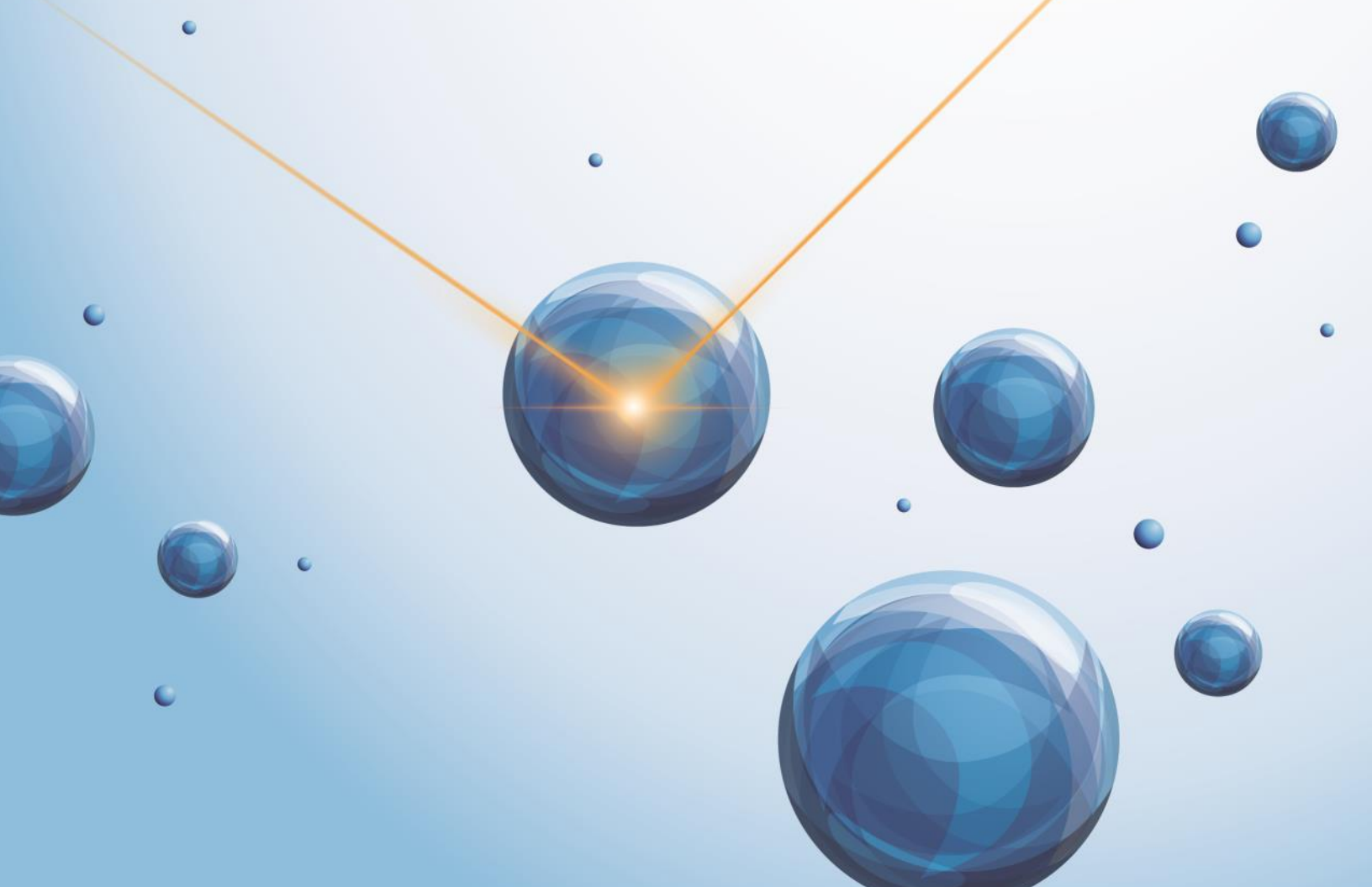
FITNIR ONLINE – DIGESTER APPLICATION

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 white liquor Effective Alkali (EA) and sulfidity, as well as black liquor Residual Effective Alkali (REA) at the various cooking zones of batch and continuous digesters. With its proven application for the digester, FITNIR is the next generation of process analyzers for pulp mills.



Innovative Solution to Traditional Measurement Challenges

THE NEED FOR ACCURATE & TIMELY DATA

Kraft cooking processes rely on alkali measurements to determine chemical charge and consumption during the various cooking phases. Manual titrations are widely accepted as standard monitoring information since they provide a solid basis for cooking management. However, these tests lack frequency and accuracy.

To optimize digester operations, white liquor (WL) strength, moisture content of wood chips, and weak black liquor (WBL) Residual Effective Alkali (REA) at the various cooking zones are needed. For example, the measurement of REA at various zones in the digester hastens the feedback of the rate of alkali consumption, allowing for timely adjustments to compensate for changes in wood properties. Knowing the REA throughout the digester cooking process, mills have better kappa control, reducing over-cooking or under-cooking to ultimately realize yield gains, reduce kappa variability, and reduce WL consumption.

