Portable Infrared Analysers Provide an Easy On-Site Method for Detection and Measurement of Biofuels

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While the current economic recession has impacted most industries worldwide, there still have been gains in global biofuels production. The EU had almost a 20% increase from 2009 to 2010. South America also increased production for both domestic and export markets. The news from the Asia-Pacific region is similar to the US -- the intention to reduce oil imports is there; but, in most countries, the financial backing to get it going is not.

As the financial situation begins to stabilise, it is very likely that more biofuels will be blended into petroleum fuel. At the same time, there are fuel consumers and distributors who want to make sure that there is no biodiesel in their storage tanks, pipelines or in the case of the military in the fuel for their tactical and emergency vehicles. The presence of biodiesel in diesel fuel can also negatively impact the performance of emergency back-up generators.

With the increased integration of biofuels into petroleum fuels comes the need for accurately measuring the amount of biodiesel in fuel -- whether it is for ensuring a correct blend or detecting contamination. Portable infrared analysers, such as those discussed below, represent the quickest and easiest way to accurately make such measurements on-site and in a matter of minutes.

On-site blend measurements help ensure product quality

Blend ratio measurements are important, not only when the fuel is initially blended, but also as it travels the distribution network and especially when it finally arrives at the pumps. In the US, the responsibility of making sure what comes out of the fuel pump is the labeled ratio falls on state agencies. The state of Pennsylvania passed a mandate in May 2010, for 2% biodiesel in all diesel fuel sold at retail stations. The Pennsylvania Department of Agriculture (PDA), who has the responsibility of enforcing the mandate, chose portable fixed-filter infrared analysers (photo 1) for testing the diesel fuel at service stations throughout the State. These analysers provide PDA with the required accuracy of 0.2 percent and can be operated on-site from a truck. Fuel distributors can also benefit from having such a quick and accurate analysis method to verify a blended load and the fuel receiver can make sure they have the correct delivery.

Low level biodiesel detection in petroleum fuels

Shipping fuel through pipelines is generally the most economical method. Transportation by rail can cost 5 times more than by pipeline. With a barge, it is around 2.5 times more and trucking can be 20 times more. While pipeline distribution is the preferred method due to cost, biofuels shipments are limited in pipelines due to material compatibility and contamination issues.

Biodiesel blends are already being moved through some pipelines in Europe. In the fall of 2009, a major US pipeline operator transported blended biodiesel through a pipeline for the first time. Tests on the biodiesel blend were done using the mid-infrared analysers at the beginning and end of the shipment to ensure the biodiesel met blend specifications.

Photo 1: Single wavelength infrared analyser

The ASTM Method D 975 currently allows up to 5% biodiesel in diesel without the requirement for biodiesel content labeling. Since biodiesel is a surface active material, it tends to stick to tanks, pipes, vehicles and distribution manifolds. For pipeline operators who move jet fuel, it is a concern that the residual biodiesel will "trailback" and contaminate the jet fuel which has a limit of 5 ppm. For pipeline operators this creates a need to check incoming diesel fuels to insure that no biodiesel is present before they allow the fuel into their line.

Portable infrared analysers can easily verify that the fuel contains 100 ppm or less of biodiesel. A recent seven week on-site test at a major pipeline company in the US verified the effectiveness of the Wilks InfraSpec Biodiesel Detection Spectrometer (see photo 3) for detecting biodiesel contamination in fuels about to enter the pipeline. Over 25 different types of diesel fuels were tested for the presence of biodiesel. The testing concluded that the infrared spectrometer could detect biodiesel levels below 100 ppm in under 5 minutes. Trace amounts of biodiesel in diesel fuel is also an issue for emergency diesel generator operators who store fuel for years and are worried about bacterial growth clogging their filters or tactical military and emergency vehicles that can't afford to go down during a crucial operation.

Infrared analysis of biofuels

The approved methods for biodiesel measurement are ASTM D 7371 in the US and EN 14078 in Europe - both specify mid-infrared for the measurement of the biodiesel or FAME (fatty acid methyl ester) blend ratio. Infrared analysis works well for FAME because the biodiesel ester has characteristic infrared absorption (due to the carbonyl band at 5.7 micrometers or 1745cm^{-1}). As the concentration of biodiesel goes up, the infrared absorbance at that wavelength increases. The infrared absorbance can be directly calibrated to readout in percent biodiesel.

Advantages of filter-based infrared analysers

An infrared analyser can be set up with a filter mounted on a detector that is specific to the biodiesel analysis. The advantages of a filter-based infrared analyser are many -- convenient size, lower cost, ruggedness, portability and ease of use. For regulatory agencies, blenders, terminal and emergency diesel generator operators, a sturdy little box that fits in their trucks, operates off a car battery, and functions in a wide temperature and humidity range is ideal. The operation involves simply putting a sample on the exposed sample plate, pressing the "run" button and in less than a minute, the display reads the percent biodiesel.

Photo 2: Filter based infrared spectrometer

Comparison to analytical methods

The most common concern is how filter-based infrared analysers compare to other reference methods that use FTIRs (Fourier Transform Infrared Spectrometers). The data in Table 1 compares a single wavelength (InfraCal Biodesel Blend Analyser, photo 1) and a spectral range (InfraSpec VFA-IR Spectrometer, photo 2) filter-based analysers to ASTM D7371 and EN 14078. In Table 2 the same samples were tested by three different laboratories performing ASTM D7371 and with a filter-based infrared spectrometer. Both examples show that the filter analysers perform as well as the laboratory methods.

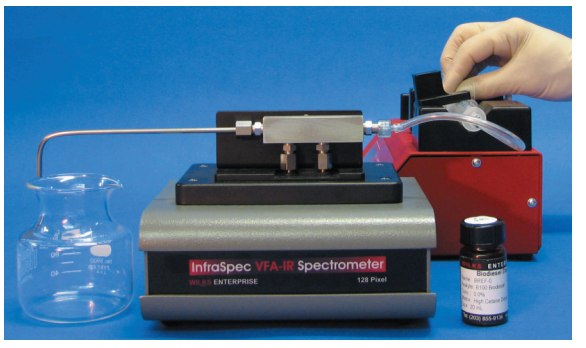

Photo 3: InfraSpec Biodiesel Detection Spectrometer

Conclusion

As higher percentages of biofuels enter the supply chain, knowing the biodiesel/diesel or ethanol/gasoline blend becomes more important for regulators, distributors, blenders, pipeline operators and end-users. Portable infrared analysers can provide the quick analytical method for on-site blend ratio measurements which will be a valuable asset for the biofuels industry as it continues to grow.

Sample ID	EN 14078 FTIR	ASTM D7371 FTIR	InfraCal Biodiesel Blend Analyser	InfraSpec VFA-IR Spectrometer
105-003	0.2	0	0.2	0.22
1.0 STD	1.1	1.15	1.3	1.4
5.02 STD	5	4.99	5	5.12
30.0 STD	30.2	30.07	30	30.11
50.0 STD	50	50.06	50.4	50.6

Table 1: Infrared filter based analysers compared to EN and ASTM blend measurement methods

% FAME in Diesel	ASTM D7371 lab 1	ASTM D7371 lab 2	ASTM D7371 lab 3	InfraSpec VFA-IR Spectrometer
2.0	1.1	1.8	2.2	2.4
4.0	3.0, 2.8	3.5, 3.7	4.0, 4.0	4.4, 4.3
10.0	8.4	9.2	9.7	10.1
20.0	17.3	19.8	18.0	19.5

Table 2: Three laboratories and Infrared filter based spectrometer testing the same samples