

Helping BioEnergy of America LLC Make the “Best Biodiesel in America”



Figure 1. Monte Malone, BioEnergy of America's national sales manager with the PerkinElmer Clarus Gas Chromatograph.

As the world searches for new sources of fuel, maybe the answer to the problem could be found in every household kitchen. Wouldn't it be convenient if we could use everyday cooking oil instead of gasoline to run our cars? It may sound absurd, but it is slowly becoming a reality. A renewable and biodegradable fuel source called biodiesel, which can be made from vegetable oil, is rapidly gaining momentum around the world as an alternative fuel source for diesel engines. It is considered renewable, because it can be derived from plants, which produce oil from natural sunlight, water and air every year; and biodegradable, because unlike

petroleum-based fuels, it breaks down into its natural components in the ground. Currently, the industry is producing approximately 300 million gallons of biodiesel per year, but with the anticipated demand, additional manufacturing plants are being built, which will increase production by another 600 million gallons per year.

Benefits of biodiesel over fossil fuels

So what is commercially attractive about biodiesel, besides the fact that it is not a product of crude oil? Here is a list of the recognized benefits of biodiesel, which are all well-documented in the public domain:

- It requires about one third of the energy to produce 1 gallon of biodiesel compared to petroleum diesel.
- Biodiesel is extremely friendly to our environment, by reducing emissions of carbon monoxide, carbon dioxide (compared to the amount sequestered during the growing process), hydrocarbons and other particulate matter that causes respiratory damage.
- Another environmental attraction of biodiesel is that its sulfur content is less than 15 ppm, compared to 500 ppm for conventional S500 diesel fuel. This means that the emission of harmful sulfur dioxide, which contributes to acid rain, is significantly reduced.

- It also eliminates the cloud of dense, black smoke normally associated with diesel vehicles – in fact, the exhaust fumes from an engine running biodiesel smells like popcorn or French fries.
- Biodiesel also has better lubricating properties than regular diesel fuel because of its higher viscosity.

Its environmentally-friendly image has captured the attention of one of our most famous and controversial celebrities. Last year, you might have seen photographs of Willie Nelson on a nationwide concert tour. While Willie was traveling from venue to venue in his luxurious touring bus, one of the trucks in his ensemble was towing a tank of biodiesel, which was being used to refuel the bus. He is so enamored by this new fuel, which he discovered in Hawaii where he has a home, that he recently formed a company called Willie Nelson's Biodiesel. Their main product, called *BioWillie*[®], which is predominantly made from soybeans, is being marketed directly to truck stops and gas stations.

Biodiesel production

Biodiesel is produced by a chemical process known as transesterification, where a vegetable oil or animal fat is reacted under heat with an alcohol, in the presence of a catalyst. The



Figure 2. BioEnergy of America facilities based out of Denver, CO.

products of the chemical reaction are an alkyl ester (commonly referred to as a biodiesel) and glycerin. The reacting components in the vegetable oil are actually mono-, di-, and triglycerides, which consist of long chains of carbon, hydrogen, and oxygen atoms called fatty acids. Soybean oil is the most common crop used in the U.S. for the production of biodiesel. It consists of pure triolein, which is a triglyceride where all three fatty acid chains are oleic acid. If triolein is reacted with methanol at 120 °F, using potassium hydroxide as a catalyst, the alkyl ester called methyl oleate will be formed together with the by-product, glycerin. Once the alkyl ester is separated from the glycerin and washed with water, it is ready for use. The commercial attraction is that the manufacturing process is very straightforward, doesn't require a huge financial investment and more importantly, the yield of alkyl ester in the chemical reaction is approximately 100%.

BioEnergy of America

One of the leading new producers taking advantage of the explosion in demand for biodiesel is *BioEnergy of America*, LLC (Figures 1 and 2), based in Denver, CO. The company was founded in 2004 by several entrepreneurs, with a mission to make “the best and highest quality biodiesel in America.” They began the venture by acquiring a small environmental company that cleaned asphalt out of railcars. Due to the favorable nature of the market conditions at the time, it only took them about 6 months to start

production, mainly because they inherited the equipment, including a 400,000 gallon tank farm, rail access, transfer equipment, together with an existing laboratory and ancillary equipment. Their capacity is currently 20 million gallons of biodiesel per year, with plans to expand production to 100 million gallons by building several new facilities in the next few years.