INNOVATIVE SOLUTION

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 choice method for complete liquor composition analysis. For digester applications, standard titration suffers from endpoint detection and interferences from the organic acids (i.e. carboxylic acid, acetic acid, etc.).

FITNIR Online is a fully automated process analyzer capable of sampling from multiple sources and testing numerous components simultaneously. FITNIR Online's digester application provides a complete digester liquor concentration profile. The installation of FITNIR Online provides rapid and accurate measurements of WL EA to the digester and BL REA at the various cooking and washing zones providing feedback on liquor chemistry.

PROPERTIES MEASURED

As shown in Table 1 below, FITNIR Online for the digester measures a comprehensive set of properties associated with the WBL samples. Information for REA provides liquor consumption while the total solids, organic solids, inorganic solids, and lignin content provide information on the liquor quality, which is particularly important for evaporator operations.

KEY FEATURES

- ***Fully automated for frequent testing***
- ***Patented application utilizing a large pathlength flow cell for high repeatability, accuracy and reliability***
- ***Automated flushing of sample lines and cell with water to prevent scaling***
- ***Sample scanning and measurements take only minutes***
- ***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***
- ***Little or no need for recalibration resulting in nearly 100% uptime***
- ***No chemical requirements***

Table 1: Liquor measurement accuracy

WEAK BLACK LIQUOR	MEASUREMENT RANGE	ACCURACY*
Residual Effective Alkali (REA)	4 - 40 g/L as Na_2O	± 0.5 g/L Na_2O
Organic Solids (%)	0 - 25%	± 0.5%
Inorganic Solids (%)	0 - 25%	± 0.8%
Total Solids (%)	0 - 40%	± 1.0%
Lignin Content (g/L)	0 - 200 g/L	± 2.0 g/L

WHITE LIQUOR	MEASUREMENT RANGE	ACCURACY*
Effective Alkali (EA)	50 - 140 g/L as Na_2O	± 0.5 g/L Na_2O
Active Alkali (AA)	40 - 120 g/L	± 0.75 g/L
Total Titratable Alkali (TTA)	50 - 150 g/L	± 1.0 g/L
Sulfide (Na_2S)	0 - 50 g/L	± 1.0 g/L
Causticizing Efficiency (CE)	0 - 100%	± 1.0%

*1 sigma value

DIGESTER OPTIMIZATION & CONTROL

The primary advantage of the FITNIR Online digester application is its ability to reliably and accurately provide WL EA, sulfidity, WBL REA, and solids content measurements at the various cooking zones. Control strategies based on reliable data can significantly reduce kappa variation, yield loss (overcooking) and rejects (undercooking), while increasing pulp quality. Reducing kappa variability can also have a tremendous impact on the reduction of bleaching costs.

FITNIR Online samples digester liquor for analysis at the various extraction zones via a remote field sampling station. Being a true platform technology, the system can be easily expanded to measure other process streams outside of the digester (i.e., recovery boiler/smelt dissolving tank, recaust, etc.) by simply connecting additional field sampling stations to the spectrometer by fiber optic cables. This minimizes analyzer hardware and configurations can be done centrally at a single station.

DIGESTER ANALYZER INSTALLATION & RESULTS

Installation: Figure 1 is a schematic of a single vessel continuous digester integrated with FITNIR Online, having typical sample points for measurements. Measurement sequencing is controlled by a user-defined table on the DCS allowing for frequency control of streams to measure. Boosted demineralized water is used to flush the flow cell as well as to backflush the sample lines, ensuring reliable performance.

For a typical mill with a continuous digester, a field sampling station is installed close to the digester and is connected by fibre optics to the analyzer's FT-NIR spectrometer, located in a control room or MCC.

Results: Figure 2 illustrates results from FITNIR Online applied to a digester for a period of 15 days for WL, Bottom Circulation (BC), Upper Main Circulation (UMC), and Wash Circulation (WC) for a dual vessel digester. The ability to measure the REA (true REA) allows for direct control of the liquor addition as well as temperature profile to maintain level REA trend.

Figure 3 shows the WBL REA profile through a chip pile transition, new to old.

KEY BENEFITS

- ***$1M - $2M savings/year***
- ***3 – 6 month average ROI***
- ***Enhances digester control***
- ***Reduces kappa variability***
- ***Decreases bleaching costs***
- ***Reduces overcooking and rejects for improved pulp quality and yield***
- ***More efficient white liquor consumption***
- ***Cutback of off-grade pulp***
- ***Fewer manual lab tests required***

As seen in the graph, changes in chip quality (either in moisture, density or other parameters) can have a significant impact on liquor consumption. The results clearly indicate that less alkali is required to achieve the same blowline kappa if all other digester parameters are constant.

