Fats into jet fuel -- NC State 'green' technology licensed

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New biofuels technology developed by North Carolina State University engineers has the potential to turn virtually any fat source – vegetable oils, oils from animal fat and even oils from algae – into fuel to power jet airplanes.

The technology – called Centia™, which is derived from "crudus potentia," or "green power" in Latin – is "100 percent green," as no petroleum-derived products are added to the process. Centia™ can also be used to make additives for cold-weather biodiesel fuels and holds the potential to fuel automobiles that currently run on gasoline.

NC State received provisional patents to use the process to convert fats into jet fuel or additives for cold-weather biodiesel fuels. The technology has been licensed by Diversified Energy Corp., a privately held Arizona company specializing in the development of advanced alternative and renewable energy technologies and projects.

Dr. William Roberts, professor of mechanical and aerospace engineering and director of the Applied Energy Research Laboratory at NC State, developed the biofuels process with NC State's Dr. Henry Lamb, associate professor of chemical and biomolecular engineering; Dr. Larry Stikeleather, professor of biological and agricultural engineering; and Tim Turner of Turner Engineering in Carrboro, N.C.

Roberts says that besides being "100 percent green," the new technology has some key advantages over other biofuel projects.

"We can take virtually any lipid-based feedstock, or raw material with a fat source – including what is perceived as low-quality feedstock like cooking grease – and turn it into virtually any fuel," Roberts says. "Using low-quality feedstock is typically 30 percent less costly than using corn or canola oils to make fuel. And we're not competing directly with the food supply, like ethanol-based fuels that are made from corn."

The fuel created by the new process also burns cleaner, so it's better for the environment, Roberts says. There is no soot or particulate matter associated with fuel from fats.

Further, Roberts says, the Centia™ process puts to use what other biodiesel processes throw away. Converting feedstock into fuel produces a low-value commodity – glycerol – as a by-product. Rather than discarding glycerol as waste like most biodiesel plants do, the NC State engineers' process burns glycerol cleanly and efficiently to provide some of the process' requisite high temperatures.

"Instead of composting the glycerol as waste, we use it as an integral part of the fuel-making process," Roberts said.

It really does take a rocket scientist to make jet fuel, especially out of oils or agricultural crops, Roberts says. The physical and chemical properties of traditional biodiesel fuels – their combustion characteristics and viscosity, for example – don't match the stringent requirements required of jet fuels, making biodiesel unacceptable for the task.

"Jet fuel travels at 25,000 to 35,000 feet where temperatures can reach 70 degrees below zero Fahrenheit, so it needs to flow better in cold temperatures," Roberts says.

The Centia™ process comprises four steps, Roberts explains. First, the

engineers use high temperatures and high water pressure to strip off the so-called free fatty acids from the accumulated feedstock of oils and fats, or triglycerides. Next, the engineers place the free fatty acids in a reactor to perform the decarboxylation step; that is, carbon dioxide is taken off the free fatty acids. Depending on the feedstock used, the scientists are left with alkanes, or straight-chain hydrocarbons of either 15 or 17 carbon atoms.

"After these first two steps, which are always the same no matter which fuel you want, we can make any fuel we want to make," Roberts says. "In the last two steps, we can change the recipe based on the fuel output desired."

In the last two steps, the engineers break up the straight chains into molecules with branches, making them more compact and changing their chemical and physical characteristics. Jet fuel and biodiesel fuel require a mixture of molecules with between 10 and 14 carbon atoms, while gasoline requires only eight carbon atoms, so the engineers can control the process to elicit exactly the type of fuel they desire.

Finally, the engineers make some other chemical tweaks to create the desired fuel. Also, the glycerol by-product is burned off to provide heat for the various processes involved.

"We produce one-and-a-half billion gallons of animal fats annually, which is about half of the amount of vegetable oil produced yearly," Roberts said. "Animal fats are harder to work with, but cheaper. Last year, for the first time ever, fuel costs in the aviation industry exceeded labor costs. We think the aviation industry is keen on finding alternatives to petroleum-based jet fuel."

Source: North Carolina State University