# BIOdiesel TechNOTES

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## BIODIESEL BLEND LEVEL DETERMINATION

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Last year (2018), the US mandated 2.1 billion gallons of biomass-based diesel (biodiesel or renewable diesel) to be blended with regular diesel as part of the renewable fuel standard. The vast majority is blended with diesel, typically in the range of 5, 10, and 20% biodiesel. Blending at fuel distributors is typically accomplished using metering pumps and flow meters while in the field it is usually done by splash blending. The accuracy of both methods can be questionable. Calibration on flow meters can be incorrect and in the case of splash blending, the mixing methodology, as well as the temperature of the two streams, can be a factor affecting the true blend level.

If biodiesel is blended at a temperature less than 10°F above its cloud point, it will not mix well with diesel, causing a rich mixture in one portion of the tank and a lean mixture in another portion. Other reasons for the discrepancy may include profit-driven fraud and involuntary mixing of diesel into the blend to lower the overall level of biodiesel. Biodiesel is sometimes sold at a higher price than diesel fuel; therefore, the price of the fuel is dependent on the blend level.

It has been reported that the actual biodiesel content of blended biodiesel fuel sold at gas stations can be significantly different from the nominal blend level. For instance, 2% nominal blend has been found to actually contain anywhere from 0% to 8% biodiesel. Many engine manufacturers have limited the recommended amount of biodiesel that can be blended with diesel fuel, and the National Biodiesel Board provides details of the individual engine manufacturers' limitations on biodiesel use. The blend level determines many important characteristics of the blended fuel. A higher-than-specified level of biodiesel may exceed the engine manufacturer's recommended limitation, compromising the engine performance. A lower blend level of biodiesel may reduce the expected benefits, such as fuel lubricity and tailpipe emissions. In addition, the cloud point and pour point of biodiesel are usually higher than that of diesel fuel, and a higher blend level could make the fuel more difficult to use in cold weather conditions.

Blend level detection has been accomplished with chromatography and specifically designed meters such as the commercial diesel fuel analyzer CETANE 2000 which is capable of measuring multiple characteristics of biodiesel simultaneously. These instruments are not a cost-effective solution for a quick and easy blend level detection application. A simpler approach for University of Idaho researchers was to focus on a specific component of diesel which is not present in biodiesel as a distinguishing characteristic. This component is aromatic compounds, which are a class of hydrocarbons that are characterized by a stable chemical ring structure present in diesel fuel up to 20- 30% by weight.

The presence of aromatics in diesel and their absence in biodiesel creates the possibility of distinguishing these two fuels using ultraviolet spectroscopy. Benzene, the simplest aromatic compound, has maximum absorption at 278 nm. Biodiesel is made up of esters of long-chain fatty acids and when adequately diluted in n-heptane, has negligible absorbance compared to the aromatics at the same frequency.

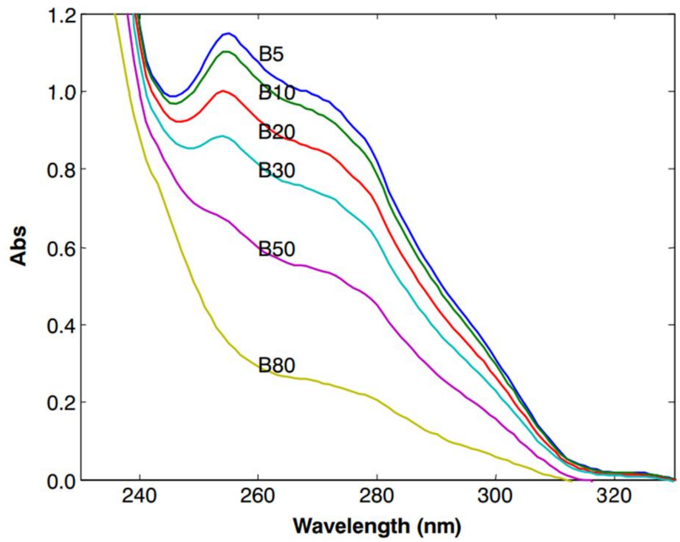



**Figure 1. UV absorbance spectra of soy methyl ester and No. 2 diesel blend diluted 1:2915 in *n*-heptane.**
**From *Biodiesel Blend Level Detection Using Ultraviolet Absorption Spectra*, A. Zawadzki, D. S. Shrestha, B. He**