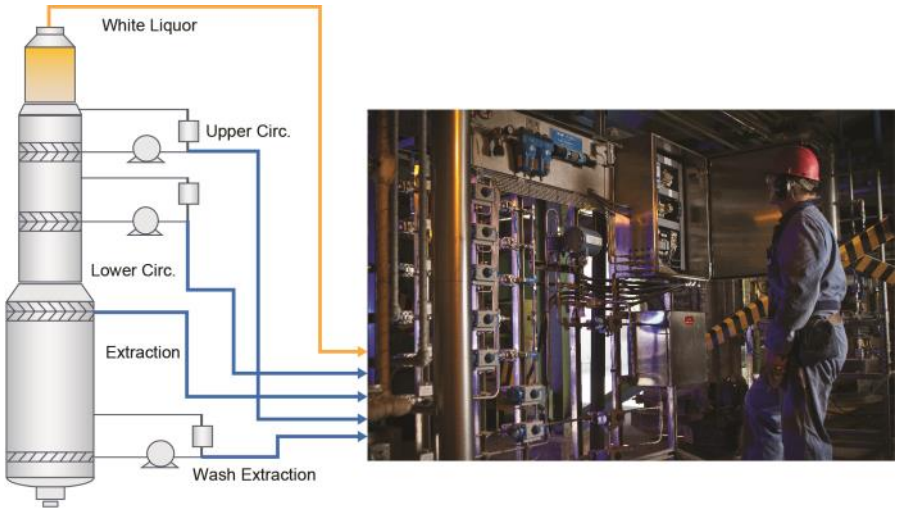


Figure 1: Typical digester operation integrated with FITNIR Online. Five separate streams (WL and WBL) are integrated with the FITNIR field sampling station for complete digester measurements.

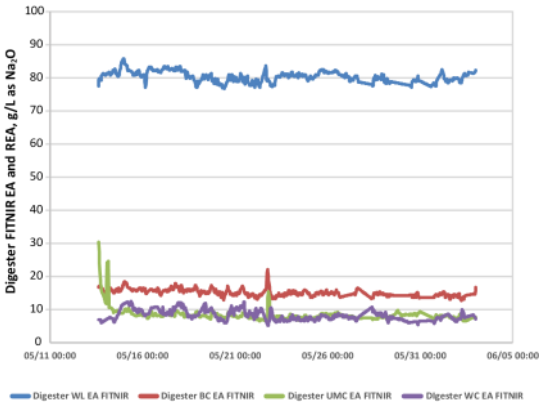


Figure 2: Mill data trend showing the WL EA and the digester REA results at the BC, UMC, and wash liquors for a period of a month.

Figure 4 shows the solids content of the WBL as measured by FITNIR Online. The graph illustrates a drop in total solids content, matching lower REA consumption. As such, rapid measurements of true REA, particularly early on in the process, allow for compensations in disturbances to the process, including chip quality fluctuations, WL strength changes, and other mechanical issues that may affect digester operation. By incorporating FITNIR Online with supervisory control, mills have reported approximately 2% increase in yield while reducing kappa variability as much as 50%.

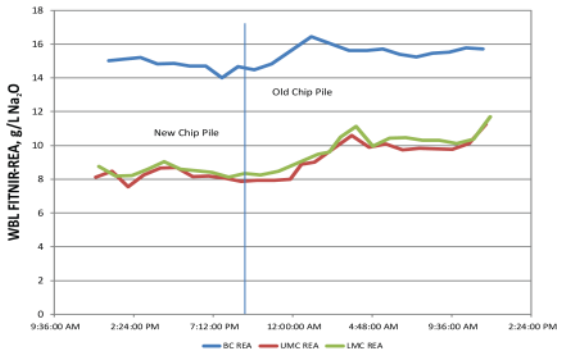


Figure 4: WBL Total Solids as measured by FITNIR Online for the digester showing the total solids dropping with a decrease in alkali consumption.

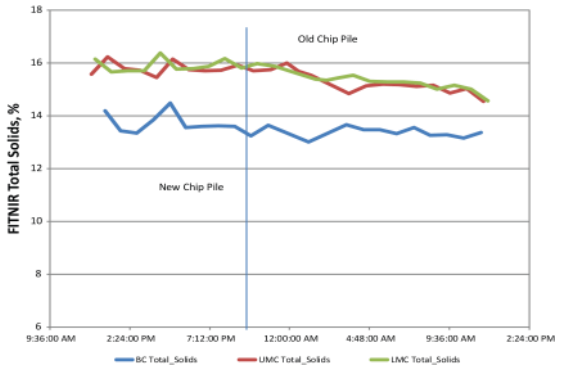


Figure 3: WBL REA profile showing changes in liquor consumption, as shown in the FITNIR REA measurements for BC, UMC and lower MC.

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 of overtones and combinations of fundamental vibrations of -CH, -NH, -OH, and -SH. Molecules and anions have unique spectral features that can be used for 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. Consequently, NIR can operate through glass, can be transmitted via low hydroxyl fibre optic cables, and generally requires minimal sample preparation. Moreover, NIR is more amenable for use with large pathlength cells, up to 20 mm, thus eliminating plugging.

ROBUST EQUIPMENT

The sample interface between the process and the spectrometer 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. Boosted high pressure demineralized water is used to flush the sample lines, ensuring reliable operations without plugging. Water references are performed every hour to eliminate measurement drift. 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 digester operations.

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