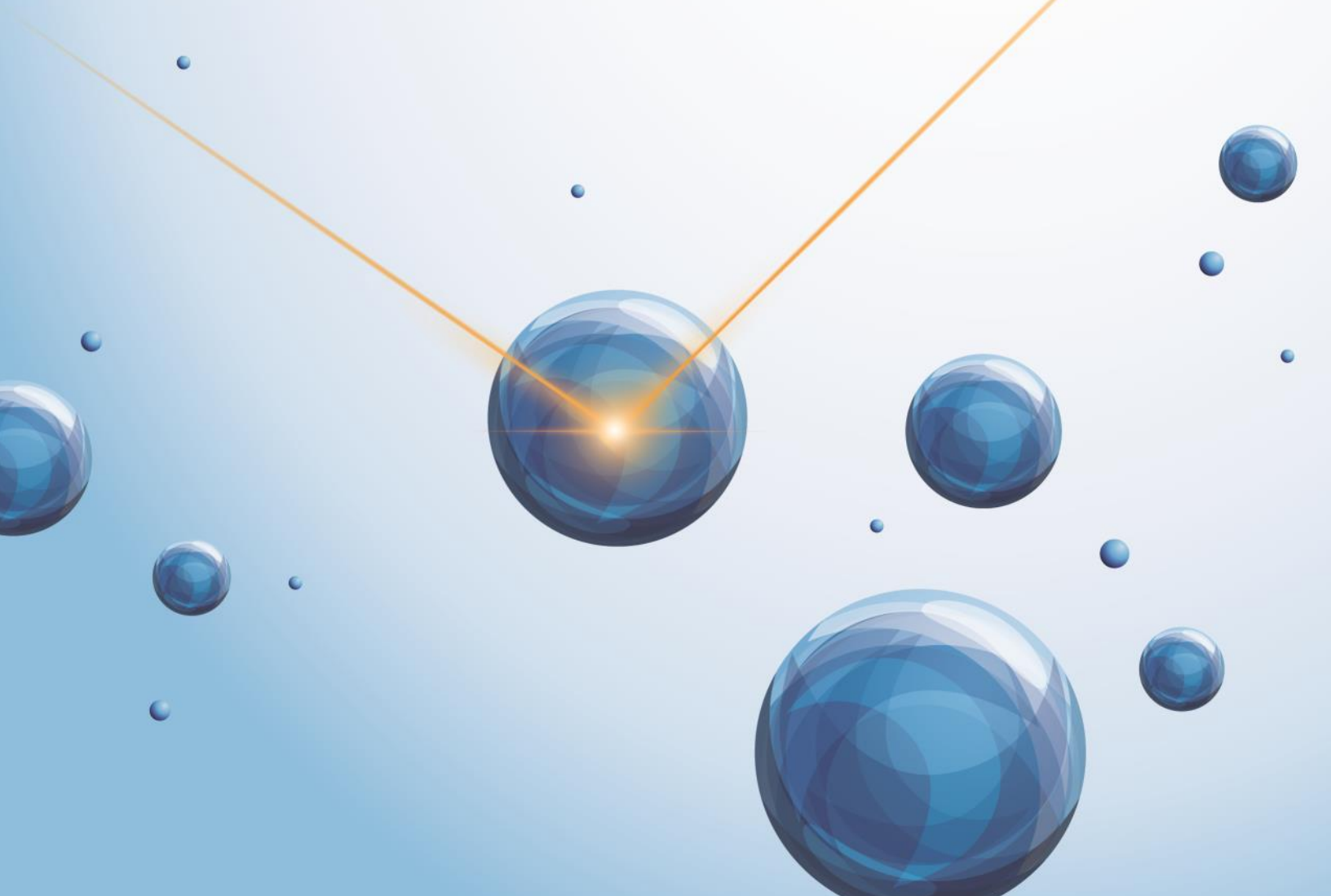




FITNIR ONLINE – RECAUSTICIZER APPLICATION

FITNIR's fully automated online analyzer reliably measures complete liquor compositions to help pulp mills decrease process variability for improved efficiency and profitability. Fast, frequent and accurate measurements drive process control strategies for optimization. FITNIR Online is capable of sampling from multiple sources and testing numerous components simultaneously, providing a complete green and white liquor concentration profile for the recausticizer. With its proven application for the recausticizer, FITNIR is the next generation of process analyzers for pulp mills.



