

Monitoring Edible Oil Refining

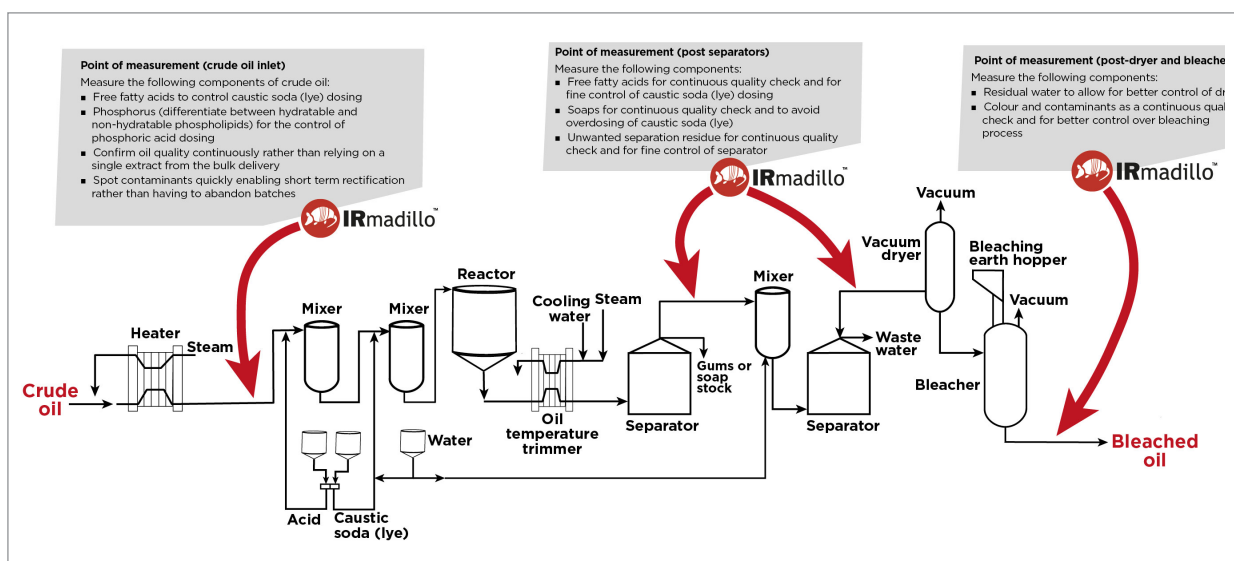
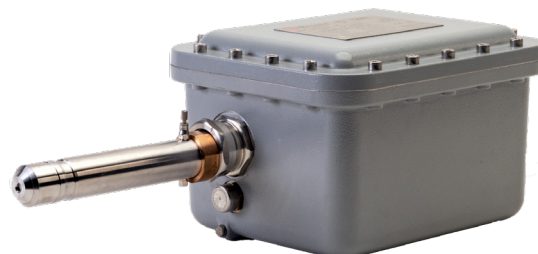
Improving Production with the IRmadillo

What is it?

The IRmadillo is a process analyser based on FTIR spectroscopy that monitors in real time the concentration of different chemicals in liquids. 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 and forget about it.

What's the point? Why should I use it?

That's a good question! The IRmadillo acts as both a concentration meter for the chemicals present throughout the entire refining process, and a qualitative contamination and adulteration monitor. This allows you to optimise your process in real time, reducing costs and saving money.



What's the benefit when it monitors edible oil refining processes?

Above is representative process flow for edible oil processing with suggested installation points for the IRmadillo. Some suggested applications for the IRmadillo include:

- **Chemical dosing control:** analysing the crude oil as it enters the refinery and measure the concentration of free fatty acids (FFAs), and phosphatides so that you can establish exactly how much acid and lye/caustic soda to add to effectively degum and neutralise.

This means no more wasted chemicals that need to be removed later on, reducing the cost of separation, chemicals and waste disposal.

You will also end out-of-specification product with too much FFA because of underdosing of caustic soda.

■ Process optimisation and efficiency improvements:

by installing an IRmadillo on the outlet of a separator you can ensure it's running effectively and fine tune the centrifuge control to confirm you're still removing the soap stock and residual water (but without losing any valuable product!). By having real-time analysis of the output of the separators, you can run them to a much tighter specification to reduce waste without reducing quality.

