pH AND ORP MONITORING FOR THE INDIGO DYE PROCESS

BACKGROUND

Indigo dye is used for dyeing cotton and other cellulosic fibers such as rayon. In its pure form, indigo dye is not soluble in water, so the dye bath contains additives to solubilize it.

Sodium hydrosulfite ("hydro", sodium dithionite, $Na_2S_2O_4$) is present in the dye bath to reduce the indigo dye to its reduced (leuco) form. Sodium hydroxide (caustic, NaOH) is added to the bath to form phenolates with the reduced indigo dye, which are water soluble.

After the dye has been applied to the fabric, it is reoxidized to its insoluble form which makes it resistant to water and other environmental factors.

THE PROCESS

pH:

The properties of the dye are affected by the pH of the bath solution. There are actually two phenolates that can form in solution depending upon the amount of caustic added.

The first is monophenolate, which is predominant between pH 11.0 and pH 11.5. Monophenolate has relatively low affinity for the fabric, which leads to a more thorough and uniform dye penetration.

The second, diphenolate, predominant between pH 12.5 and pH 13.5, has a higher affinity for the fabric and tends to aggregate on the surface of the fabric. This leads to a deeper blue color, a faster rate of dyeing (strike rate), and the ability to be washed down to a faded denim look.

Measurement and control of the dye bath pH can be used to maintain either form of phenolate, in order to produce the desired effect.

Oxidation-Reduction Potential:

The oxidation-reduction potential (ORP) must be maintained at a low enough level to keep the indigo dye in the reduced (leuco) form for solubility. The ORP of the bath can also affect the final shade. The typical ORP range is -760 to -860 millivolts, with the actual target ORP dependent upon the desired final shade (Figure 1).

INSTRUMENTATION

The dye bath pH is greater than pH 10, so the pH electrode used must be a high pH electrode to minimize the effects of sodium error.

Mounting of the sensors can be either retractable, in-line, or submersed, depending upon particular design of the equipment. In any case, the sensors should be mounted so as to receive a representative sample. When controlling caustic (NaOH) is added, the sensors should be immersed in a well mixed sample. The lag time between the moment the additives are applied and the time the sample reaches the senor should be minimized.

If local indication and alarming are required, the Model 1056 analyzer can be specified. The 1056 is available as a single or dual measurement instrument with dual 4-20 mA outputs and three alarms. The Model Xmt-P pH/ORP Smart Two-Wire transmitter with FOUNDATION fieldbus or HART communication can also be used.

INSTRUMENTATION

Model 1056 Multiparameter Analyzer

- Large local display and operator interface
- Single or Dual Input
- pH/ORP/ISE, Resistivity/Conductivity, % Concentration, Chlorine, Oxygen, Ozone, Temperature,Turbidity, Flow, and 4-20mA Current Input.
- Profibus DP and HART Digital communications protocols available

Model 385+ Retraction/Insertion/ Submersion pH/ORP Sensor

- High pH glass option
- Advanced on-line sensor diagnostics
- Retractable version allows safe removal and replacement under pressure without process shutdown
- Long-life, triple junction reference electrode provides longer service life where poisoning ions are present
- TEFZEL and Titanium design provides maximum chemical resistance and economic advantage

Model Xmt pH/ORP Smart Two-Wire Transmitter

- Digital communications
  - FOUNDATION Fieldbus
  - HART
- Complete diagnostics
- Two-wire, loop powered

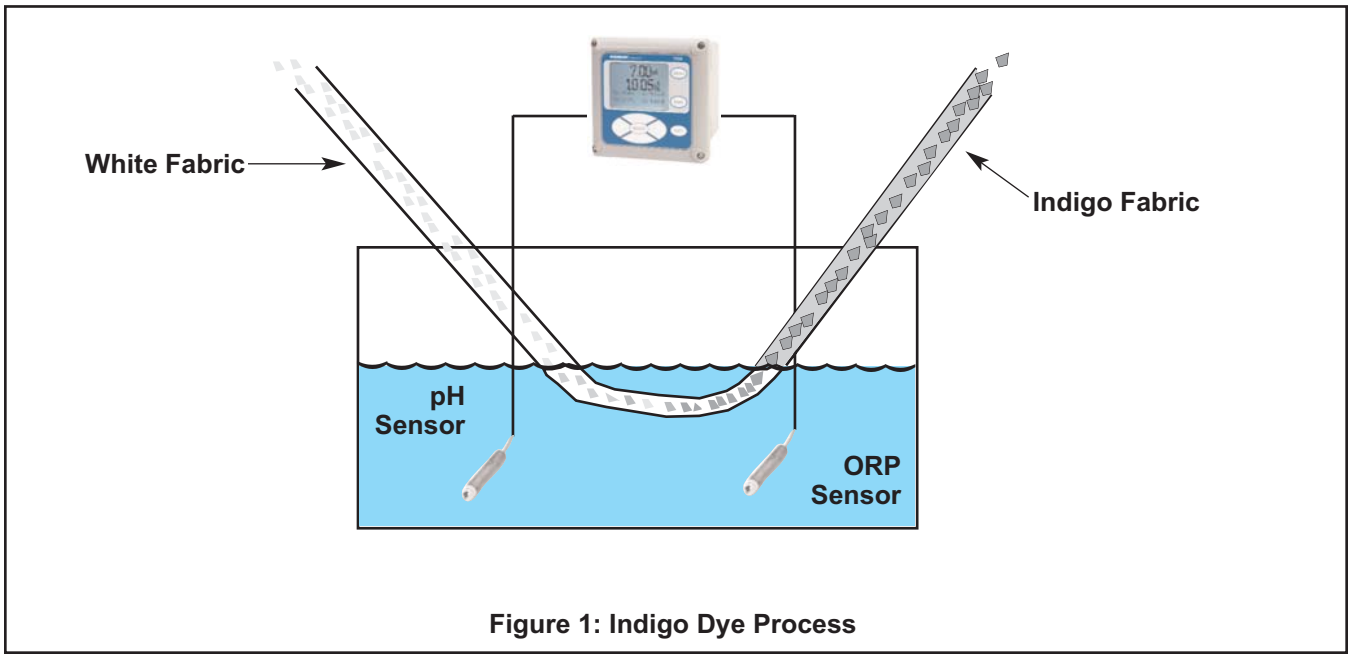

Figure 1: Indigo Dye Process

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