Success Story

INGOLD
Leading Process Analytics

Controlling Oxidative Disinfectant Chemistries

Using On-Line ORP Analysis

Chlorine products are widely used in the pulp and paper industry due to the inherent strong oxidizing and disinfection power. The measurement of Oxidation Reduction Potential (ORP) provides chlorine strength, which is valuable for on-line control.

Appleton Coated L.L.C.
Combined Locks, USA

Appleton Coated L.L.C. in Combined Locks, Wisconsin, USA, produces 1100 tons per day of Coated Free Sheet (CFS) paper on three paper machines. CFS grade lines have diverse furnishes, some of which include BCTMP (Bleached Chemical Thermal Mechanical Pulp) and varying levels of machine and recycled broke. Subsequently, maintaining levels of oxidants in the system sufficient to maintain microbiological control without adversely affecting color control when overfed has been the challenge.

Paper mill application history

The first ORP was installed to monitor the water leaving the Dynasand Upflow Filters and gravitating into the 750,000 gallon clearwell storage containment. The second ORP meter was installed to monitor the water leaving the clearwell for the mill's distribution system. In the following year a third ORP meter was

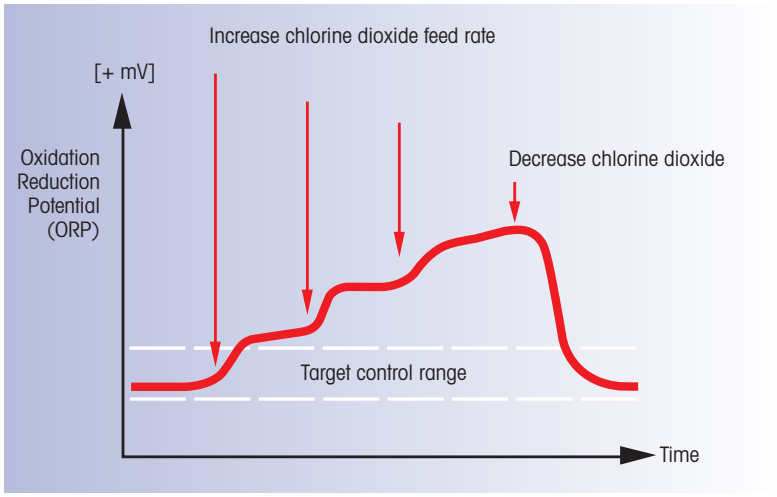

Figure 1: Chorine feed rate effect.

METTLER TOLEDO

installed at the end of the filtered water distribution system to insure full disinfection throughout the entire system.

During winter, as the river water temperature approaches freezing, the reaction time of the sodium hypochlorite for disinfection and the alum for flocculation and color removal slows down substantially. The ORP and conventional bacteria counts verified lapses in disinfection. As a remedy, chlorine dioxide was added to the filters as an additional fast acting disinfectant.

The obvious next step was to take ORP technology to the paper machine. Over the next five years in-line ORP measurement on various machine water loops failed primarily due to probe fouling. In 2004 Mettler-Toledo INGOLD installed a redox probe in the cleaner bank very close to the headbox on #1 paper machine. The velocity of the stock furnish in the area was very effective at preventing the probe from fouling. As an added precaution, a retractable housing was installed to allow operators to clean the probe in the event of fouling.

Operational and experimental observations

Several cause and effect ORP relationships have been observed during normal mill operations. In addition, deliberate "upset" testing has been performed to demonstrate further interactions, as summarized later on.

ORP technology from METTLER TOLEDO

The inline ORP measurement loop from METTLER TOLEDO which was installed to gain the following findings consisted of: the pre-pressurized, liquid-electrolyte ORP electrode InPro 3250 SG with a platinum contact near the tip (solution ground) allowing measurements of the redox potential; the CPI proven retractable housing InTrac 777/NPT with a TRI-LOCK™ safety system and a flushing chamber for regular cleaning without process shut down; the transmitter pH 2100 e with RTD and diagnostic functions as well as PID controller.