Innovative Solution to Traditional Measurement Challenges

Online measurements of Kraft pulping liquors have historically been a hurdle for the pulp processing industry. Traditional measurement techniques (i.e., conductivity, density, temperature and differential pressure) have only had moderate success due to scaling and fouling of their probes, along with lacking chemical specificity that only infers key chemical properties. Until recently, the industry has accepted laboratory titrations as its method of choice for complete liquor composition analysis.

Today, FITNIR Analyzers provides reliable, accurate and true measurements for the broadest set of liquor properties. With its ability to provide simultaneous measurements of multiple chemical properties, minimal sample preparation, and no plugging or fouling, FT-NIR has become the technology of choice for superior causticizing efficiency.

Together with FPIInnovations, FITNIR Analyzers has developed and patented a comprehensive set of process analyzers using FT-NIR spectrometry to measure key parameters for process control in Kraft pulping operations. FITNIR offers proven applications for the recausticizer, digester, recovery boiler/ dissolving tank, chlorine dioxide generator, brownstock washer, and for kappa measurement.

MEASUREMENT PRINCIPLES

Near infrared (NIR) spectrometry, which roughly spans the frequency range 14000 cm^{-1} to 4000 cm^{-1} (700 nm to 2500 nm), comprises overtones and combinations of fundamental vibrations of -CH, -NH, -OH and -SH. Molecules and anions have unique spectral features that can be used for identification and quantification as the absorption bands are proportional to concentration.

By scanning the entire spectral region, simultaneous measurements of multiple chemical properties can be determined. NIR spectrometry has seen wide-spread use due to its lower water absorption bands. NIR can operate through glass, can be transmitted via low hydroxyl fibre optic cables, and requires minimal sample preparation. Furthermore, NIR is more amenable for use with large pathlength cells, as much as 10 mm to 20 mm, eliminating the possibility of plugging. FITNIR's process analyzers specifically focus on the use of FT-NIR technology due to its higher resolution, higher energy throughput, and stable and repeatable operations, all necessary for the accuracy and repeatability of online process analyzers.

PROPERTIES MEASURED

As shown in the table below, FITNIR Online's recaust application provides reliable, accurate and true liquor compositions through FT-NIR technology.

KEY FEATURES

- > **Fully automated for frequent testing**
- > **Patented, large pathlength flow cell for high repeatability and accuracy**
- > **Automated flushing of sample lines and cell with water prevents scaling**
- > **Sample scanning and measurements take only minutes (45 secs for scanning)**
- > **Data transfer to mill's PLC and DCS via Modbus and OPC**
- > **Automated process and diagnostic alarms ensure reliable operations**
- > **Remote analysis via fibre-optic cable: field sampling stations located at process points**
- > **Little or no need for recalibration resulting in nearly 100% uptime**
- > **No chemical requirements**
- > **Spectrometer can expand to other applications and up to 8 field sampling stations**
- > **Measurements of additional parameters: solids, chloride, etc.**

GREEN & WHITE LIQUOR ABCs	MEASUREMENT RANGE	ACCURACY (1 sigma value)
Effective Alkali (EA)	4 - 120 g/L as Na ₂ O	± 0.5 g/L Na ₂ O
Active Alkali (AA)	6 - 120 g/L	± 0.80 g/L
Total Titratable Alkali (TTA)	10 - 150 g/L	± 1.00 g/L
Carbonate (Na ₂ CO ₃)	4 - 100 g/L	± 0.80 g/L
Sulfide (Na ₂ S)	0 - 50 g/L	± 0.50 g/L
Sulfate (Na ₂ SO ₄)	0 - 20 g/L salt	± 0.25 g/L salt
Thiosulfate (Na ₂ S ₂ O ₃)	0 - 15 g/L salt	± 0.25 g/L salt
Causticizing Efficiency (CE)	0 - 95%	± 0.50%
Solids	0 - 30%	± 0.50%

RECAUST APPLICATIONS

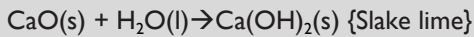
FITNIR Online for recaust provides reliable, accurate and true concentrations of chemical compositions for superior slaker and CE control. For example, knowing the carbonate concentration of clarified green liquor (GL), feed-forward slaker control is possible by metering the optimal (stoichiometric) amount of lime into the slaker and consequently reducing the occurrence of overliming.

