Improved Causticizing Control using FT-NIR Analyzer and CAUST-X Controls at Celgar Pulp

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ABSTRACT

Zellstoff Celgar LLP is using a Fourier-Transform Near Infrared Spectrometer (FT-NIR) analyzer to measure the chemical constituents of various liquor streams in the recovery area. This information is used to control the Green Liquor Total Titratable Alkali (TTA) in the dissolving tank and causticizing areas, and to control the White Liquor (WL) Causticizing Efficiency (CE). It is also used to monitor Green Liquor (GL) Reduction Efficiency, liquor sulphidity, and solids content of our liquor. This paper will discuss the results produced since commissioning the system. The mill has benefited from an increase in Causticizing Efficiency (CE), a reduction in the standard deviation of white liquor effective alkali, production of a more consistent cooking liquor and faster response to changing mill requirements.

BACKGROUND

Zellstoff Celgar LLP, located in Castlegar, BC, is a modern single line Kraft mill and producer of renewable power. The mill significantly updated in 1993 and in 2012, is currently producing 490,000 ADT of pulp and 521 GWh of power. The mill continues to improve its throughput with the goal of producing 540,000 ADT of pulp annually by 2018. With this projected capacity increase it is imperative that the mill operate as efficiently as possible. Installation of an on-line analyzer and advanced control system in the chemical recovery cycle will assist in reducing the possibility of the recausticizing process from becoming a bottleneck to production. Celgar's recausticizing system has four causticizers, a WL pressure filter, a lime mud pressure filter and a 380' lime kiln with a production capacity of over 450 tpd.

There are many compounds present in Kraft liquors and the wet chemistry procedures performed by technicians provides information to operators every two hours. The titrations performed are also susceptible to variations in the technician's assessment of the end-point determination. A Kemotron system previously provided more frequent data, but its reliability was impaired by drifting readings due to scaling and required frequent cleaning and calibration. The frequency and accuracy of the FT-NIR analyzer and the TEXO CAUST-X APC allow the system to operate closer to target values.

The online analyzer is the FT-NIR technology developed by FPInnovations and is currently being commercialized by FITNIR Analyzers Inc. A demo FT-NIR unit was installed at the mill in March 2011 to analyze the Clarified Green Liquor (CGL) composition and control the TTA. The result of the trial showed a reduction in standard deviation by 46% which encouraged the mill to adopt this technology. In early 2012, with funding from the Pulp and Paper Green Transformation Program (PPGTP), the mill invested in a FT-NIR analyzer which takes regular measurements of: Raw GL, Weak Wash, CGL, Causticizer 1, Causticizer 4, and WL.

Celgar commissioned FITNIR Analyser Inc. to implement a six-stream analyzer system, based on software FTSW100 version 2.71, to provide complete liquor composition determination as well as solids content. The FITNIR analyzer provides reliable and accurate compositions of green and white liquors. Traditional measurements for the recausticizing operation include differential temperature, density and conductivity. All of these measurement techniques infer a concentration of EA, TTA, sulphide, and/or carbonate. FITNIR provides more reliable concentrations of chemical compositions to perform superior slaker and CE control.

Celgar utilizes CAUST-X an advanced process control solution developed in partnership between TEXO and FPInnovations. CAUST-X is deployed under license directly within the mill DCS. CAUST-X consists of several modules: SMELT for raw green liquor TTA control, LIME for reburnt and fresh lime dosage to slaker, SLAKER for clarified green liquor, TEMP for slaker temperature control, and LQE lime quality estimator with CE soft sensors at causticizers.

RESULTS

Celgar's objective with the installation of the on-line analyzer and controls was to obtain an improvement in the WL strength and provide a consistent product to the digester. The beneficial results from the demonstration unit, which analyzed only the CGL stream, carried through to the installation and commissioning of the commercial system. Commissioning of the commercial analyzer started in mid-January and by mid-Feb 2012 all streams were up and running and validated, with the exception of the 1st Causticizser stream, due to a delay in the delivery of the pump. Figure 1 is a photo of the sampling station that is mounted in the recausticing area. A roof structure and plastic screen pane has since then been installed to minimize the amount of lime dust from settling on the sampling skid.

Figure 1: Celgar's FITNIR Analyzer Sampling Skid: six sample streams (RGL, CGL, WW, WL,#1C, #4C), shown without roof and plastic cover.

The DCS graphics showing the analyzer operations are illustrated in Figure 2. The DCS drives the sequences and triggers the request for each stream measurements. The analyzer would carry out the specific valve sequencing for sampling and scanning of the liquor to determine the liquor compositions. A sampling sequence consisting of CGL – #1C – RGL – #4C was implemented in the DCS and a timer was used for WL and WW, corresponding to every 2hrs. for WL and every 8hrs. for weakwash.

