



# Fryer Fat as Fuel

Straight vegetable oil can be a viable fuel with equipment modifications

By Christopher S. Gray Sr.

**P**art 1 of this series published in August explained how to produce biodiesel from vegetable oil at your golf facility. But some people aren't big fans of handling all the necessary chemicals necessary to induce the transesterification process, which converts the raw vegetable oil into a usable diesel fuel by lowering its viscosity through replacing the glycerol bond with an alcohol bond. Don't worry if you fall among this group, there is another option: straight and waste vegetable oil. Using straight vegetable oil in your diesel equipment poses no more risk to the machinery than regular biodiesel and is actually more environmentally responsible and cost effective.

Vegetable oil is an easily obtainable and cheap resource that a lot of us already have available in the kitchen at our golf facility. Last year alone, the United States generated more than 9 billion gallons of waste vegetable oil. So it's available in mass quantities across the country. The really cool part about using waste vegetable oil as an alternative fuel is that we are taking a by-product that restaurants would normally have to pay to have discarded, and we are making it productive and valuable. With diesel fuel prices at an all-time high, exploring this alternative fuel option makes economic sense in addition to the environmental benefits it offers.

It's not too difficult to sell this idea to your general manager, board of directors or course owner. Here's a little history lesson: This concept is, in fact, the original concept Dr. Rudolf Diesel had in mind when he first developed his engine. He demonstrated his first engine at the 1900 World's Fair using peanut oil as the fuel. His futuristic vision was that biofuels would become the dominant fuel due to the lack of sustainable petroleum supply. He certainly was ahead of his time. After his untimely death in 1913, the Cummins Corp. altered the fuel intake to accept less viscous fuels than his biomass fuels. Thus the new diesel engine was born

with a modified fuel intake, but the underlying principle of using biomass fuels in the engine remained possible.

Vegetable oil has many properties that make it an attractive substitute for diesel fuel, except for one: It has a much higher viscosity. The vegetable oil must be made thinner to make this system work. This is accomplished by applying enough heat to the vegetable oil to reduce its viscosity to pass into a diesel engine with no problems. That principle is the basis for the rest of the processes discussed in this article.

What temperature is that exactly? There is no precise answer, but the generally accepted minimum range is between 140 degrees Fahrenheit to 180 F. With this temperature, the viscosity of the vegetable oil is reduced to resemble that of petroleum diesel, which will allow it to atomize properly and operate the engine. We will not be able to ever match the exact viscosity because that would require heating the vegetable oil to 302 degrees F, which is too hot for an equipment application.

There are two types of conversion systems that allow you operate diesel equipment with straight and waste vegetable oil. Both of these systems have been used extensively for the past 30 years in the automotive industry without major incidents. These systems have proved themselves reliable and economical over the past three decades. All I have done is borrow the technology and apply the component modification to turf equipment. These two systems are simply referred to as a "two-tank conversion system" and a "one-tank conversion system."

## Choosing a system

As you might have guessed, the two-tank system employs two separate tanks in the system: one for the vegetable oil and one for petroleum diesel. Each tank has a separate fuel line and return line that converge at one point where a fuel-line

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JOHN DEERE

### QUICK TIP

If you aerate and verticut your course, each separate process can be quite time consuming. To free up time for other course responsibilities, try an aerator with a verticutter, such as the John Deere Aercore 800 with verticutter attachment. This accessory allows you to aerate only, verticut only, or simultaneously aerate and verticut. For more information on labor-saving equipment, please visit [www.johndeere.com](http://www.johndeere.com).



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switch allows you to toggle between each line. The principle behind a two-tank system is that you start the engine on petroleum diesel and allow the vegetable oil to heat up from the heat generated by the radiator through a heat exchanger that is spliced in. When the temperature of the vegetable oil is hot enough, you switch over to the vegetable oil fuel line and operate the equipment in the usual manner. When you are finished using the equipment, but before shutting the engine off, you switch the fuel back to petroleum diesel and allow it to purge the engine for several minutes. This system has been criticized by industry manufacturers for being a poor system because you can't start the engine on the vegetable oil. Enter into the picture, a one-tank system.

The one-tank system utilizes an external electrical heater to pre-heat the fuel tank and other components before starting the engine. The fuel tank can contain vegetable oil, biodiesel, petroleum diesel or a mixture of the three. The real beauty of this system is that it can use multiple fuel options. Because the fuel tank and components are heated without heat from the engine, you can start it on vegetable oil. The electrical heater can run off the battery of the equipment with no problems. This system is the preferred choice among the automotive industry. In essence, this system operates essentially identical to regular petroleum diesel, with the only exception being the need to heat the system before starting.

There are several components that are necessary to make both of these systems viable. Remember that biodiesel production requires the use of chemicals to convert it into a usable fuel, but it does not require any modifications to the equipment itself. Vegetable oil is the exact opposite. It requires only filtering to use it in your equipment, but it necessitates having some specialized components to make it operate properly in your equipment. These components are necessary to heat and keep the vegetable oil at the right temperature until it enters the combustion chamber of the engine.

An additional fuel tank will be necessary if you are interested in a two-tank system. Traditionally, the factory-mounted fuel tank is used for the vegetable oil because it is larger. A

smaller tank will need to be fixed firmly on the equipment. You will want to fasten the additional tank so that the fuel lines can run close to the original lines from the other tank.