Equations 1 and 2 below illustrate the slaking and causticizing reactions. The formation of slaked lime (Ca(OH)_2) is quick and exothermic. The causticizing reaction is an equilibrium reaction, which favours the product (NaOH) at elevated temperatures, but does require residence

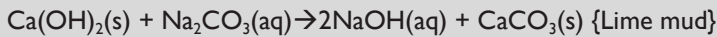
time to achieve the highest level of causticizing. As such, typically three to four causticizing tanks are placed sequentially to maximize CE efficiency.

From equations 1 and 2, clarified GL compositions (i.e., TTA and carbonate) must be analyzed to allow for feed-forward control of the slaker, by ratioing the slaker screw-feeder to maximize the slaking reaction while preventing overliming. Feedback immediately at the number 1 causticizer enables compensation of lime quality variations, while slow feedback from number 3 and final white liquor compositions allow for better CE control.

Eqn. 1: Slaking Reaction



Eqn. 2: Causticizing Reaction



KEY BENEFITS

- > **\$0.6M – \$1.2M savings/year**
- > **5 – 12 months ROI**
- > **Diminishes risk of overliming**
- > **Reduces TTA and EA variability**
- > **Increases CE at target TTA**
- > **Reduces deadload content (carbonate)**
- > **Eliminates environmental hazards and safety concerns**
- > **Reduces chemical costs**
- > **Requires fewer lab tests**

RECAUST ANALYZER INSTALLATION & RESULTS

Installation: Figure 1 shows a mill installation of the field sampling station at a recausticizing unit operation with measurement points for clarified GL, number 1, 2, and 3 causticizer samples, and a final WL sample. In this particular installation, WL is measured before and after a pressure filter.

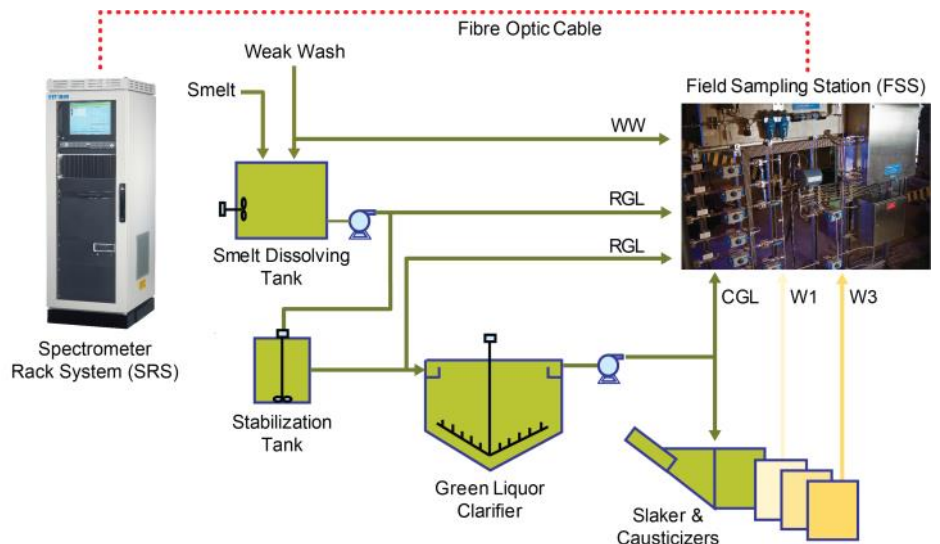


Figure 1: Typical recausticizing plant operation integrated with FITNIR Online for recaust with four sample points.

Results: The following figure illustrates CE results from FITNIR Online at the number 4 causticizer for a period comparing manual and automatic control. In figure 2, the top graph shows the number 4 CE, while the bottom graph shows the lime ratio.

