

# Measuring Strong Black Liquor Chemical Composition

## Key Words

- Pulping Process
- Evaporator
- Black Liquor Measurement
- Tall Oil
- REA
- Residual Effective Alkali
- Sulfate
- Thiosulfate

## Introduction

Black liquor is a complex, hazardous and challenging liquid to analyse. Its highly concentrated nature makes measuring its make-up very difficult, and often requires the use of advanced laboratory techniques to identify its chemical constituents.

The need for laboratory analysis makes a detailed chemical analysis of strong black liquor out of reach for most pulp mills. Even making a simple residual effective alkali (REA) measurement requires a titration - which is time consuming and expensive.

Spectrometers allow continuous and detailed measurement of chemical concentrations in real time. Unfortunately the majority of process spectrometers are based on near infrared light, which is fundamentally less informative than mid infrared light. Conventional mid infrared spectrometers (which often use a Fourier transform are referred to as "FTIR spectrometers") have sensitive moving parts and fragile fibre probes - making them wholly unsuitable for production environments such as pulp mills.

The IRmadillo is a process analyser built using FTIR spectroscopy, but with static optics: removing the need for moving mirrors or fibre

probes, and dramatically improving stability, reliability, and ruggedness.

## Example use case

This application note presents data collected at a single site in North America, directly into a strong black liquor line (~ 60 % solids). Originally designed purely to measure Na<sub>2</sub>S for environmental monitoring, the customer then expanded the calibration to become a universal chemical composition analyzer for black liquor. The IRmadillo was installed directly into an existing line with a 2" ANSI flange, no additional installation work was required.

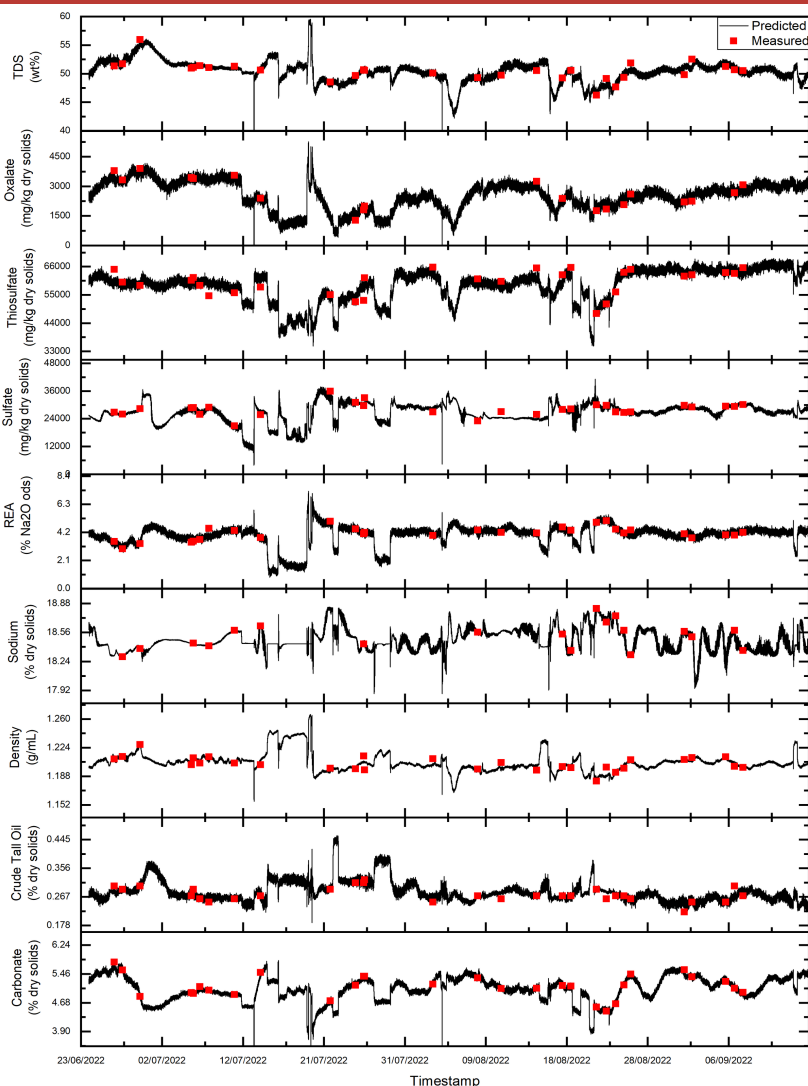
After the IRmadillo was installed the customer was able to make continuous measurements of composition - which they are intending to use to make process improvements, and to identify potential problems such as scale and corrosion early enough to fix them whilst they're small.

## Results

Discrete calibrations were made for a large range of different chemicals, using laboratory analyses as reference data with a combination of partial least squares (PLS), support vector regression (SVR) and locally weighted regression (LWR) modelling techniques.



**Photo:** An IRmadillo process analyser installed in strong black liquor line, with accompanying compressed air dryer and filtration unit



**Figure:** The measurement of 9 different chemicals and physical properties in a strong black liquor line performed simultaneously with a single IRmadillo installation over several months

Average errors of measurement for the chemicals of interest are shown here.

- TDS: 1 wt%
- Oxalate: 300 mg / kg
- Thiosulfate: 2800 mg / kg
- Sulfate: 2200 mg / kg
- REA: 0.29 %
- Sodium: 0.1 %
- Density: 0.006 g / mL
- Crude tall oil: 0.02 %
- Carbonate: 0.1 %

## Conclusions

This work has shown that the IRmadillo spectrometer is easy to install directly into the strong black liquor line, and then operates as a single instrument measuring 9 different chemicals and properties simultaneously - updating to the DCS every two minutes.

The IRmadillo is able to measure both chemicals to high levels of accuracy (in many cases in the mg / kg, or ppm level) as well as physical properties such as density.

Additionally the instrument is inherently stable with a single installation able to make measurements for several months with no maintenance or attention from the customer. A single dry air line source from a co-located compressed air dryer is all that is required to keep the instrument operational.

## Keep in Mind

The IRmadillo is a static optics FTIR spectrometer that is then calibrated to measure the process of interest - changing it from a spectrometer outputting spectra, into an analyzer reporting concentrations and properties of interest.

It can be calibrated for almost any application in almost any process. Whether it's measuring reduction efficiency in green liquor or controlling the effective alkali in white liquor - the IRmadillo is a universal analyzer for pulp and paper making.



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