The main workhorse in either system is the fuel tank heater. This component will be doing all the heavy lifting by heating up the vegetable oil. For the two-tank system, you can use either a 12-volt electrical heater connected to the battery or the more traditional method by means of a heat exchanger that transfers the heat from the radiator to the fuel tank. A one-tank system must use a 12-volt electrical heater. Depending on the size and depth of the tank, the fuel tank heater will need to generate ample heat to reach 140 F to 180 F. These heaters come in varying sizes and heat output to adjust for the sizing differences among tanks. In my experience, it's better to have more heat than not enough.

Depending on the piece of equipment, you might need to use an in-line lift pump to help with the pumping duties. Regardless of how much you heat the vegetable oil, the density of vegetable oil will always be larger, and the weight will be heavier than petroleum diesel. Some fuel pumps, primarily on larger equipment, cannot operate properly with these differences. It has not been necessary on smaller equipment, like triplex mowers and bank mowers.

### **Beyond the tanks**

One of the most critical components you will need to convert are the fuel lines. To absolutely ensure that the vegetable oil remains heated while being transported from the fuel tank to the engine, you will need to replace the stock fuel lines with insulated, heated fuel lines. Depending on your heating method, there are options for both. There are pre-made insulated heat exchanger lines that run on immediate contact with the fuel lines to keep them heated. There are also electrically heated fuel lines with micro-heating elements that maintain the fuel temperature in the fuel line. Both of these choices have been specifically manufactured for the sole purpose of using vegetable oil in diesel engines.

On a two-tank system, you will need to install a fuel line switch so that you change from one tank to the other easily. This switch can be manual or it can be controlled electronically.

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Bayer Environmental Science

#### **QUICK TIP**

You might not want to think about it now, but winter is right around the corner. Make preparations now for snow mold control. Gray snow mold occurs where there is snow cover for extended periods of time. Pink snow mold can thrive with or without snow cover. Both can appear together in the same area of turf. Several products from Bayer Environmental Science are registered for snow mold control, including 26GT®, Bayleton®, Compass®, and ProStar® fungicides. Years of research have demonstrated their ability to provide effective, long-lasting control.



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To maintain the purity of the system, a heated fuel filter will also need to be installed. These filters should clean the oil of particles between 1 micron to 5 microns and will pick up any missed particles that the initial filtering process might have missed. In one-tank systems, you can simply employ a heated filter wrap around the stock filters you currently use. These heated filters will need to be changed more frequently than traditional fuel filters, roughly about twice as often depending on your oil quality.

Injector line heaters are also critical to the success of using vegetable oil. Injector line heaters are electronically controlled elements that are fitted right on top of the existing injector lines. These heaters make certain that the oil is at the proper temperature before entering the combustion chamber.

The final component of these systems is a dash-mounted control system that monitors the oil temperature in the fuel tank and provides the electrical controls for the heating elements in the fuel lines, fuel filter and injector line heaters. It also provides the electronic fuel line switch on a two-tank system.

Because both of these systems have been used for years in the automotive industry, there are actually ready-to-go kits available from several companies that specialize in using vegetable oil as fuel for diesel engines. These kits include everything you would need to convert a single piece of equipment. Depending on the complexity and how many extras you want your system to have, prices can vary from \$500 for a basic set-up, all the way up to \$2,000 for more elaborate kits.

Using vegetable oil in your equipment does have some issues and concerns that you need to be aware of before starting down this road of alternative fuel use. The advantages are easy to see. Vegetable oil provides a renewable energy source from a waste substance that is generated in mass amounts and is completely biodegradable and non-toxic. It also burns with far less emissions than petroleum diesel. The concerns with using vegetable oil are a little more complex, however. The biggest concern is locating and securing an ample supply of vegetable oil. The fuel efficiency with using vegetable oil is approximately 90 percent of petroleum diesel.

The amount of vegetable oil needed to satisfy your facility's operational requirements may be quite large. Each facility should thoroughly evaluate whether or not the use of vegetable oil makes economic sense.

The largest concern with using vegetable oil in your equipment is the same as using home-made biodiesel in your equipment: It will void any warranty on any components that is at all related to this alternative fuel use.

I have used waste vegetable oil and home-made biodiesel for three years with few problems. Whether to use vegetable oil in golf course equipment will depend on the individual golf facility. It's not for every golf operation. But it is an available option that should be considered.

Vegetable oil is most definitely a viable option for those of us who believe in its obvious environmental benefits and also the genuine economic savings that we all are searching for in these times of extreme budgetary constraints.

*Christopher S. Gray Sr. is superintendent and general manager of the Marvel Golf Club in Benton, Ky. He can be reached at [cgray@marvelgolf.com](mailto:cgray@marvelgolf.com).*



**QUICK TIP**

More than 40 grass species are suitable for turf in the world. Of those, only a select few are intensely managed for golf courses. One limiting factor in choosing the most suitable species for an application is climate. Decisions are made based on the required temperature ranges needed for optimal growing conditions of the turf species. Two classifications of turfgrass are warm-season and cool-season, and the most widely used turf species for the warmer climates is bermudagrass. Currently, there are almost 100 varieties of bermudagrass used on golf courses, each one unique in growth characteristics and management requirements.

**TURFGRASS TRENDS**

**SECTION STAFF**

**Managing Editor**

Curt Harler  
440-238-4556; 440-238-4116 (fax)  
[curt@curtharler.com](mailto:curt@curtharler.com)

**Graphic Designer**

Kristen Morabito  
216-706-3776; 216-706-3712 (fax)  
[kmorabito@questex.com](mailto:kmorabito@questex.com)

**Golfdom Staff Contact**

David Frabotta  
216-706-3758; 216-706-3712 (fax)  
[dfrabotta@questex.com](mailto:dfrabotta@questex.com)

**INDUSTRY ADVISORS**

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