

Improving Pulp & Paper Production Using the IRmadillo



What is it?

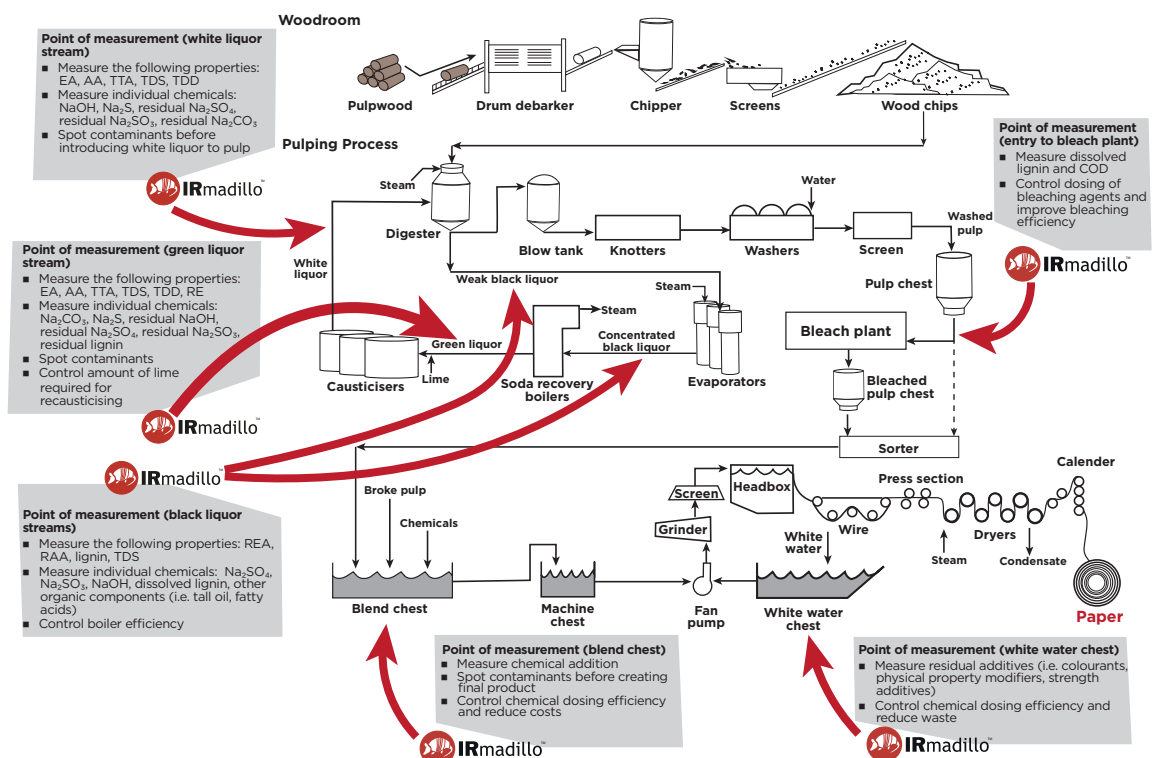
The IRmadillo is a process analyser based on FTIR (mid-infrared) spectroscopy that monitors in real time the concentration of different chemicals in liquids and slurries.

What makes it different to other analysers is that it's built to last, is stable, and extremely reliable with no internal moving parts - so you can fit it into your pipework or vessel and forget about it.



What's the point and why should I use it?

That's a good question! The point is that the IRmadillo acts as a concentration meter simultaneously for a whole range of different chemicals used in both pulp processing and paper manufacturing. The system is designed to analyse the entire mixture, whether it is a clean and clear liquid, emulsion, or a thick and dirty slurry. Different calibrations can then be loaded onto the system to enable you to see the concentrations of chemicals of interest - as many as are needed. The system works regardless of the paper, tissue or board manufacturing process used such as the Kraft and the sulphite processes.



