Maintaining biodiesel quality standards

A problem that is sometimes encountered with biodiesel blends is inaccurate blend ratios. This article describes a quick analytical method to assess blend ratios and ensure fuel performance.

According to a study[1] done by the National Renewable Energy Laboratory, the chief problem found with biodiesel blends was inaccurate blend ratios. Retail customers and fleet managers do not typically worry about whether the blend ratio is correct until a problem occurs. For fleet managers, this can mean a total shutdown of operations. With the image of biofuels vacillating in the public eye because of food versus fuel issues and the environmental advantages of biofuels, it is important to keep quality standards high in order to further biofuels' acceptance. Analytical testing equipment is essential to this goal.

Portable mid-infrared analysers offer a quick analytical method to assess the blend ratio of either biodiesel in diesel or ethanol in gasoline and can be a valuable asset not only for distributors and terminal managers who blend the fuel, but also for finished product testing by fleet operators and regulatory agencies.

Blending methods

There are basically two methods of blending biodiesel: splash blending (either in a tank or in the delivery truck) and in-line blending. The fact that biodiesel is typically denser than petroleum diesel, and that the cold flow properties can change with different biodiesel feedstocks, adds challenges to getting an adequate mix during blending.

Splash blending: The most common, and least accurate, blending method used for biodiesel is splash blending. Diesel fuel and B100 are pumped by the distributor separately into the delivery truck at the time it is loaded. The hope is that the blend will be adequately mixed by the time the truck gets to the delivery site. Splash blenders are not necessarily open to on-site blend testing. As one blender who preferred to remain anonymous for obvious reasons stated, "What is in it for us except making our blending techniques look bad?"



The InfraCal Biodiesel Blend Analyzer is an easy-to-use analyzer for measuring biodiesel blend quality.

At a demonstration of a portable fixed-filter infrared analyzer that measures per cent biodiesel (Photo 1), a sample was taken from a delivery truck destined to deliver B20, but the analyser indicated that the blend was only 8.7 per cent biodiesel. The initial reaction was that something must be wrong with the analyzer, which was then checked with a B20 standard and the reading was 20.1 per cent. After some investigation, it was discovered that they had run out of B100 and the truck had been topped off with diesel.

Splash blending also has the risk of inaccurate blend ratios if the delivery truck has not traveled far enough to provide adequate mixing. In another demonstration test, five minutes after filling the truck for B20, a sample taken from the top was 11.9 per cent and another from the bottom was 24.1 per cent.

Ambient temperature is another issue. Blending fuels in cold weather with non-heated biodiesel further reduces the chance of an adequate blend prior to delivery. Each feedstock has a different temperate at which it will begin to solidify or gel, called the cloud point. To account for cold flow properties of each feedstock, B100 should ideally be kept at least 10° above the cloud point for blending and storage. If unheated biodiesel is loaded into an empty delivery truck on a cold day, there could be little or no mixing.

Cold flow properties can also vary according to the feedstock used. In colder temperatures crystals can form and could plug a filter. A reliable distributor may want to change blend ratios according to climate conditions to ensure that customers will have a reliable fuel. All of these mixing challenges suggest the need for quick on-site blend measurements.

In-line (injection) blending: While typically used for ethanol blending at pipeline terminals and racks, some biodiesel distributors are just beginning to consider using in-line blending. With in-line blending, the biofuel is metered into the diesel or gasoline as it travels through a pipe. There are different blending system configurations and equipment. *Sequential blending* loads the biofuel and petroleum fuel through the same meter sequentially. *Ratio blending* loads the individual products through



The InfraSpec VFA-IR Spectrometer can measure a spectral range, making it possible to use the instrument for the measurement of both biodiesel/diesel and ethanol/gasoline blends.