Their main product is B100 (100% biodiesel), which they currently sell to petroleum companies and fuel distribution organizations to make blends of biodiesel with petroleum-based diesel for commercial use. Although neat, undiluted biodiesel can be used in some diesel engines, the engine has to be modified in order to ensure “trouble-free”, long-term use. It is therefore more usual for it to be blended with petroleum diesel. Biodiesel blends are typically denoted as representing the percentage of biodiesel contained in the blend. For example, B20 is a 20% biodiesel, 80% petroleum diesel mix. Many U.S. states are now passing legislation to mandate that all petroleum diesels for road use contain at least 2% biodiesel.

Ensuring quality of biodiesel fuel

Unless the transesterification process is closely monitored and well controlled, biodiesel will most likely contain high levels of impurities. For that reason, it is absolutely essential that commercial grade biodiesel be supported by a rigorous quality control procedure. *BioEnergy of America* is therefore very proud

of the fact that their in-house QA/QC process ensures the highest quality product, by adopting the ASTM D-6751 standard method for the production of B100 biodiesel. This method covers the analytical methodology and specification for biodiesel that is used for blending purposes with petroleum diesel fuels. This Standard, which is comprised of 14 separate physical and chemical tests, including flash point, viscosity, cloud point, moisture, sulfur and glycerin content, guarantees that all biodiesel manufactured for use in diesel engines conforms to the highest purity standards. This means that the manufacturing process is under tight control and produces a product that has no adverse effects on the engine, is going to run with no long term degradation of the engine components, is free of contamination and is not going to pollute the air with toxic gases or particulates. It is important to emphasize that in order for biodiesel to be registered as a fuel, it must meet U.S. EPA health effect regulations as defined by 40 CFR, Part 79. For that reason, the National Biodiesel Board (NBB) has completed the required health effects testing on behalf of the industry and has deemed that an alkyl ester can only be called biodiesel if it meets the ASTM D-6751 specifications.

Gas chromatography

Of the 14 individual ASTM test methods that cover the analysis and specification of biodiesel, probably the most important one with regard to the manufacturing process is ASTM D-6584 – A Test Method for the Determination of Free and Total Glycerin in B100 Biodiesel Methyl Esters by Gas Chromatography (GC)

Using Flame Ionization Detection (FID). Measuring the level of free glycerin and any unreacted mono-, di- and tri-glycerides in the biodiesel indicates how efficiently the transesterification reaction is proceeding. Ideally, all the vegetable oil will react with the methanol and be converted to the methyl ester. Analyzing the sample using this GC method will give an indication as to whether there are any unreacted triglycerides in the final product as well as any traces of free glycerin.

For this crucial analysis and to carry out other purity tests, *BioEnergy of America* utilizes a PerkinElmer® Clarus® Gas Chromatograph (Figure 3), with an 82-vial autosampler and dual FID detectors. The instrument is an integral part of their QA/QC process to ensure that biodiesel and other related products meet ASTM specifications. They run approximately 100 samples per week using this approach, comprising many different types of analyses, including the measurement of contaminants in incoming raw materials and monitoring the purity of various manufacturing process streams. In addition to this QC function, the GC system is also used as a troubleshooting research tool to support their biodiesel production process.

Clearly, the Clarus GC is critical to the philosophy of high quality at *BioEnergy of America*, as explained by Geoff Brown, the principal scientist in charge of the QA/QC process, “We utilize several proprietary manufacturing processes and rely on GC analysis to monitor performance and quality of both the process and effluent streams. The Clarus GC and, in particular, its high up-time, is therefore vital to our

production of ASTM-specification grade biodiesel”.

“We chose PerkinElmer because of their product innovation, intelligent software, recognized customer support and high reliability at an economic price,” said Monte Malone, Vice President of Sales, Western Region for *BioEnergy of America*.

As they plan for expansion with new production plants, we are excited to be their partner in an industry which is going to see unprecedented growth in the next few years – clearly an industry where quality is going to define the marketplace.

We’d like to leave the last word to Tom Davanzo, the President of the company, who fully understands the business implications of high quality in this potentially huge new market: – “...our proprietary manufacturing process and quality assurance/control procedures allows us to make the claim that *BioEnergy of America* produces the best soy-based methyl ester biodiesel in the USA”.



Figure 3. Clarus Gas Chromatograph.

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