FITNIR

FITNIR LMS (LIME MUD SOLIDS)

FITNIR LMS (Lime Mud Solids) utilizes NIR spectroscopy to deliver rapid, accurate and reliable online solids content measurements for control strategy integration. A non-contact, over-the-conveyor sensing head, installed above the conveyor, rapidly scans the moving lime mud prior to feeding the mud into the kiln. FITNIR LMS's high quality and high frequency data provides clarity of mud solids variation, essential for feed-end-temperature (FET) control of the kiln. Ultimately, the objective is to reduce fuel consumption and costs, potential kiln ring formations (mud rings), and greenhouse gas emissions. An improved approach to process control and optimization, FITNIR LMS is the next generation of process analyzers.

TRADITIONAL MEASUREMENT CHALLENGES

Solids content determination of lime mud for kiln operations relies mainly on oven-dry testing of manual grab-samples from the process line. Many challenges exist with manual sampling: infrequent sampling, inherent dangers with sampling from moving conveyors, test methods where samples immediately evaporate, as well as difficulty in retrieving representative samples. Mills are faced with finding solutions to provide high quality and frequent mud solids data in the hopes of optimizing kiln operations to ultimately minimize fuel consumption, improve kiln operations, and save costs. Belt weightometers provide total weight, but do not account for moisture content. Some available conductance measurements require a probe be in contact with the moving lime mud. This poses mechanical issues of the probe and results in loss of quality measurements.

INNOVATIVE SOLUTION

FITNIR Analyzers' LMS system addresses the gap in measurement frequency as well as mechanical challenges inherent with technology available today. Based on NIR spectroscopy, FITNIR LMS characterizes lime mud solids content, along with the potential to analyze other metal oxide properties (i.e., Al_2O_3, Fe_2O_3, etc.). Online measurement is performed via an over-the-conveyor, remote sensing head situated above the conveyor and does not come in contact with the moving lime mud (Figure 1). Consequently, the system requires little maintenance.

A broadband light source illuminates the lime mud sample, and its energy is absorbed by the sample's molecules. The diffusely reflected light is collected and analyzed, directly measuring solids content based on the water absorption.

Measurements are done in real-time with a scanning rate of 30Hz and an average frequency of one measurement output per minute. The software and database developed in-house seamlessly send data directly to the mill's DCS.

LIME KILN APPLICATION

As part of the chemical recovery cycle, the lime kiln is used to convert lime mud ($CaCO_3$) into active lime (CaO). CaO is used for converting Na_2CO_3 to NaOH in the causticizing plant, chemicals required for the kraft pulping process. Fuel is injected into the kiln at the hot end through nozzles and is ignited to generate the required heat for calcination. Lime mud enters the kiln at the feed-end and heat from the hot end travels down the kiln. As the mud moves towards the hot end of the kiln, the mud dries (newer kilns have cyclone dryers). Variations in mud solids often result in excessive heat or too low of temperatures at the feed-end. As a result, wetter mud moves further into mid-kiln, potentially causing kiln operating problems, such as a mud-ring.

FITNIR LMS measures the mud solids content feeding the kiln, providing information for feedback control of mud thickener and feedforward control of the kiln FET. Consequently, fuel consumption and potential kiln operating issues are reduced. When used with a weightometer, dry mass flow can be calculated.

KEY FEATURES

> *Full spectrum NIR sensor*

> *Non-contacting, over-the-conveyor (OTC) system*

> *Online measurements in real-time*

> *High accuracy (± 1.5%) and repeatability of ± 1% (1-sigma)*

> *Expandable properties measurements (metal NPEs)*

> *Robust and transferable calibration models*

> *Large solids content range*

> *Industrially designed analyzer*

> *Direct communications to the DCS*

Figure 1: FITNIR MC sensor head above the conveyor.

CALIBRATION TRANSFERABILITY

FITNIR LMS's calibration has been developed both online and in the laboratory, generating a rugged calibration model that is transferable to both a wide range of mud solids and temperatures. FITNIR LMS is the only lime mud solids content analyzer able to measure both solids, colour, and other properties.