- **Real-time confidence:** the IRmadillo can also act as a real-time adulteration or contamination monitor. This ensures that every drop of oil that runs through the refinery is within specification and corresponds to the product you intend to make.

No worries about having to throw away a batch of contaminated oil, no issues with high value oils that have been adulterated with lower value ones - instant and consistent confidence.

How do I use it?

The IRmadillo is a flexible 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: in this mode the IRmadillo will output the concentration for each different chemical present in your process that it's been calibrated to detect. Example chemicals it can detect and monitor are:

- Free fatty acids (FFAs)
- Fatty acids methyl esters (FAMES) - in biodiesel production
- Phosphatides, hydratable and non-hydratable phospholipids
- Soaps
- Free glycerol
- Water
- Chlorophyll

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

Quantitative analysis - Physical property: in this mode the IRmadillo will correlate the spectra with the physical properties of interest at that stage. Examples are:

- Colour
- Iodine value (IV)
- Melting point
- Viscosity

Qualitative analysis: In this mode the IRmadillo will give you readings such as "within specification", "contamination spotted", "wrong oil type present" 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.

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.

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 the process. This means it's not quite as accurate as a lab 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 FFA in sunflower oil is shown below in Figure 1, with an average error of just 0.24 % across the concentration range studied.

This measurement was also made with other contaminants present - such as fatty acid methyl esters - showing that the calibration is robust and resistant to different process conditions.

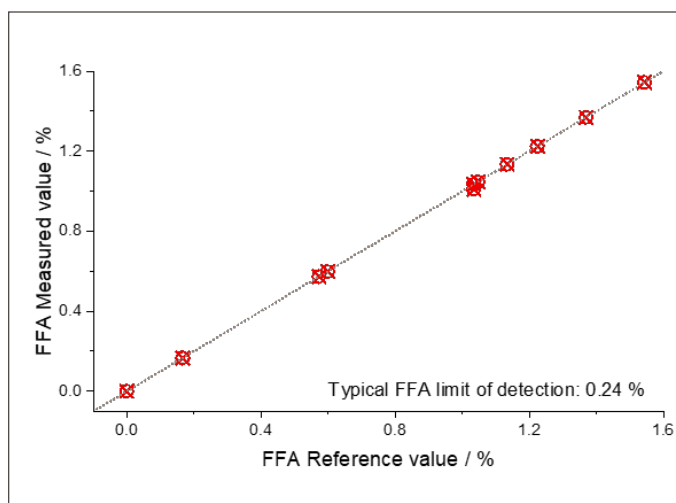


Figure 1: Calibration results for a variety of different FFAs dissolved in sunflower oil.

I process lots of different oils, with different makeup of FFAs - how do you cope with that?

The examples we've listed in this brochure deliberately use a variety of different FFAs, triglycerides and carrier oils. This is to ensure that the results are not just sanitised lab experiments, but have real tangible relevance to our customers.

Customer results are on real process lines with different oils being processed - the IRmadillo doesn't care. As long as the calibration is built on different oils then real-time analysis can be performed on them too.

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 below (Figure 2) shows the results of a customer installation of the IRmadilloDiamond on the outlet of the bleacher. This installation was monitoring the residual FFA in the final product to check for contamination and as a continual quality control. The IRmadillo spotted that the residual FFA value drifted above specification (0.10 %) almost immediately, but the routine testing did not catch it for almost 12 hours.

The IRmadillo will also talk to your existing process control 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 feed-forward and feed-

back process control strategies. For example, by communicating the FFA value in crude oil to the lye/caustic dosing pump, a fine control over neutralisation can be achieved thereby reducing chemical costs.

I run multiple parallel streams in my refinery - do I have to calibrate each instrument individually?

Keit is currently working on a calibration transfer product so you can calibrate once and transfer the calibration to each and every instrument you purchase, no matter where it is installed in the refinery, or even in a different refinery! If your processes require a different calibration, Keit will work with you to make this as painless as possible.