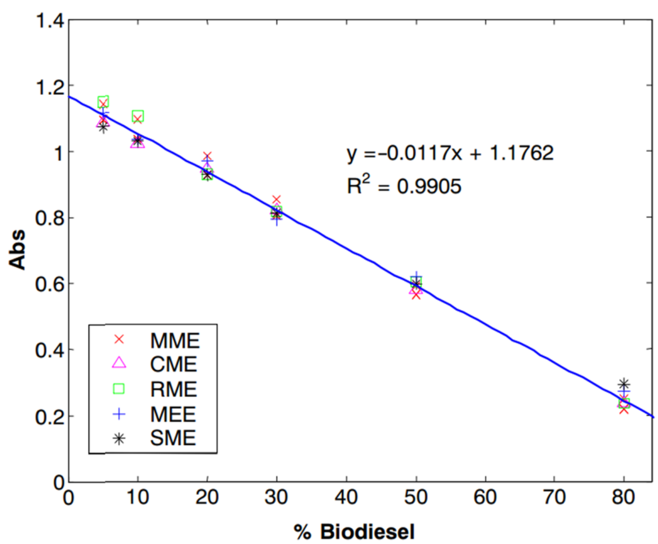


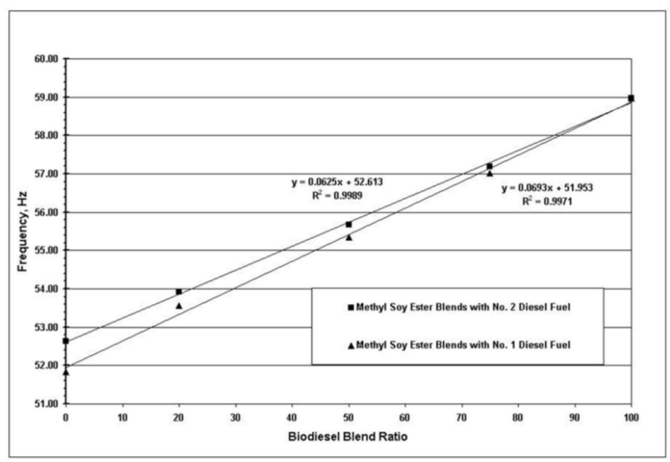

**Figure 2. Absorbance of diluted biodiesel-diesel blends from different feedstocks at 260 nm wavelength (MME = mustard methyl esters, CME = canola methyl esters, RME = rapeseed methyl esters, MEE = mustard ethyl esters, and SME = soybean methyl esters).**

Since biodiesel blends have very high absorbance in the UV range, the samples had to be diluted with n-heptane in order to bring the absorbance to the measurable range of a spectrophotometer,
The final dilution of the biodiesel-diesel blends was 1:2915 v/v. This dilution reduced the absorbance in the 240- 350 nm wavelength range to within 1.2 for diesel samples.

The shapes of the absorbance curves in the 265-280 nm range were very consistent (Figure 1). Therefore, the absorbances at three wavelengths where the aromatics were best absorbed (265, 273, and 280 nm) were used to extract the absorbance index. The absorbance index, calculated using absorbances at three different wavelengths was used as a method to determine blend level with an unknown source of biodiesel and diesel. The absorbance index correlated linearly with the blend level (Figure 2) and was found to be applicable to any biodiesel feedstock independent of the diesel fuel origin.

Another approach studied by Tat and Van Gerpen was to take a commercial Flexible Fuel Composition Sensor designed to detect the amount of ethanol in gasoline and adapt it for use in biodiesel/diesel fuel blends. The frequency output of the sensor was observed to be linearly proportional to the percentage of biodiesel in the blend. Implementing this technology in diesel-powered vehicles would allow for real-time injection timing adjustment to improve the engine's emissions and performance.

**Figure 3. Methyl Soy Ester Blends with No. 2 and No. 1 Diesel Fuel**




In order to comply with engine manufacturers warranties, state and federal mandates as well as consumer preferences, blenders, distributors and users of biodiesel/diesel blends need a quick, inexpensive and reliable method to measure blend level. To date, this has required the use of expensive equipment which is not widely available. However, the use of spectroscopy has been shown to meet the criteria for quick, low-cost blend level detection.

For more detailed information see:
Zawadzki, D. S. Shrestha, B. He; Biodiesel Blend Level Detection Using Ultraviolet Absorption Spectra

Mustafa E. Tat, Jon H. Van Gerpen; Biodiesel Blend Detection Using a Fuel Composition Sensor