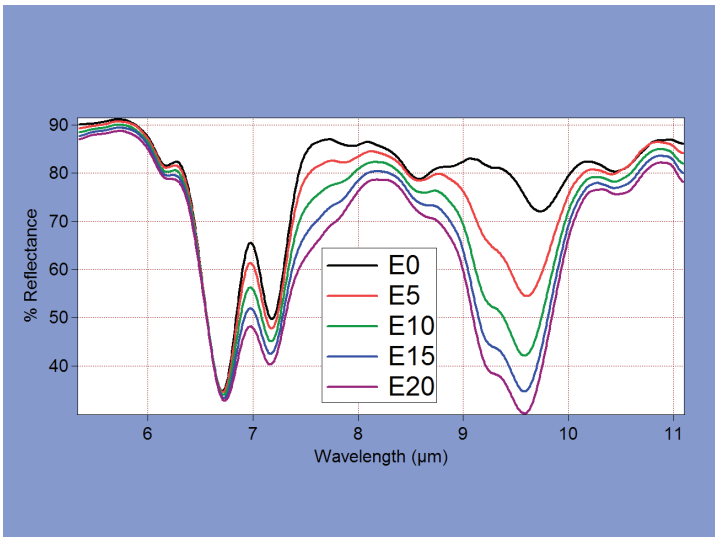

Fig 1. Ethanol content of blends can be measured independently of gasoline content using infrared spectrometry.

separate meters simultaneously. They are then blended at the downstream connection. Because the fuels are pumped in at the same time, they tend to mix better than they do with sequential blending. With *side-stream blending*, the biofuel is metered into the diesel or gasoline line upstream of the delivery meter prior to loading the truck. Passing through the delivery meter gives the blend an additional mechanical mix.

Additional mixing for all of these systems occurs as the fuels enter the receiving tank. These methods offer better blend consistency than splash blending. For biodiesel, density and viscosity changes require adjustments to the meters for an accurate blend. Although manufacturers of in-line blending systems claim indisputable accuracy, a quick check for the correct blend gives actual data to validate this claimed assumption.

Infrared measurement of biodiesel/diesel blend ratios

The approved methods for biodiesel measurement, EN 14078 and the ASTM Method D 7371, both specify mid-infrared for the measurement of the biodiesel blend ratio. An infrared analysis works well because the biodiesel ester has characteristic infrared absorption due to the carbonyl band at 5.7 microns or 1745 cm^{-1}. As the concentration of biodiesel goes up, the infrared absorbance at that wavelength increases. The infrared absorbance can be directly calibrated to read-out in per cent biodiesel. The simple design of the InfraCal Biodiesel Blend Analyzer has a 5.7 µm filter selecting the wavelength for biodiesel absorption mounted directly onto a detector. The result is a portable analyzer that weighs less than 5 pounds and can be battery-operated, making it ideal for regulatory agencies, blenders and fleet managers.

Volumetric standards % biodiesel in diesel	InfraCal Biodiesel Blend Analyzer	FTIR-EN Method 14078
17.00	17.02	19.90
25.00	24.57	28.30
47.00	46.97	52.00
63.00	63.22	77.30
76.00	74.55	82.00
100.00	100.00	99.85

Table 1: Comparison of EN Method 14078 and a fixed-filter infrared analyzer.

The data in Table 1 show a comparison of volumetrically mixed standards tested with the InfraCal Biodiesel Blend Analyzer and with an FTIR using EN Method 14078. The fixed-filter analyzer's ease of use reduces operator error compared to the more complicated EN Method. As the data show, in this comparison the fixed filter analyzer matched the volumetric standard numbers more closely than the FTIR-EN Method.

Infrared measurement of ethanol in gasoline

Ethanol also has a characteristic absorbance in the mid-infrared range. Like biodiesel, the increase and decrease of infrared absorbance correlates directly to the amount of ethanol present in the sample. Ethanol can be measured independently from gasoline at 9.6 µm (1042 cm^{-1}) as demonstrated in the ethanol spectra in Fig 1. The same filter-based analyzer set-up for the biodiesel measurement is used, only the wavelength is selected for ethanol analysis. A fuel sample is placed directly on the exposed sample window of the analyzer and in less than a minute the per cent ethanol is displayed. The InfraSpec VFA-IR Spectrometer (Photo 2) has the capability of measuring a spectral range rather than only one fixed wavelength. This makes it possible to measure the appropriate wavelengths for both ethanol and biodiesel with one spectrometer.

To conclude

As more mandates for minimum blends of biofuels come into effect, concerns about cold weather performance and engine warranty issues, as well as regulators verifying percentages for incentive programmes, emphasise the need for a quick blend analysis. Keeping quality control standards high will help avoid fleet-stopping events from getting into the news, which will certainly encourage public acceptance of biofuels.

REFERENCE

1. Production of Biodiesels from Multiple Feedstocks and Properties of Biodiesels and Biodiesel/Diesel Blends, J. A. Kinast, March 2003, NREL/SR-510-31466.

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