Briefing Note

KEIT spectrometers

Industrial analyser for monitoring & controlling **extractives and high-value organics in pulp mill black liquor**

Introduction

The processing of woody biomass into pulp results in a significant level of organic materials dissolved into the black liquor. These include a large number of different molecules, including water-soluble molecules such as sugars, furans and some lignins, but also insoluble chemicals such as resin acids, unsaponifiables and fatty acids. Many of the insoluble and immiscible chemicals can be removed from the black liquor by allowing them to settle out, and can then be sold as medium to high value by-products such as tall oil.

However, if they are accidentally fed into the recovery boiler, then the organic molecules are destroyed by combustion and lost. This generates heat which is fed into the mill's infrastructure, but may not be the best use of the chemicals. Ideally, a mill would be able to measure these chemicals in the black-liquor line in real time, and then change the flow of the liquor either to optimise separation and removal of the organics, or feed lower-value organics as part of the black liquor into the boiler.

Measuring these chemicals ("extractives") in the laboratory is slow and time consuming, requiring significant investment in analytical equipment. Even a simple measure of dry weight of immiscible compounds takes a long time as it involves drying and washing the black liquor itself.

What's the solution?

Traditional analysis tools – such as density, conductivity or capacitance probes – are not able to measure extractives. The best solution for this problem is spectroscopy! There are many different types of spectrometers, such as near infrared (NIR), Fourier transform mid infrared (FTIR), Raman, fluorescence and UV-visible spectrometers. Each one has a different niche and strength, and it's important to pick the right tool for the job.

The IRmadillo is a static-optics FTIR spectrometer that can be calibrated as a universal process analyser – able to measure a wide range of properties, processes and applications throughout the pulp mill chemical recovery process including extractives in the black-liquor line.

What applications can it measure?

The IRmadillo can be calibrated to measure a vast range of chemicals, including:

- Water-soluble organic molecules (sugars, some lignins, furans, short chained acids, etc.)
- Water-insoluble organic molecules (tall oil, long chained organic acids, unsaponifiables, resin acids, terpenes, etc.)

The IRmadillo can also be used to run qualitative classification models (such as SIMCA, PLS-DA and SVC). These chemometric models can be converted into simple outputs for the process engineer or operator to read such as "In specification", "Drifting outside of specification" and "Take action", giving the production team enough warning to fix issues before they become problematic.

Keep in mind the IRmadillo is an FTIR not an NIR instrument

There has been a lot of work trying to bring NIR instruments to the manufacturing floor, and various attempts have been made to use NIR for process measurement and control in paper manufacturing.

Unfortunately, the fundamental physics behind NIR means it's not an ideal solution for the challenges faced in paper manufacturing, and struggles to provide meaningful information. The IRmadillo is an FTIR, not an NIR, so has substantially more information available for interpretation!

IRmadillo™

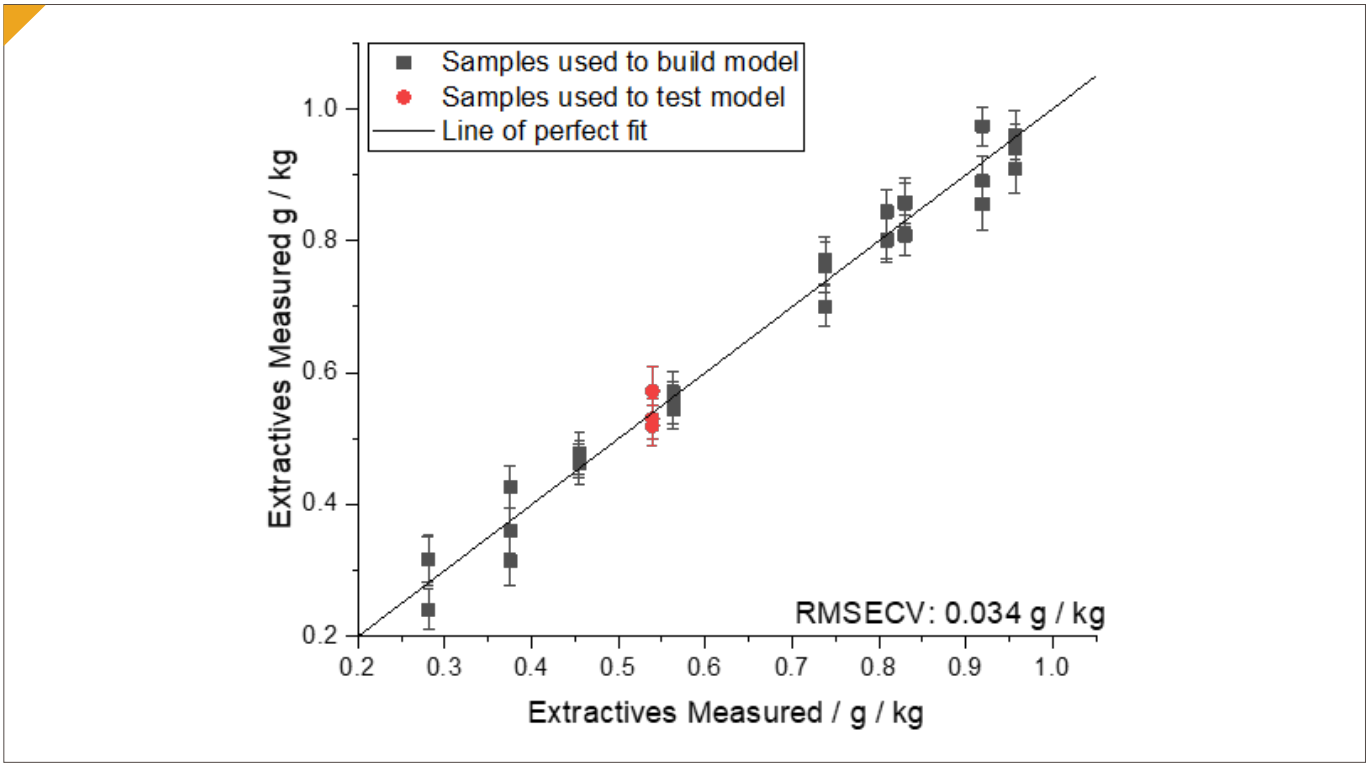

Figure 1: Example performance of measuring extractives (water-insoluble organic molecules) measured in g extractives per kg dry matter

How well does it work?

This depends on the process you wish to measure, and the typical chemicals present. For quantitative measurements, the IRmadillo typically has **detection limits of 100 ppm** for a range of different organic and inorganic chemicals. In some situations it's even possible to achieve a detection of < 1 ppm!

An example graph of measuring extractives – defined as g water-insoluble material per kg dry matter from black liquor – is shown above. In this instance the average error (RMSECV) is 0.034 g / kg.

We've previously mentioned the ability to output qualitative measurements to create meaningful classifications for the production engineer to act on making the IRmadillo an invaluable process analyser providing real-time actionable information.

Features & Benefits

- Mid-infrared spectral analysis
- In-line, real-time process monitoring
- Robust industrial process analyser
- Compact design
- Easy to use

Contact us

+44 (0)1235 431260

enquiries@keit.co.uk

www.keit.co.uk

DOC0856 (27 September 2021 5:08 pm)