These graphs demonstrate that automated control using FITNIR Online resulted in an over 50% reduction in the variability of the number 4 causticizer CE. FITNIR Online is capable of measuring samples from all locations throughout the causticizers with varying mud content. Its large pathlength eliminates any plugging at either the flow cell or the sample lines as they are purged after each measurement.

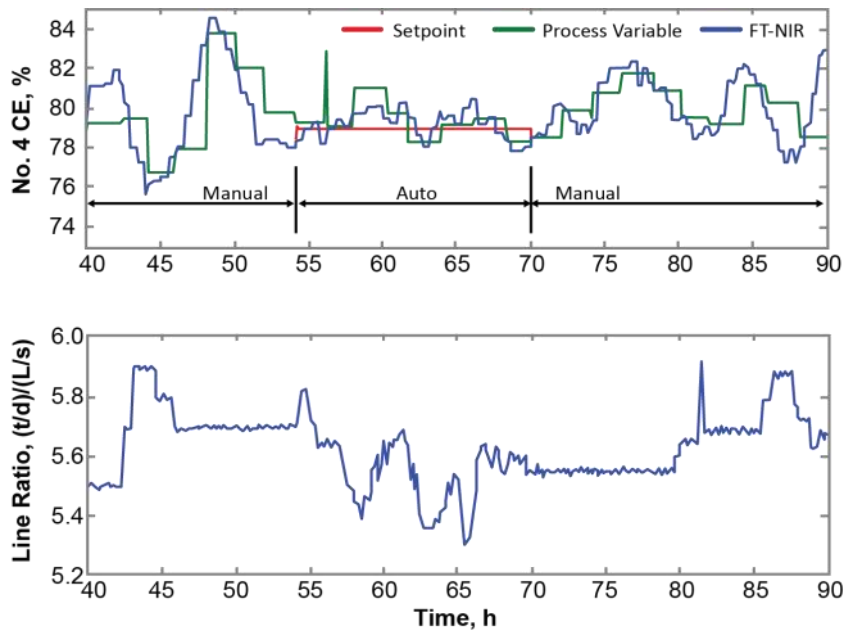


Figure 2: FITNIR Online recaust application results for white liquor measured at No.4 Causticizer.

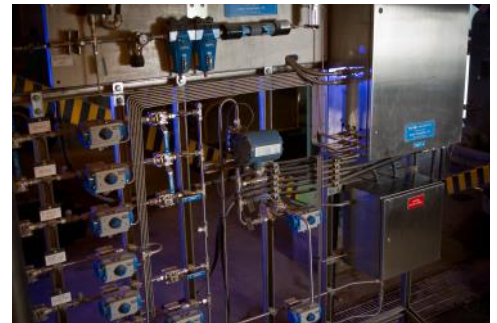
PLATFORM TECHNOLOGY

Connected by fibre optic cables, one centralized spectrometer/analyzer can monitor up to eight field sampling stations. Each sampling station can typically accommodate up to six samples. Being a true platform technology, the system can easily be expanded to measure other process streams such as the digester, recovery boiler/dissolving tank, chlorine dioxide generator and brownstock washer by simply adding additional field sampling stations. This minimizes analyzer hardware and maintenance, as configurations can be done centrally at a single station.

ROBUST EQUIPMENT FOR MINIMAL MAINTENANCE

The sample interface between the process and FITNIR Online is a rugged flow cell with a large optical pathlength. The window material has high hardness and excellent chemical resistance for acid and caustic environments, as well as a large temperature range. All piping and valving utilize standard mill store parts, including ½” to ¾” stainless steel tubing and valves. High pressure demineralized water flushes the sample lines for reliable operations without plugging. References are

performed every hour to ensure no measurement drifts. Many mills have been running with the same calibration for as long as 10 years without the need for recalibration. The result: excellent reliability and superior uptime.



FITNIR SUPPORT

At FITNIR, we understand your business. Our expertise in both the lab and in the field goes into every aspect of our product development. Our innovations, process knowledge and dedication are focused on supporting your business success.

FITNIR offers a wide range of customer support services, including project coordination, application engineering (including kickoff meeting, system configuration calibration and validation), system verification and testing, application documentation, training and after-sales support.

Contact FITNIR Analyzers Inc. to find out how we can partner with you to optimize your recaust operations.

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The Next Generation of Process Analyzers

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