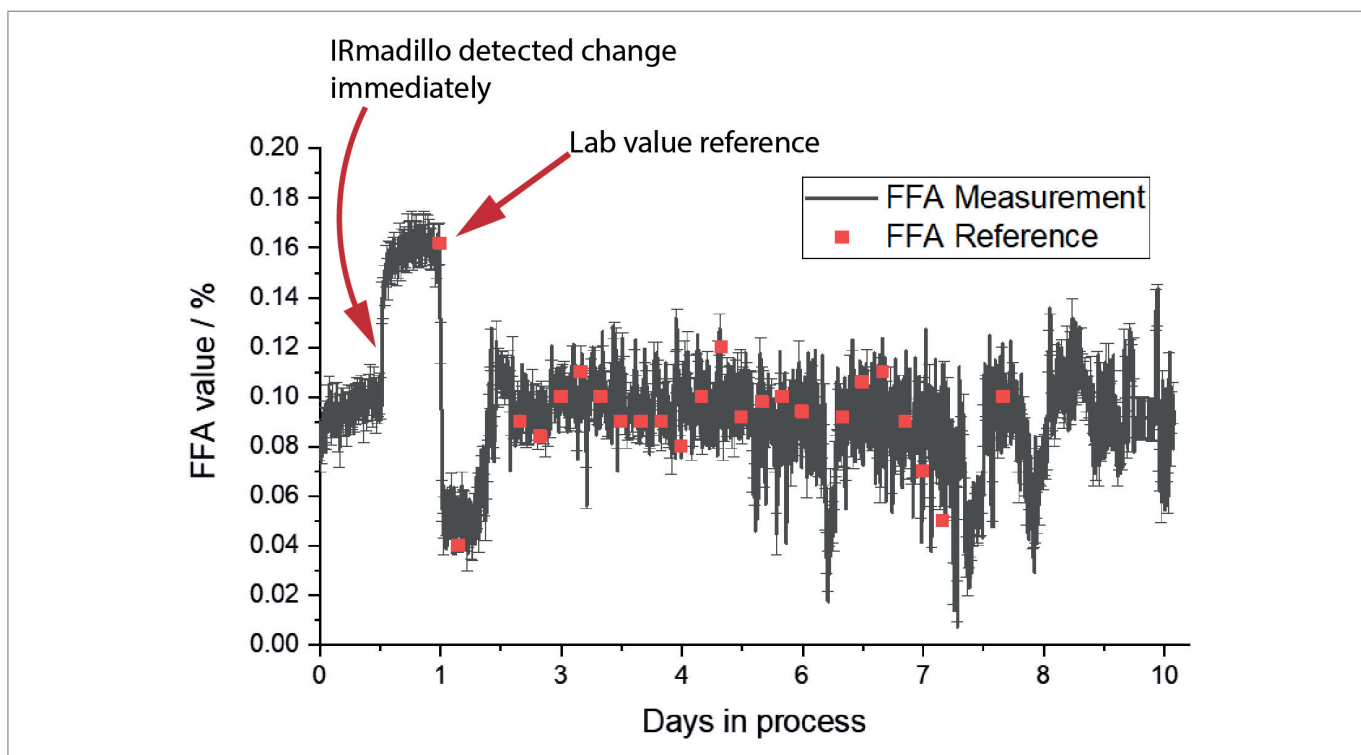


Figure 2: On-line results from a customer installation measuring FFA at the outlet of the bleaching earth to check for quality control. The results clearly show the moment when the product drifted out of specification, and the difference between when the IRmadillo spotted the issue and the routine testing identified it.

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 "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. They also use a probe with a reflecting window in it that can easily get blocked with high solid loadings, bubbles or gums – such as crude oil!

So how do I actually install this?

The IRmadillo can be installed directly onto and 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 probe, coupled with another flange directly on the pipework of the refinery. This means the analyser is measuring exactly the same oil as is flowing through the refinery, benefits from any pipework

cleaning you may be running, but does require the fitting of a flanged T-piece. It also means the instrument cannot be easily removed while the refinery is in use.

■ **Recirculation loop and a flow cell:** this method uses a flow cell on the IRmadillo probe coupled with a recirculation/extraction loop. The oil 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.

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I'm interested. What's next?

Keit gives you options to easily 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 upon span of time. Easy to renew, you have control over how long you keep it — from a few months to a longer rent-to-own plan.

Lease

Consider a longer 2-year leasing plan that is a cost-effective alternative for those needing an instrument, but who also need to keep the CAPEX expenditure in check.

Purchase

Own your IRmadillo outright to monitor your process in-line and in real time as you see fit.

Begin your discussion today on how you can get an IRmadillo installed into your system.

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