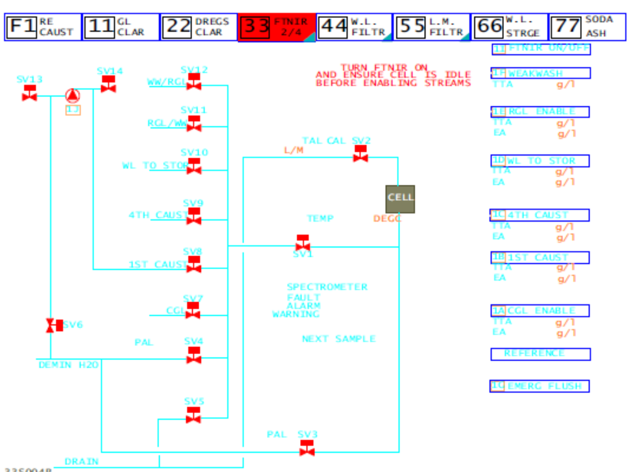

Figure 2: DCS schematic of the analyzer piping and valve operations.

Data from the analyzer is displayed both at the analyzer graphics as well as the recaust control graphics (Figure 3). One feature for the control graphics is that when a manual test is taken, the operator freezes the sampling time, thereby, when the manual test is completed sometime later, results can be better match with the online measurement values.

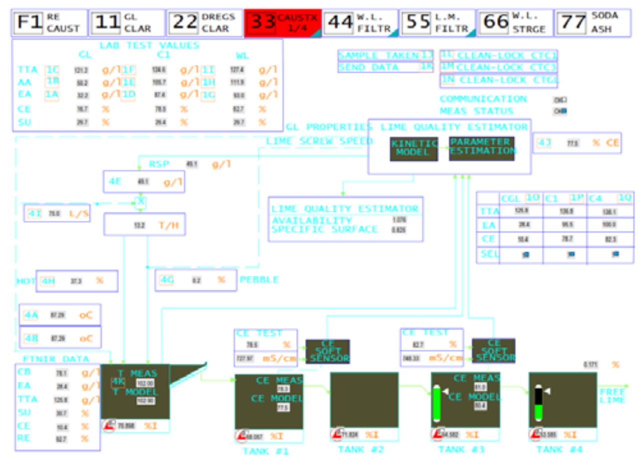

Figure 3 illustrates the DCS recaust control graphics with integrated FITNIR analyzer results and APC model parameters.

As the analysis and controls of the additional streams came on-line, further improvements to the WL have been measured. APC came online in Feb 2012, associated with the CGL, 4th Causticizer and WL while the 1st Causticizer application came on-line in July 2012 and the RGL came on-line in August 2012.

A trend of the CGL data since Feb. 2012 is shown in Figure 4. When compared to manual testing of the CGL TTA, we see good correlation and good stability of the process.

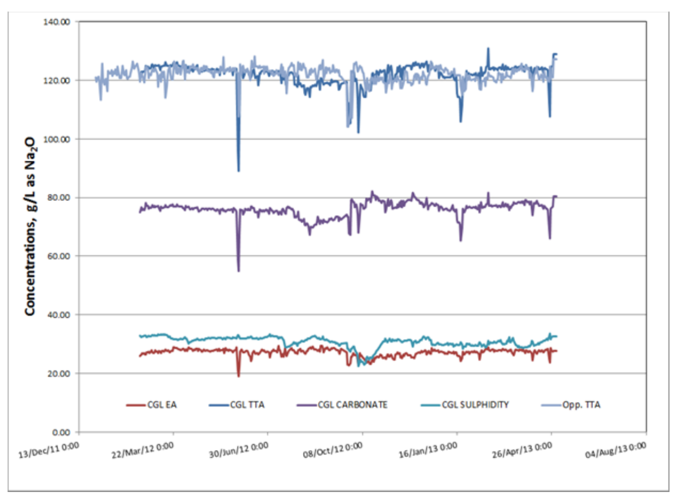

Figure 4. Trend of CGL data from analyzer since Feb. 2012. An overlay of the manual operations TTA value show good correlation.

Table 1 provides the results and the standard deviation of the WL prior to on-line analysis and control and through to the current status. It should be noted that the values for the period before the demo are based on operations' lab tests. There has been a continual improvement in the WL EA with a large decrease in the standard deviation of the product strength. The CE standard deviation has also improved and the CE increased (Table 2) with variability reduction by as much as 42%. The CE improvement once the RGL came on-line was most notable. Figure 5 - 6 show the 4th causticizer and WL EA and CE from the commissioning of the FT-NIR system until the present.

By improving the stability of the RGL at the dissolving tank, less variability is observed at the outlet of the green liquor clarifier feeding the slaker, and better control of the Causticizing process was realized.

