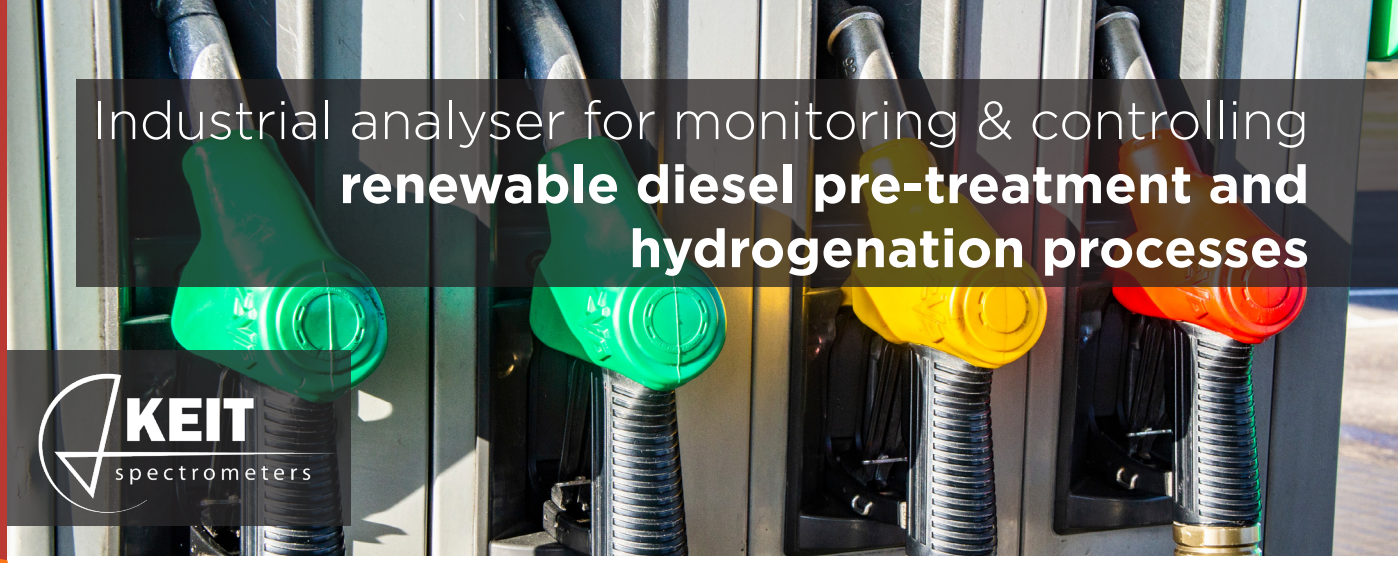

Industrial analyser for monitoring & controlling **renewable diesel pre-treatment and hydrogenation processes**

KEIT spectrometers

Introduction

The application of hydrotreating and hydrogenation of triglycerides, vegetable oils and animal fat feedstocks to produce renewable diesel is a significant step in moving away from petrochemicals and fossil fuels to power the modern economy. Given the potentially variable nature of the feedstocks to this process, it is important to measure and understand the pre-treatment process to avoid potentially contaminating the reactor and catalyst bed. Replacing a catalyst bed can cost up to $1,000,000 as well as the opportunity cost of plant downtime, so detecting and removing contaminants before damage occurs is critical.

Furthermore, it is important to accurately record the inputs into the process to schedule preventative maintenance accordingly – for example, recording the total acid number (TAN) originating from free fatty acids in tallow or used cooking oils. The TAN can be directly linked to corrosion rates so measuring it in real time gives the plant the information it needs to decide whether to continue production or schedule in repairs.

Off-line analysis such as titration, HPLC and ICP-AES technologies can measure the chemicals of interest, but they are slow, expensive and sample removal can be hazardous. On-line analytical tools – such as pH probes or temperature probes – are not able to measure the chemicals of interest directly.

What's the solution?

The best solution for this problem is spectroscopy! There are many different sorts of spectrometers, such as near infrared (NIR), Fourier transform mid infrared (FTIR) and Raman spectrometers. NIR spectrometers are typically not sensitive or specific enough to be of high value in measuring the chemicals of interest in pre-treatment for renewable diesel. Raman spectrometers are not ideally suited for the study of molecules like fats and fatty acids because of the lack of polarizability.

FTIR spectroscopy is ideally suited for the study of fats, fatty acids and other triglycerides. But it is also very good for monitoring phospholipids, phosphates, and other potential contaminants for renewable diesel pre-treatment. Traditional process FTIR spectrometers have not been robust enough for industrial use, and have fragile fibre optic elements. The IRmadillo is a static-optics FTIR spectrometer, designed for industrial installations. This makes it ideally suited for use in renewable diesel pre-treatment process monitoring and control.

