tec5 USA
MEMBER OF THE NYNOMIC GROUP

In-Line Monitoring of Seed and Soybean Oil Transesterification for Biofuel Production

As a renewable fuel, biodiesel is a promising alternative energy source. Biodiesel fuel production involves oil-based plant feedstock containing triglycerides, such as soybean and seed oil. The process involves the transesterification of triglycerides with methanol or ethanol to produce long chain fatty acid methyl esters (FAME) as shown in Fig. 1.

Traditional methods for analyzing the quality of the biodiesel production process utilize offline testing methods, which take place at the end of a production cycle. These methods lead to higher production costs due to the process requiring stopping, time consuming analytical tests and potential reprocessing if the product is out of specification. With in-line NIR spectroscopy, various parameters during the transesterification can be measured in real time. These measurements in include methyl ester, monoglycerides, diglycerides, and triglycerides concentration levels. Understanding the levels of glyceride present during the reaction process allows for more accurate control of the transesterification process. Ultimately, this will reduce the time and cost to produce biodiesel fuel.

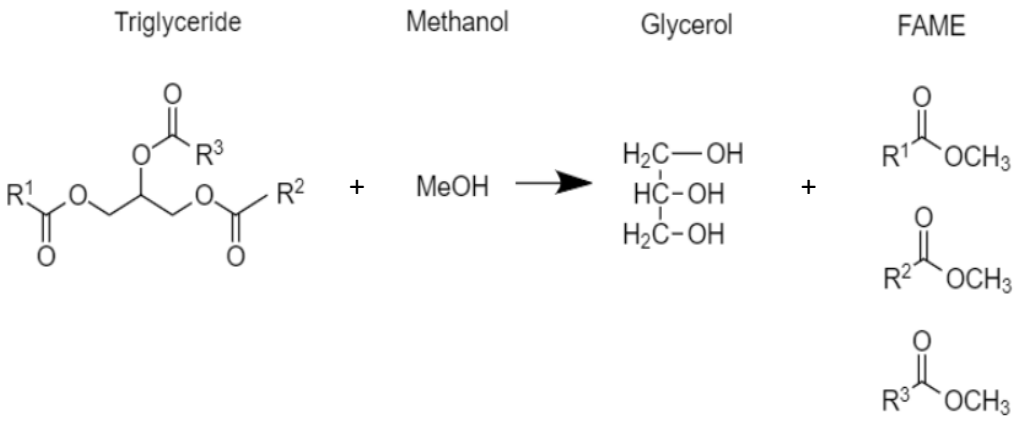

Fig. 1 Mechanism for the transesterification of triglycerides to fatty acid methyl esters (biodiesel fuel)

Application Note

tec5USA Compact Near Infrared Spectrometer (CNIRS):

The analysis of glyceride levels in real-time is possible with the Compact Near Infrared Spectrometer (CNIRS). Available as a Class I Division 1 rated device, the CNIRS can withstand the harsh conditions present in the industrial production environment. The device combines the maintenance free miniaturized NIRONE™ Fabry-Perot sensor module with MEMS technology, miniaturized dual halogen light source and the tec5USA tecSaaS® embedded electronics platform. The combination of these components allows for a compact and cost-efficient device. With the tecSaaS® embedded platform, the result output is processed without the need for a separate PC, where the results can be transferred via Modbus TCP, EtherNet/IP, CAN Bus and 4..20mA current loop protocols.

[IP65 Compact Near Infrared Spectrometer (CNIRS)]

[Class I Division 1 Compact Near Infrared Spectrometer (CNIRS)]

Measurement

The Compact Near Infrared Spectrometer (CNIRS) system was utilized to understand the transesterification process of radish seed and soybean oil to biodiesel fuel (FAME). During this measurement, seed and soybean oil were monitored as their concentration in ethanol was decreasing. This concentration reduction can be observed primarily in the wavelength region between 1620 nm and 1880 nm on Fig. 2a and 3a. This region corresponds to the first overtone region of C-H stretching in glyceride. As the concentration was reduced from 1.3 mL to 0.1 mL, the absorbance bands in this region decreased in intensity. This intensity reduction is shown clearly by the first derivative spectra shown in Fig. 2b and 3b. The relative changes in peak intensity allow for a quantitative measurement of the glyceride levels during the transesterification process. To achieve the highest product yield, it is necessary to fully transform the reactant (seed and soybean oil) to product (biodiesel fuel). By monitoring the concentration of the reactant during the process, operators can alter the reaction conditions in real time to allow for the greatest yield. A full understanding of this process allows for decreased production times, cost reduction and improved quality of the biodiesel products.

