

Improving Food and Drink Production using the IRmadillo



What is it?

The IRmadillo is an in-line process analyser based on infrared light. It works by using a technique called FTIR spectroscopy to monitor the concentration of different chemicals with great accuracy and in real time. It can be calibrated to become a universal analyser measuring almost any chemical and property in liquids.

One thing that makes it different to other FTIR analysers is that it is robust and built to last. The IRmadillo installs directly into your process to perform continuously in any production environment. Fit it and forget about it!

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

Importantly, the IRmadillo monitors your process in real time as your feedstock is converted into product. Because it's in-line to your process, it immediately tells you what is going on and eliminates lengthy delays from standard off-line sampling techniques. This results in three main benefits when using the IRmadillo within the food and drink manufacturing industries:

Improve your efficiency - By having a trustworthy real-time measurement of your process, you can run closer to the product's specification limits. You can reduce product giveaway while still creating a high-quality final product - all this without the need to increase laboratory sampling.

Improve your capacity - identify the exact moment when a batch process has consumed its feedstock and reached optimum product level, then stop the process or changeover to a fresh batch. The IRmadillo lets you identify the endpoint at the right moment. Alternatively, measurement of key product and intermediate qualities in continuous processes will allow you to push production harder and increase throughput.

Fix problems early - the IRmadillo lets you see exactly what's going on in your process. If something does go wrong, you have time to fix it early. For example, you may spot an infection in your fermentation process, or identify the need to change cooking oil due to acrylamide build up early enough and minimize any negative impact.



The IRmadillo empowers you to understand what your process is doing, enabling you to make informed decisions about how to improve or control it. This is something simply not possible with off-line sampling analysis.

How do I use it?

The IRmadillo is a flexible process analyser based on FTIR (mid-infrared) spectroscopy. This means you can use it for concentration monitoring (quantitative analysis) or for condition & qualification monitoring (qualitative analysis). You can even run both at the same time - no need to choose.

Quantitative analysis - in this mode the IRmadillo will output the concentration for each different chemical present in your process that it's been calibrated to detect. There is an enormous range of chemicals it can monitor and measure. There's no maximum concentration, and the scales can be adjusted depending on the chemical of interest. So you can monitor sugars in % terms whilst keeping an eye on ppm level organic acids at the same time.

Qualitative analysis - in this mode the IRmadillo will give you readings such as "within specification", "contamination spotted", "fermentation stressed" 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 it for a while) to look back at "good batches" and "bad batches", and give you an indication of where your batch is likely to go over time.

I have multiple process lines, do I have to calibrate every instrument?

No! We can build a single calibration that is common to all instruments.

What are some examples in food & drink?

Some example use cases might be:

Optimising fermentations:

- Monitoring sugars, alcohols and acids in ethanol fermentations
- Nutrient level control and contaminant spotting in biomass fermentation (i.e. plant-based meat or fungal fermentation)

Dairy processing:

- Monitoring fats, lactose, protein and urea levels in raw milk
- Control of protein level in whey protein production
- Contaminant spotting and process optimisation in liquid/cream cheese, yoghurt and kefir production

Cooking oils:

- Oxidation and decomposition of cooking oils - know exactly when to change over oil for fresh feedstock and prevent waste caused by unnecessary replacement
- Measure acrylamide build-up to optimise oil turnover

Edible oil refining:

- Control chemical dosing and FFA neutralisation process by monitoring free fatty acids, phosphorus, metals, moisture, etc.
- Monitoring phosphorus and phospholipids to optimise degumming process

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 an update on chemical concentrations (normally in %wt but that can be changed to whatever units you're used to using) over the whole process.

The graph in Figure 1 shows an example sucrose fermentation over 30 hours to give a representation of the output. These batch trends can then be exported into text files for further analysis by your team for process optimisation if needed.

The IRmadillo will also talk to your existing plant communications setup. The standard communications protocols are OPC-UA or Modbus (TCP/IP and RS485 are both supported). Additional protocols are available if needed.