The inorganic chemicals in the WL other than NaOH and Na_2S are non-active and referred to as dead load. Carrying dead load through the Kraft process has costs associated with chemical loss, reduced equipment capacity and operating problems. Celgar operates at a 30% sulfidity. According to Grace and Tran 2007 [4], the CE improvements that Celgar has seen would have decreased carbonate dead load by 22 kg/t of pulp. Since CaCO3 is the dominant dead load in the system and a serious contributor to scale in the digester system, this reduction in dead load will have a direct financial benefit.

It is estimated that a 1% improvements in CE would translate to an ROI of $1.5/ton of pulp [1-2, Allison et. al.] from reduction in energy requirement to evaporate the water that is associated with the dead load. The results show that there could be as much as 3% improvements in CE. Further ROI calculation needs to be done over time but the implementation of online liquor composition measurements and control have led to significant improvements to liquor quality and stability of the recaust operation. Similar process improvements were also documented by other mills that have implemented the FITNIR analyzer and the Caust-X control strategy [3, Goradia et. al.].

Table 1: White Liquor EA Results

	WL EA (g/L)	WL EA st.dev. (g/L)	WL EA st.dev. Reduction (%)
Before FT-NIR	88.14	4.52	-
CGL DEMO	88.40	1.76	-61.1
Feb 2012 - Aug 2012	89.40	1.94	-57.1
Aug 2012 - Apr 2013	90.70	1.93	-57.3

Table 2: White Liquor CE Results

	WL CE (%)	WL CE st.dev. (%)	WL CE st.dev. Reduction (%)
Before FTNIR	79.84	2.53	-
CGL DEMO	78.69	1.38	-45.5
Feb 2012 - Aug 2012	78.43	1.60	-36.8
Aug 2012 - Apr 2013	82.20	1.47	-41.9

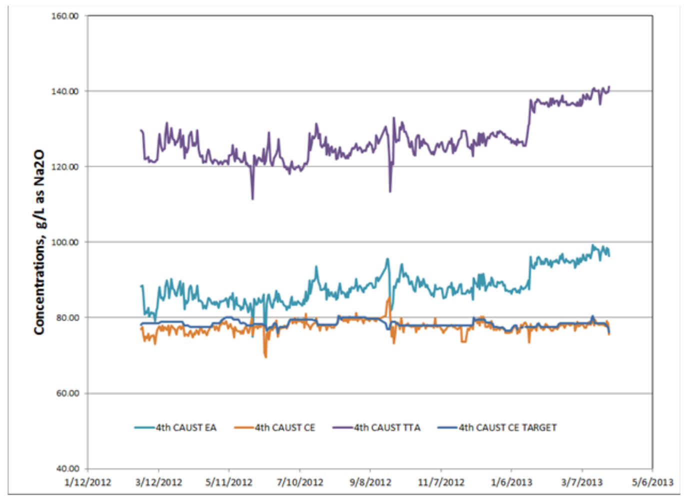

Figure 5: 4th Causticizer EA, TTA, and CE trend. 4th Causticizer CE target tracks well with FT-NIR CEs.

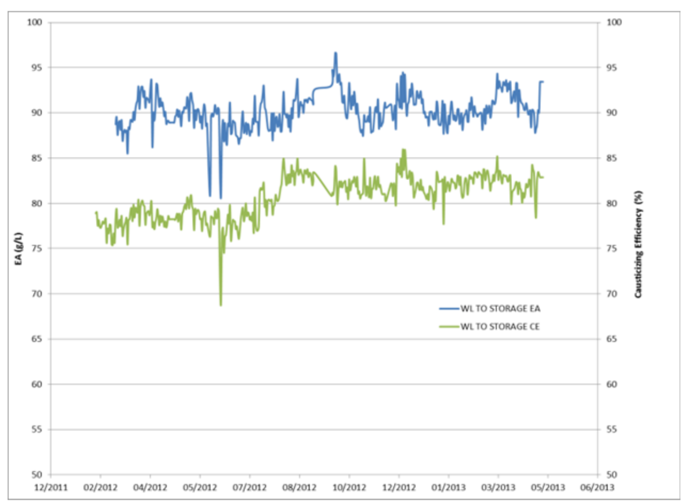

Figure 6: WL EA and CE utilizing FTNIR Analysis and CAUST-X Controls

CONCLUSIONS

Celgar's use of on-line analysis of liquor compositions and advanced controls in the recausticizing area has led to improvements in the final WL EA and CE. Although further ROI calculation is needed, the implementation has led to more stable recaust operation. 40 to 50 percent in process variability reduction was achieved and final WL CE was increased from 79 to 82 percent, resulting in dead load reduction in the liquor cycle. The consistency of the WL product sent to the digester decreases the amount of variability entering the cooking process. The FITNIR analyzer and CAUST-X system will enable Celgar to move towards advanced process control of liquor-to-wood ratio at the digester. The system is still relatively new and continued improvements on the control strategy and use of the data provided are being investigated.

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