What chemicals can it measure?

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

- Free fatty acids (FFAs)
- Water
- Phospholipids
- Phosphates, phosphatides and phosphoric acid
- Amines, amides, nitrates and nitrites
- Glycerol
- Metals (by studying the chelation to other chemicals present in the mixture)
- Triglyceride makeup

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 manufacturing industries.

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

IRmadillo™

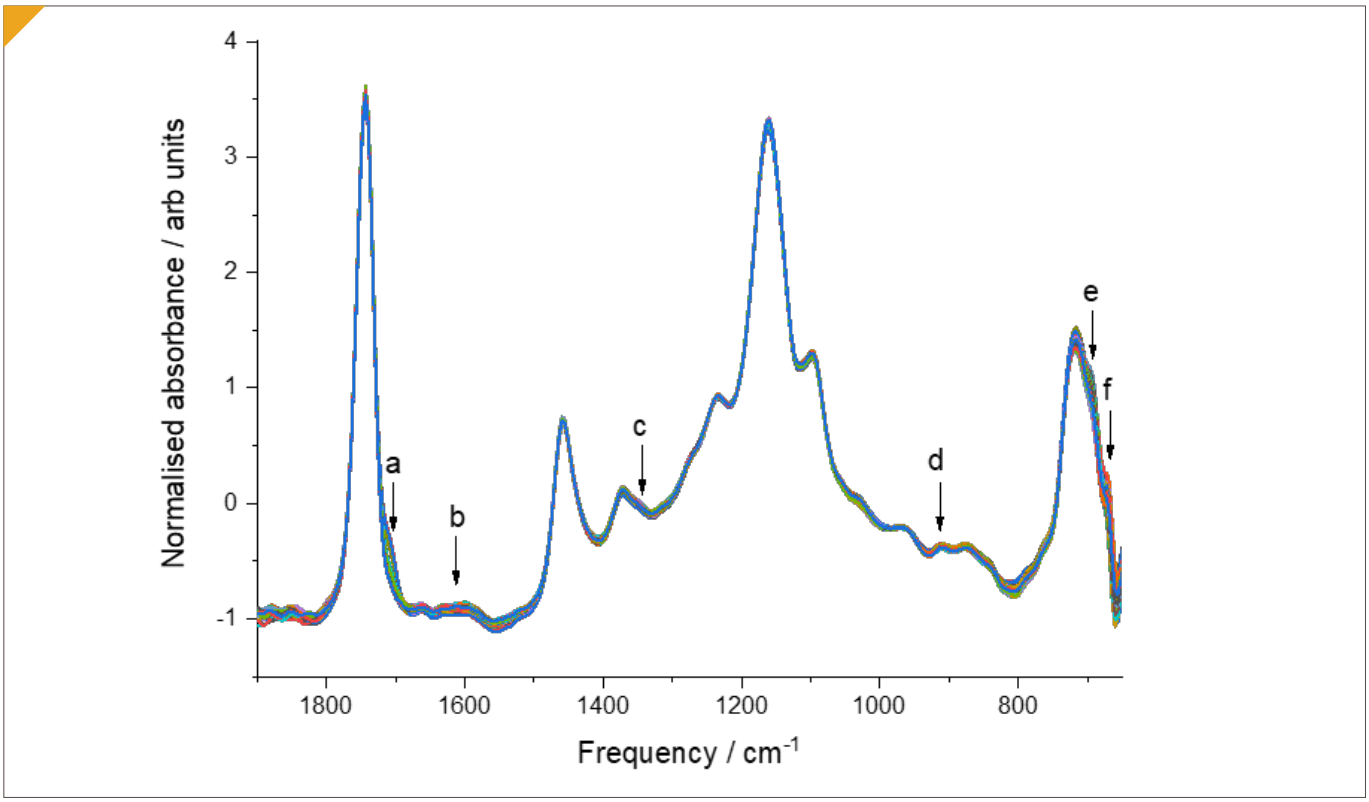

Figure 1: Example spectra of a mixture of triglyceride feedstocks. Band assignment: a) C=O in FFAs, b) C=C bonds in unsaturated FFAs and FAMEs, c) C-H bends in FFAs and FAMEs, d) C-C and C-O stretches in FFAs and FAMEs, e) O-C=O bend in FFAs, f) 0-C=O bends in FFAs and FAMEs

How well does it work?

Quantitative calibrations – i.e. concentration measurements

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!

Qualitative measurements

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 on shift 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.

Contact us

Get in touch with us to find out more about how the IRmadillo can improve real-time monitoring of renewable diesel processes.

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