PROVEN REPEATABILITY AND ACCURACY

FITNIR LMS is proven to deliver accurate and reliable mud solids content measurements in real-time. Validated during a one-year mill trial, FITNIR LMS demonstrated a strong correlation between laboratory solids content measurements and analyzer measurements to the kiln (Figures 2 & 3).
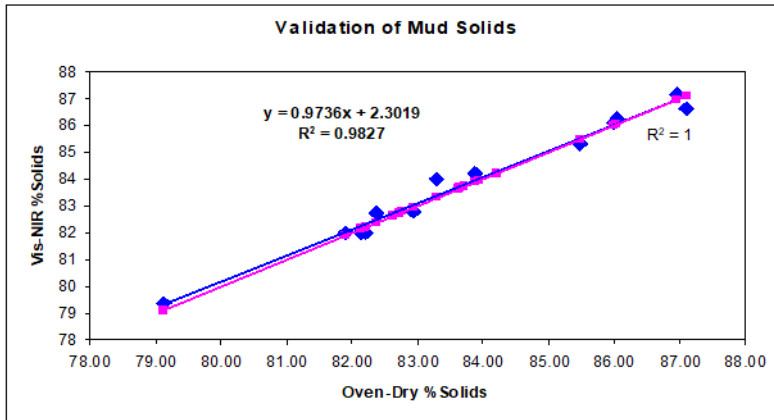
Validation of Mud Solids

$y = 0.9736x + 2.3019$
$R^2 = 0.9827$

$R^2 = 1$

(Vis-NIR % Solids vs Oven-Dry % Solids)

Figure 2: Lime Mud Solids Validation - OD vs. FITNIR LMS

% SOLIDS	NIR SOLIDS
81.91	81.99
82.21	81.99
82.94	82.79
79.12	79.36
82.39	82.75
83.88	84.23
85.48	85.34
86.06	86.27

Figure 3: Lime Mud Solids Validation Data - OD vs. FITNIR LMS Analyzer.

KILN BENEFITS

> *Reduce mud solids variation, leading to lower FET (Feed-end-temperature)*

> *Reduce (fossil) fuel consumption and energy costs*

> *Reduce kiln operating issues, such as potential mud ring*

> *Increase frequency of mud solids measurements*

> *Low maintenance*

> *Reduce risk for operators associated with sampling on moving conveyor*

MEASUREMENT PRINCIPLES

FITNIR LMS is based on molecular absorptions of water molecules in lime mud. A light source is used to illuminate the sample surface. The light interacts with the sample where molecules absorb the energy from the light. The diffusely reflected light is collected and the frequency spectrum is recorded on the detector. For online measurements, the unique spectral data is then correlated with this previously built calibration to determine lime mud solids.
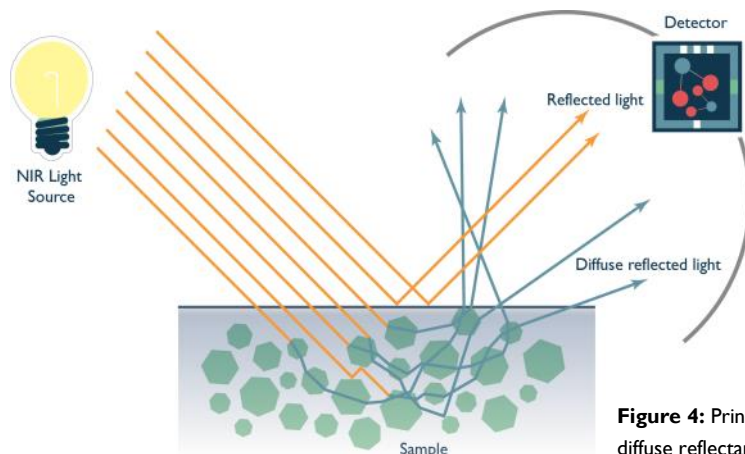
Figure 4: Principle of NIR diffuse reflectance spectroscopy

IMPLEMENTING FITNIR LMS: MEANINGFUL RESULTS

A one-year FITNIR LMS trial, in combination with a supporting control strategy, significantly stabilized the mud solids content from the mud drum thickener at a kraft mill. FITNIR LMS data was used to generate a model for kiln FET control of the lime kiln and showed that the temperature could be reduced by 30 degrees Celsius. This resulted in significant fuel savings (Figure 5).