Chlorine dioxide feed rate

The chlorine feed rate was deliberately varied in order to demonstrate the ORP response under otherwise stable conditions (Fig. 1). Successive increases in chlorine feed rate yields a positive (+) increase in ORP reading. Decreasing chlorine feed rate results in a less positive reading.

Other cause and effect ORP relationship

Impact of paper break. The most significant process change to impact ORP values is a paper break. It was standard procedure on a break to shut off the dyes, ash and broke. The ORP spiked substantially on every break, because the flow of all the reducers in the system was shut off, but the oxidant continued to flow. The excess oxidant in the system was causing bleaching and loss of color control when the sheet was back on the iron.

Filler material. Another significant finding was the unexpected reductive potential of the filler materials, granulated calcium carbonate and precipitated calcium carbonate. Increasing flow of either of these fillers causes a lowering of ORP value. With this information we were able to stabilize the dramatic changes in oxidant demand observed above, by reducing rather than completely shutting off some of the fillers on machine breaks.

Introduction of process water. During machine breaks, additional fresh process water is drawn into the machine system. This water contains a rather high chlorine residual. An increase in the ORP value was seen each time a large amount of process water entered the system.

Grade shift. Changing between various grades of product in some cases results in an increase in ORP while other grades cause a decrease in ORP.

Post consumer waste. Use of post consumer waste acts as a reducer and was shown to cause a moderate decrease in ORP.

METTLER TOLEDO solution

In the months that followed the initial trial on #1 paper machine, ORP loops consisting of the pH electrode InPro 3250 SG together with retractable housing InTrac 777/NPT and transmitter pH 2100 e were installed on the other two machines, and the oxidant addition programs adjusted based on the ORP results. The mill then took the process one step further and fed the signal from the transmitter to the mill's DCS Process Control system to provide real time on-line measurement at the control centers.

Quick return on investment

In all the applications, the installation of an ORP meter provided a nearly immediate return on investment. Many "reducers" have been identified as contributors to oxidant demand competing directly with added oxidant, thereby lessening disinfection action. Knowledge of these interactions permits implementation of corrective actions to minimize the ORP upset and bring concentrations within target control range in much shorter time as illustrated in Fig. 2. This results in shorter times of out of spec product color and minimizes corrosion while maintaining sufficient disinfection action.

The most drastic economical outcome of the ORP monitoring has been the ability to run increased levels of machine broke and CFS broke, without the typical loss in microbiological control and subsequent deposits/holes in the sheet. By maintaining a target ORP setting and adjusting the oxidant feed optimal running conditions were maintained.

It has been demonstrated that online measurement of ORP can be achieved. Required maintenance is minimal, particularly with use of retractable housings. Monitoring and control of oxidant addition based on ORP has proven effective for microbiological disinfection in several application points throughout the mill.

Cases where the oxidant demand varies based upon product changes or process upsets particularly benefit from ORP control. Results have minimized production downtime and improved product quality, representing substantial financial benefit.

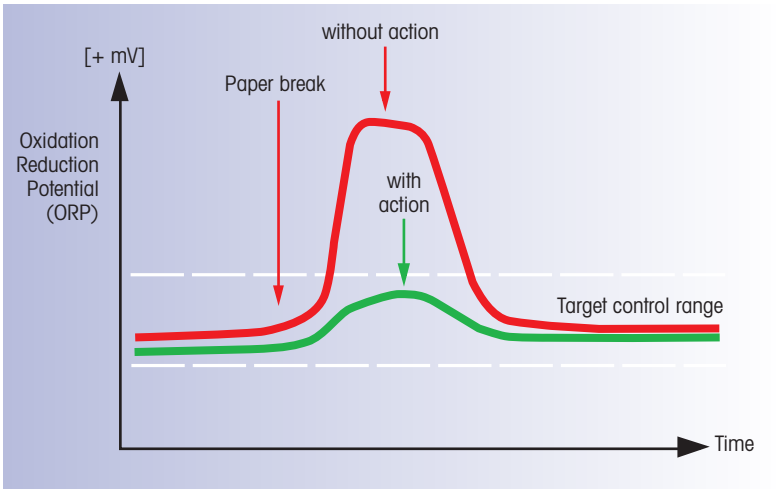

Figure 2: Effect of corrective action.

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