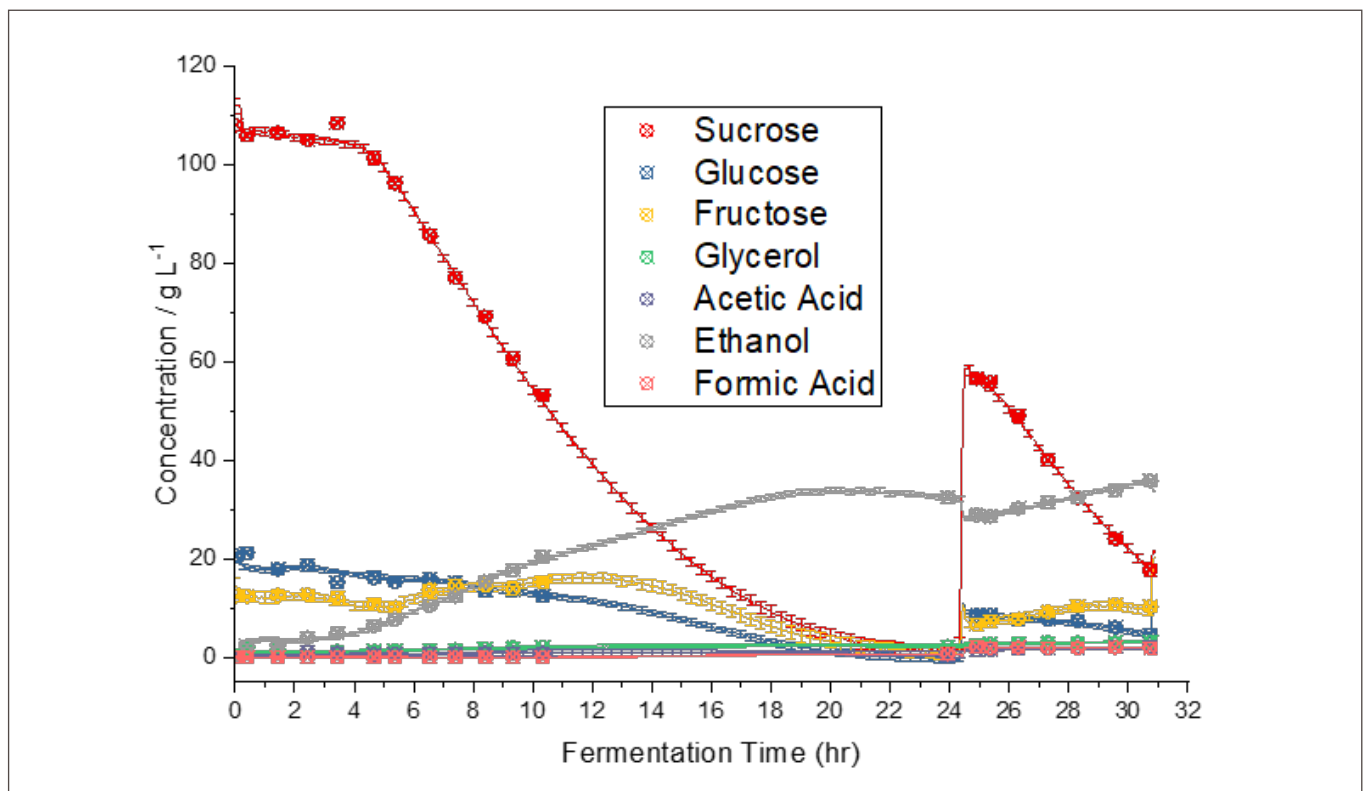


Figure 1: Sucrose fermentation process monitored over 30 hours with the IRmadillo. You can clearly see the change in concentrations of sucrose, glucose, fructose, glycerol, acetic acid, ethanol and formic acid over production time.

I already use IR in my facility - Why would I need something new?

Don't confuse FTIR (mid-infrared) with FT-NIR (near infrared). Infrared (IR) light comes in a few different wavelengths, and there are many industries and processes using NIR instruments successfully. However, some processes are simply not suitable for NIR as they are too complex or their concentrations are too low to be monitored effectively by NIR.

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 "overtones". 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. FT-NIR techniques also use a probe with a reflecting

window in it that can easily get blocked with high solid loadings, which is common in many processes.

The IRmadillo uses an ATR probe that is minimally affected by bubbles or solids in the process, and uses mid-infrared wavelengths to optimise spectral information recorded.

We give an example of this in Figure 2, showing a comparison of the IRmadillo with an NIR instrument both monitoring the same sucrose fermentation. The IRmadillo has no trouble monitoring the process and performs well. The NIR simply cannot differentiate between glucose and fructose, making it unreliable and not going to provide any meaningful information. It also shows worse results when the biomass is high - such as before the sugar feed at 23 hr and towards the very end of the process.

