Optical bleach plant concept pares chemical costs

The new approach to bleach plant control includes an inline transmitter that measures fiber-bound and dissolved lignin, replacing sampling Kappa analyzers.

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In pulp mill processes that often have long transport time delays it is always better to know what process upsets are coming in to a process stage rather than what has already happened afterwards. Then the reactive control response can be fast and sure. BTG's new Bleach Load Transmitter (BLT-5500), coupled with bleach plant controls accomplishes just that, and provides an excellent return on investment. The transmitter recognizes the total chemical demand coming into the bleach plant by measuring the bound lignin content of the incoming pulp fibers (the traditional Kappa number) plus the chemical-consuming dissolved lignin carried over from the brownstock washers in the pulp slurry filtrate. As a result, the dynamics of bleach plant control have been improved and control can be more precise, since the controls can react to the total chemical demand of the dissolved and fiber-bound lignin in a fast feedforward manner. Moreover, the continuous inline measurements are an improvement over sequential sampling that has a measurement update cycle of several minutes, thus avoiding control overshoots of bleaching chemicals.

This inline transmitter combined with other inline sensors for brightness and chemical residual has been named the Optical Bleach Plant™, meaning that all measurements are made optically and inline. Therefore, the sampling Kappa analyzer with its sampling devices, screens, pneumatics and transport lines is no longer necessary. BTG says that capital costs, installation and lifecycle costs can be reduced. The demonstrated economic benefits are compelling as well. Coupled with bleach line controls that can avoid chemical over-consumption, the benefits include significant savings in bleaching chemicals.

Heads-up measurement

Online sampling Kappa analysis for pulp fiber was introduced in the 1980s and has since been applied in hundreds of fiber line applications, including the bleach plant where it has become a cornerstone of ECF kappa factor bleaching control. This mature technology, which works very well for its purpose, samples the incoming pulp to the bleach line and then measures the Kappa number of the fibers in a washed pulp sample. That series of sequential measurements are then used as feedforward inputs to bleach line controls coupled with downstream measurements of pulp brightness and chemical residual, plus pulp consistency and pH. The objective is to attain the right degree of delignification and – most importantly - the target pulp brightness with a minimum of chemical consumption.

However, dissolved carryover from the brownstock washers is not recognized by a sampling analyzer since the filtrate is washed away. Changes in carryover are therefore compensated by time-delayed feedback from downstream brightness and chemical residual sensors. In practice, process operators tend to build in a safety margin for the chemical dosage rate to compensate for unpredictable changes in dissolved lignin carryover. This chemical control target “bias” is used to make sure no off-specification pulp is made if too much chemical is consumed by dissolved lignin. This habit raises the costs of bleaching chemical consumption. However, with the advance “heads-up” measurement total chemical demand before the first stage, chemical addition rates can be precisely controlled based on total bleach demand and this upward biasing of the dosage target can be avoided. The chemical savings are then possible.
Inline continuous measurement

The measurement of total bleach plant lignin load is based on the reflectance of ultraviolet and infrared light at several wavelengths. The measuring technique is the same as used in BTG's Kappa Analyzer; only the light sources are LEDs in the BLT-5500. The sensing head signal processing is supported by an electronics module that is common to all BTG analyzers. External communications are through HART. Since the transmitter is inline no sampling devices, supporting utilities or transport lines are required. The measuring head itself has no moving parts nor washing sequences, hence the maintenance requirements are low.

Figure 1: The inline transmitter provides a continuous reading

The transmitter is calibrated to a fiber Kappa laboratory test as well as a second Kappa test of the filtrate. The two tests combined indicate total bleach plant load. The calibration to total bleach plant load uses SPC techniques to ensure that is robust. BTG provides the recommended testing procedures and follows the progress with mill visits.

Mill results

In an Optical Bleach Plant configuration the BLT is combined with other inline sensors for brightness and chemical residual. These measurements plus consistency and pH are used in Kappa factor controls or in multi-variable bleach plant advanced process control (APC) strategies, see figure 2. In several cases the measurements have been implemented as an input to Honeywell's advanced process control (APC) for bleach plants. BTG and Honeywell have had a cooperative pulp line process control development program in place since 2010. In cooperative pulping and bleaching projects BTG supplies all the instruments, inline brightness and chemical residual sensors, sampling devices and consistency measurements required for any process control vendor's APC.
Figure 2: In an Optical Bleach Plant configuration the BLT is combined with other inline sensors for brightness and chemical residual.

Mill results are impressive. One North American mill reduced the bleach plant chemical consumption by 10% using the BLT-5500 with APC controls. In another case the BLT-5500 plus traditional feed forward Kappa factor control saved a mill $300,000 per year in chlorine dioxide costs in the D0 stage with a payback time of just a few months.

With the Optical Bleach Plant strategy the chemical savings can come from the D0 stage and the D1 stage, as a carry-through effect. As an example, a mill replaced an existing sampling Kappa analyzer that was being used for D1 stage chemical dosage with new models of the brightness and chemical residual sensors. Using an inline optical brightness measurement rather than a sampling Kappa measurement makes sense since the main function of D1 stage is to brighten the pulp rather than to delignify it, as in the D0 stage. Moreover, the pulp lignin content before the D1 stage is so low that Kappa measurement sensitivity may be an issue. Figure 3 shows the results of the new sensors and traditional regulatory feedforward controls. Notice that the ClO2 application is much more stable while on optical sensor based control. At an incoming brightness of 55 the application of ClO2 in the D1 stage before placing the optical brightness sensor, in closed loop control, ranged from 1.43% to 1.65%. The average was 1.55%. At the same brightness after the optical sensor update and control implementation the dosage ranged from 1.28% to 1.38% with a 1.32% average. The chemical savings were 15%. For a 1000 TPD mill with ClO2 costs of $0.5/lb this is corresponds to $800,000 per year savings.
Figure 3: With closed loop control using an optical brightness transmitter this mill achieved a 15% reduction in ClO2 consumption in the D1 stage. The vertical scale is % ClO2 dosage while the horizontal scale is EOP brightness.

After being introduced in 2010 there are currently 12 operating BLT applications. Five bleach lines are using the complete Optical Bleach Plant concept.