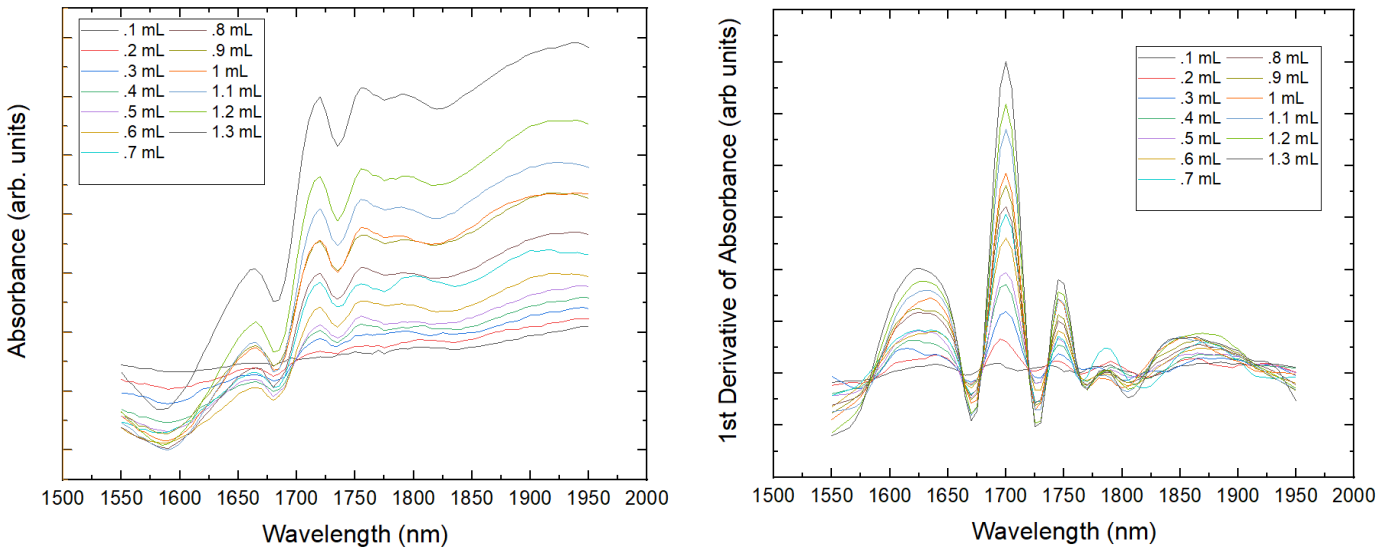

Fig. 2 (a) NIR spectra and (b) 1st derivative for the decreasing concentration of radish seed oil in ethanol

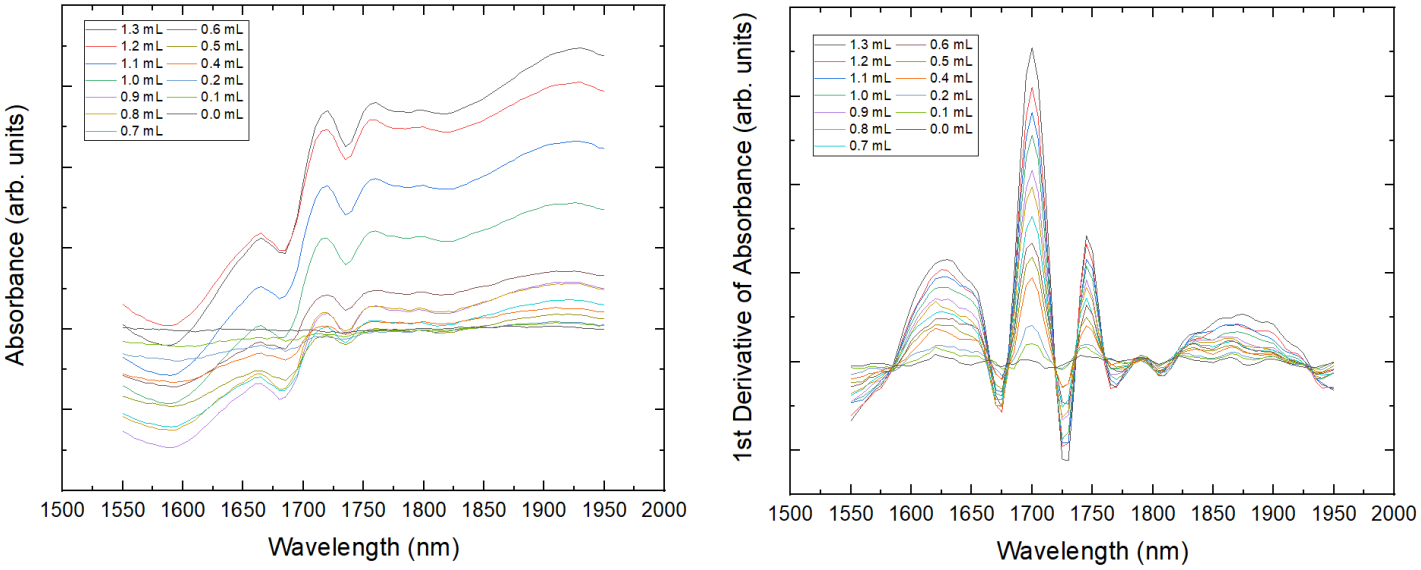

Fig. 3 (a) NIR spectra and (b) 1st derivative for the decreasing concentration of soy bean oil in ethanol