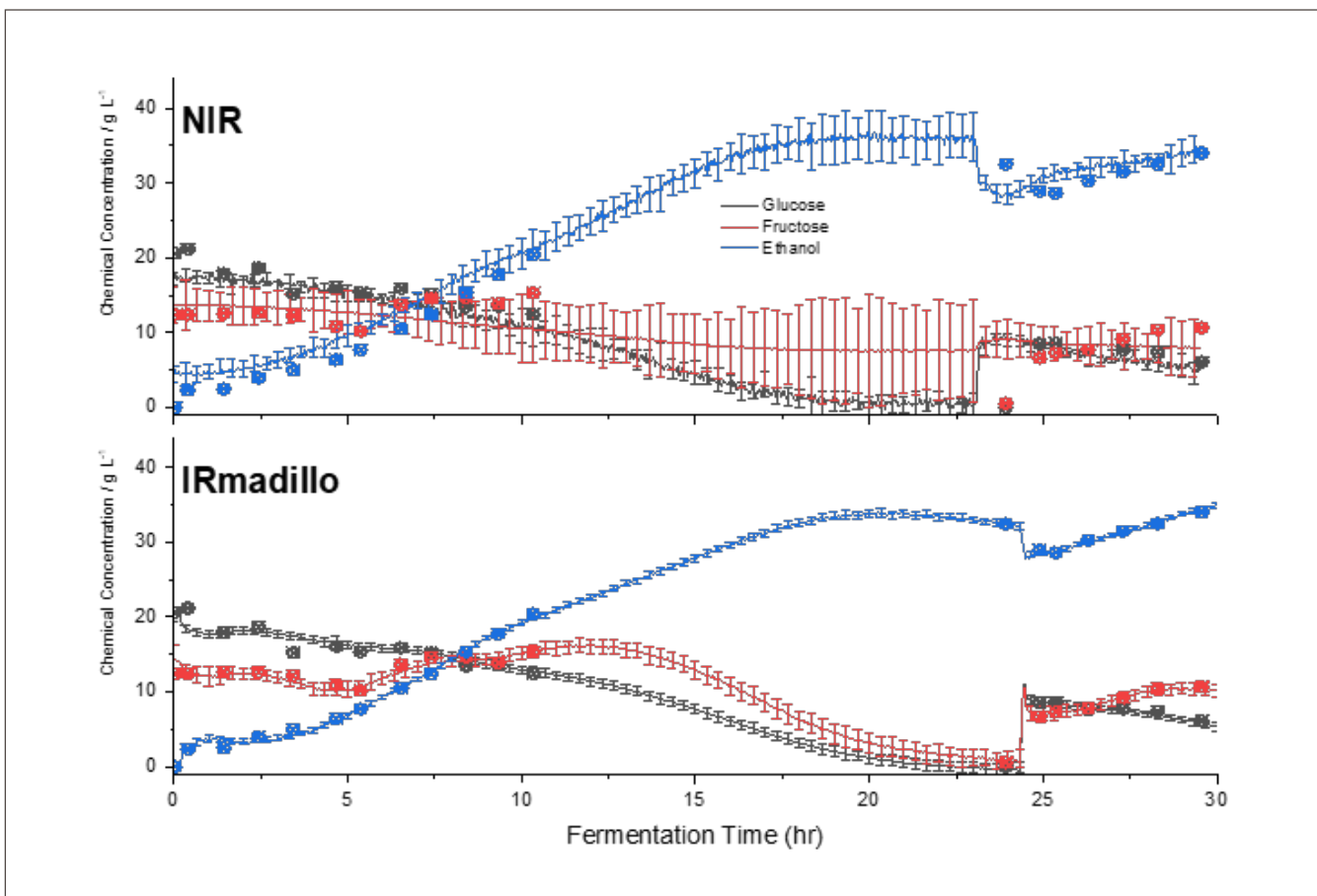


Figure 2: Comparison of the mid-infrared IRmadillo vs. near infrared (FT-NIR) monitoring a fermentation process. Note the much larger error bars on the FT-NIR analysis (top) making differentiation nearly impossible between glucose (black lines) and fructose (red lines), while the IRmadillo (bottom) clearly defines each component.

What's the performance of the instrument?

The exact performance depends on the process you use, and is very difficult to define precisely without knowing the application. Some example performances are:

Dairy processing:

- Fats: $\pm 0.85\%$
- Proteins: $\pm 0.2\%$
- Lactose: $\pm 0.10\%$
- Urea: ± 90 ppm


Cooking & edible oil processing:

- Free fatty acids (FFAs): $\pm 0.1\%$
- Moisture: $\pm 0.01\%$
- Metals: $\pm 0.01 - 0.5$ ppm (depending on metal)
- Phosphorus: $\pm 1 - 100$ ppm (depending on installation point)

The IRmadillo does not try to out-perform HPLC for error and detection limits, but it can give so much more information over a much shorter time. It also tells you when to take an extract for HPLC — using your staff much more efficiently and effectively.

Interested in finding out more?

Contact us to find out more details. Let us know about your process and what you'd like to be able to measure 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.

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 on how you can get an IRmadillo installed into your system. enquiries@keit.co.uk