Here's a representative process flow for pulp and paper manufacturing using the **Kraft process**, with arrows suggesting installation points for the IRmadillo. Some suggested applications for the IRmadillo are:

Recausticising: the IRmadillo can be installed into green liquor pipework enabling feed-forward control for the recausticising process. It can measure the concentration of both sodium sulphide (Na₂S) and sodium carbonate (Na₂CO₃) to calculate how much lime is required to effectively causticise back to sodium hydroxide (NaOH). Stabilising the operation of the recausticiser through better control can significantly improve the efficiency of the mill.

Recovery boiler control and black liquor analysis:

by installing an IRmadillo into the black liquor stream, you can measure the concentration of sodium sulphate (Na_2SO_4) and sodium sulphite (Na_2SO_3) to operate the boiler effectively and efficiently by removing undesired sulphur compounds without wasting energy. You can spot the build-up of tall oil and other undesirable organic compounds in the liquor which could lead to discolouration or unwanted marks on the finished paper or tissue product.

Paper production: the IRmadillo can also give real-time measurement of chemicals present in the white water chest such as residual wet strength chemicals, and other chemical additives needed to achieve specific product characteristics. The IRmadillo can also perform a qualitative measurement at the same time, looking for potential build-up of organic residue such as inks and glues from recycled paper, identifying a possible problem early enough to prevent process shutdown.

How do I use it?

The IRmadillo is a versatile process analyser based on FTIR spectroscopy. This means you can calibrate it to look for the chemicals and indicators of interest. It can run both quantitative and qualitative measurements at the same time.

Quantitative analysis – chemicals: The IRmadillo can output the concentration for each different chemical present in your process that it's been calibrated to detect. Example chemicals it can monitor are:

- Sodium carbonate (Na_2CO_3)
- Sodium sulphide (Na_2S)
- Sodium sulphate (Na_2SO_4)
- Sodium sulphite (Na_2SO_3)
- Sodium hydroxide (NaOH)
- Other metal hydroxides ($\text{Mg}(\text{OH})_2$, $\text{Ca}(\text{OH})_2$, etc.)
- Ammonia
- Sulphuric acid (H_2SO_4)
- Wet strength additives (i.e. celluloses such as CMC, epichlorohydrin; polyamides such as PAEA)

There's no maximum concentration, and the scales can be adjusted depending on the chemical of interest. So you can monitor NaOH in % terms while keeping an eye on ppm level contaminants at the same time.

Quantitative analysis – process characteristics:

The IRmadillo can also correlate the spectra with the characteristics or physical properties of interest. Example properties it can measure are:

- Active alkali
- Effective alkali
- Sulphidity

- Causticity
- Reduction

Qualitative analysis: The IRmadillo can give you readings such as “within specification”, “contamination spotted”, or other readings. The calibration in this case is much more flexible, and is designed to show overall types of process conditions rather than fixed chemical concentrations.

We can also build a qualitative calibration after you've been using the IRmadillo for a while to look back at the quality of your processes (high performing vs low performing) to give you an indication of where your process is likely to go over time.

You can run both a quantitative *and* qualitative calibration at the same time – no need to choose.

Keit will work with you to build the calibration that's right for you, that will help you save money from the second it's commissioned.

Mill environments are harsh, with caustic spray, scale build-up and lots of hazards. How does the IRmadillo cope?

The IRmadillo is designed to operate in harsh and challenging environments, and can be installed near pumps, on manufacturing floors and places with changing ambient conditions.

However, the instrument is based on FTIR spectroscopy and uses an attenuated total reflectance (ATR) probe. This means that although it is extremely tolerant of the physical composition in the analyte of interest, it could be susceptible to scale build-up on the end of the probe.

To resolve this, Keit integrates some small amount of scaling into our calibration models - so they continue to operate after initial formation of a thin scale film. The instrument will then be calibrated to raise a “flag” to inform you of the scale build-up, letting you schedule a time to remove it for cleaning. A simple hydrochloric or citric acid clean is often enough to resolve the issue and allow re-installation of the probe.