Implementing FITNIR LMS in conjunction with the control strategy suggests an overall benefit for a kraft mill, with a production of 1000 tonnes/day with a natural gas cost of $450,000, could save $400,000 per year. Since fuel costs vary significantly from mill to mill, mills with higher energy costs could experience much greater savings.
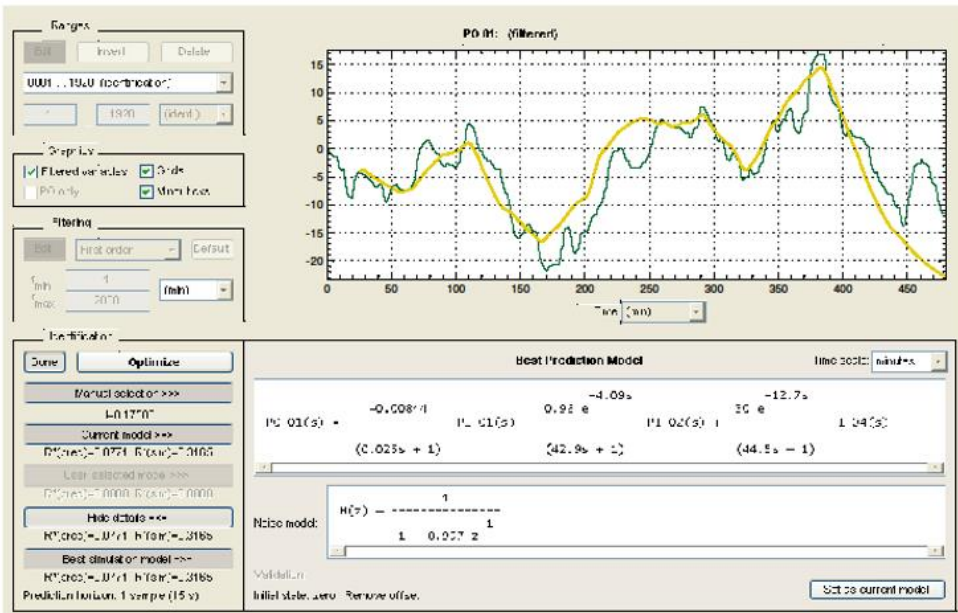

Figure 6: FITNIR LMS Spectrometer Cabinet

FITNIR LMS EQUIPMENT: PRACTICAL AND ROBUST

FITNIR LMS's remote sensing head is located above the conveyor and does not come into contact with the mud on the conveyor, preventing unnecessary issues and equipment damage.

The instrument cabinet housing the spectrometer is industrially designed to withstand harsh mill environments (Figure 6). Fibre optic cable connects the spectrometer to the sensor. FITNIR LMS's software and database provides rapid measurements and communicates to mills' Distributed Control Systems via ModBus protocol.

Figure 5: Model showing kiln FET could be reduced by 30 °C with a reduction in solids variability. A drop in FET would ultimately result in a reduction in fuel consumption for the kiln, as well as potentially a reduction in kiln operations.
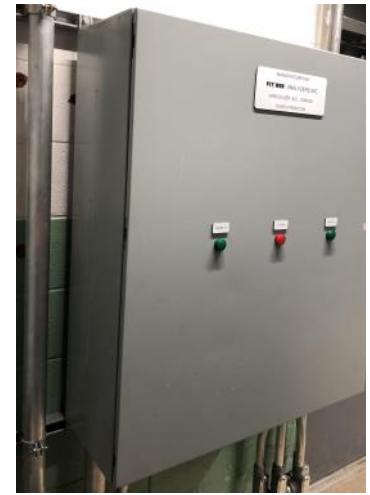
FITNIR SUPPORT

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 (i.e., 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 help optimize your mill.

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The Next Generation of Process Analyzers

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