	$CrO_3 + H_2O \longrightarrow H_2CrO_4$
	Reduction	$H_2CrO_4 + 6FeSO_4 + H_2SO_4 \longrightarrow Cr_2(SO_4)_3 + 3Fe_2(SO_4)_3 + 8H_2O$
	Precipitation	$Cr_2(SO_4)_3 + 3Ca(OH)_2 \longrightarrow 2Cr(OH)_3 + 3CaSO_4$
Sodium Metabisulfite +380 mV at pH 2.5	Hydrolysis	$Na_2\ S_2O5 + H_2O \longrightarrow 2NaHSO_3$
	Reduction	$H_2CrO_4 + 3NaHSO_3 + 3H_2SO_4 \longrightarrow Cr_2(SO_4)_3 + 3NaHSO_4 + 5H_2O$
	Precipitation	$Cr_2(SO_4)_3 + 3Ca(OH)_2 \longrightarrow 2Cr(OH)_3 + 3CaSO_4$
Sulfur Dioxide +165 mV at pH 2.9	Hydrolysis	$SO_2 + H_2O \longrightarrow H_2SO_3$
	Reduction	$H_2CrO_4 + H_2SO_3 \longrightarrow Cr_2(SO_4)_3 + 5H_2O$
	Precipitation	$Cr_2(SO_4)_3 + 3Ca(OH)_2 \longrightarrow 2Cr(OH)_3 + 3CaSO_4$

(a) Nominal ORP potentials versus Standard Hydrogen Electrode (SHE).

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