Additionally, by using the IRmadillo to measure the chemical concentration of the liquor, you should be able to better control the process preventing scale formation in the first place.

My feedstock comes from a variety of different sources so has different chemical makeup – how do you cope with that?

Small changes and variations can normally be ignored, as the ratio of chemicals within different grades of wood or recycled paper quality may change, but the types of chemicals remain constant. Calibrations are often robust and resistant to this.

For larger variations, the IRmadillo will identify and alert you that it has drifted outside of calibration, and a small calibration augmentation can normally resolve this. Every time the calibration is expanded and augmented, it reduces the likelihood that it will need to be done again.

How good is it – what’s its performance?

The IRmadillo is designed to give the best possible accuracy and precision while still being suitable for installation directly into a process. This means it’s not quite as accurate as lab sampling or an HPLC instrument, but not too far off. The exact performance

depends on the calibration, the process, the chemicals of interest and what else is present in the mixture.

A representative calibration of various different chemicals in green liquor is given below in Figure 1. You can see that for every chemical, there is excellent agreement between the reference values and the measured values – showing that the IRmadillo can measure everything of interest.

What will I see when I use it?

The IRmadillo software contains its calibration and runs the measurement in real time. This means you’ll get a live measurement of chemical concentrations (normally in %wt but that can be changed to whatever units you’re used to using) over the whole process.

The IRmadillo will also talk to your DCS or SCADA system. The standard communications protocols are OPC-UA or Modbus (TCP/IP and RS485 are both supported). Additional protocols are available if needed. This means that the IRmadillo can communicate directly with existing infrastructure and be incorporated into feedforward and feedback process control schemes.

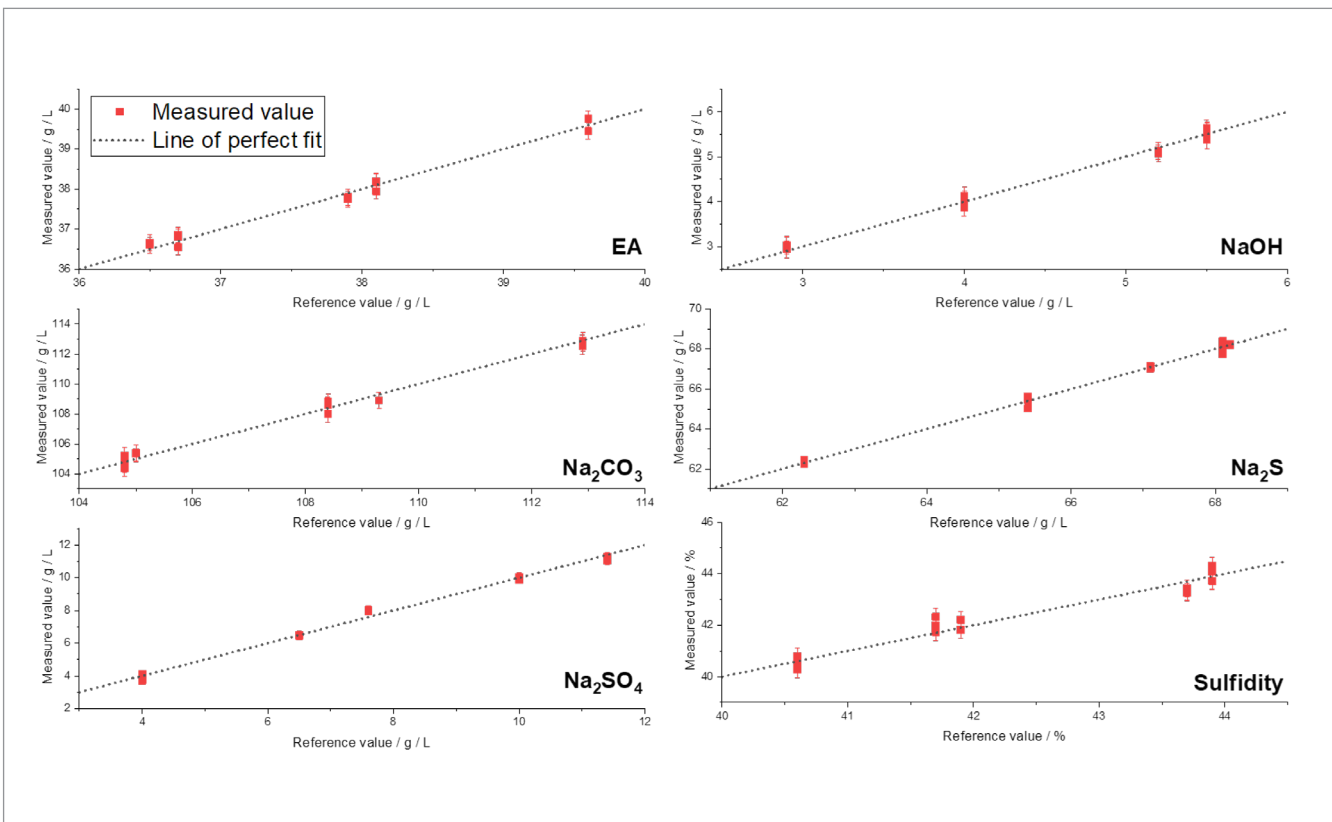


Figure 1: Example performance of the IRmadillo measuring chemicals and properties of interest in green liquor

I tried FTIR before and it didn't work...

Don't confuse FTIR (mid infrared) with FT-NIR (near infrared). Infrared light comes in a few different wavelengths, and there was a big push a few years ago to get near-infrared instruments (FT-NIR) into plants.

Near infrared is very different to the mid-infrared light that the IRmadillo uses (FTIR). FT-NIR instruments don't actually look directly at the chemical bonds, but at "overtone". This is a bit like trying to recognise someone from their shadow rather than looking at their face. It gives you a rough idea who it is, but to get full understanding you need the full picture. They also use a probe with a reflecting window in it that can easily get blocked with high solid loadings or bubbles - exactly what you would find in pulp and paper manufacturing!

So how do I actually install this?

The IRmadillo can be installed directly into the process of interest, with no need for sample conditioning, fibre probes or complicated extraction systems. There are two main methods of installing the analyser:

Direct insertion with a flanged connection: this method uses a flange welded onto the IRmadillo which can then be bolted directly into the process pipework. This means the analyser is measuring exactly the same liquor as is flowing through the process pipework (without any transportation delay), and benefits from any pipework cleaning you may be running, but does require the fitting of a flanged T-piece.


This is the default setup for the integrated ultrasonic descaling package. Adding a ball valve into this setup allows for easy removal of the probe if required during use.

Recirculation loop and a flow cell: this method uses a flow cell on the IRmadillo probe coupled with a recirculation/extraction loop. The process liquid does not need any special conditioning here - just pumping around a short circuit into the flow cell and then back into the main pipeline. This method is much faster to assemble so has a shorter lead time, and does allow for the spectrometer to be removed from the process and cleaned separately. This setup also allows for incorporation of a separate cleaning cycle - which is beneficial if the installation point is known to foul up over time.

Talk to Keit to better understand the differences in installation approach and what will work best for you.

Interested in finding out more?

Visit our website to read more. Contact us to find out how we can help you to monitor your processes in real time.

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I'm interested. What's next?

Keit gives you options to make it easy to start using an IRmadillo. For all options, we'll help you install, train your team, and we can even calibrate a chemometric model.

Trial Rental

Want to try one out? Keit will provide an IRmadillo suited to your process operating environment and bill you monthly for an agreed span of time. Easy to renew, you have control over how long you keep it - from a few months to an even longer rent-to-own plan.

Purchase

Own your IRmadillo outright to monitor your process on-line and in real time as you see fit. Begin your discussion today to find out how you can get an IRmadillo installed into your system.

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