Green Power Of Centia Moves Biofuel Energy Closer To Reality

North Carolina State University

The cry for alternative fuels echoes around the world. It doesn't really matter whether individual cries are in mourning the toll of global warming, or in fear of the ever-diminishing supply of fossil fuels, or both. In any case, the plaintive chorus calls for immediate relief.

Now, that relief may be at hand with North Carolina State University's recent breakthrough in biofuel production, which converts vegetable oil and animal fat—even cooking grease and algae—into jet fuel, bio gasoline and biodiesel using a 100 percent green process at a much reduced cost. The technology is called Centia™, a name that means "green power" in Latin. It is not that biofuel is a new idea, but low energy yields and costly raw materials called feedstock, i.e. plants and animal fat, the most common of which is corn, have made its reality more of a dream.

> *In renewable energy, we want to stay away from crop oils so that we do not compete with the food supply.*
>
> William L. Roberts, Professor and Centia co-inventor, North Carolina State University

Indeed, grocery store chains and warehouse stores saw rising prices and even purchase limitations this year as efforts to produce biofuels began to pressure the food supply.

The first order of the day, then, for Roberts and his fellow inventors was to find a way to effectively and efficiently use feedstocks that were too low in quality for human consumption. By doing so, millions of people around the globe could then afford food staples such as flour, corn meal and vegetable oil.

However, food supply was not the only thing dwindling in the wake of biofuel production. “Rain forests were being destroyed to make way for palm oil and other plantations,” says Roberts. While the renewable energy industry is launching many new jobs, a “green” technology is not truly green if its use or production wreaks havoc on the environment in any way. In essence, current biofuel efforts were selling out the long-term in favor of the short-term, even if by accident.

There was also a problem with tying the industry too closely to a handful of feedstocks. “Seventy percent of the final price of biofuel comes from the cost of feedstocks so you don’t want the process tied to one feedstock which in turn is vulnerable to market swing and unduly high costs,” says Roberts. Ultimately, it is the free fatty acid in the feedstock that is needed to create biofuel; the higher the content, the more expensive the raw material.

Thus feedstocks became a central issue in the research. Roberts worked alongside H. Henry Lamb, Ph.D., professor in the Department of Chemical and Biomolecular Engineering; Larry F. Stikeleather, Ph.D., professor in the Department of Biological and Agricultural Engineering; and, Timothy L. Turner, Doctoral Student in the Department of Mechanical and Aerospace Engineering to resolve this and other obstacles typical of biofuel production.

Remarkably, the Centia process can use low-quality feedstocks of virtually any origin and in any combination.

“We can use any starting material including crop oils—virgin or waste—animal fats, even lipids from algae,” says Roberts.

Another huge obstacle to creating biofuel was the low energy content. Simply put, previous biofuels simply did not have enough oomph to power existing machines. Usually, costly modifications to machinery were necessary to make biofuel useable at all.

“We set out to mimic the fuel we were attempting to replace so we worked backwards from there, almost a reverse engineering,” laughs Roberts.

After two months of theoretical work followed by 18 months of proof of concept work, the N.C. State team was successful in rendering the right mix of physical and chemical properties to produce a biofuel the true equivalent of a fossil fuel.

“We achieved the two extremes, lowest quality feedstock to produce the highest quality fuel,” beams Roberts.

The process consists of a first stage hydrolysis reaction, where fats and oils are converted into free fatty acids. In a second stage, a carbon dioxide molecule is removed from these free fatty acids, yielding a long, straight chain hydrocarbon. These long straight chain molecules are then isomerized, cracked, and/or aromatized, yielding a wide range of molecular sizes and structures. The final recipe of iso-alkanes, aromatics, and cycloalkanes can be adjusted to yield the desired octane number.

“The high temperature, high-pressure catalytic process changes the structure as needed to mimic diesel, gas or jet fuel," says Roberts. These fuels are consumable in any conventional gasoline engine without modification, a major plus in reducing the overall costs associated with converting to alternative energy use.

Since no petroleum-derived products are added to the process, Centia is 100 percent green. There is no soot or particulate matter associated with fuel from fats so the fuel created by the new process also burns cleaner.

What remains to be solved is scalability, i.e. moving from the teaspoon to the gallon level. N.C. State has licensed the technology to Arizona-based Diversified Energy Corporation to push the technology into the commercial space.

Diversified Energy Corporation specializes in transitioning alternative and renewal energy technologies into viable commercial products. Currently, Centia is one of four technologies in the company's portfolio. "It's still at benchmark scale in nature, but it's sexy, and we're doing the necessary R&D now to have it commercially ready by 2013," says Jeff Hassannia, vice president of business development at Diversified.

The key advantages of fuel products rendered from the Centia process, according to Hassannia, are:

- No external hydrogen is used which means no fossil fuels are needed to produce the biofuel.
- The jet fuel made in this process contains the necessary aromatics so there is no damage to engine seals and valves.
- Diversified Energy incorporates a glycerol burner (another technology in its portfolio) into the process to increase the energy conversion efficiency.

N.C. State made 2008 its "Year of Energy" to highlight its commitment to energy conservation and the development of alternative and renewable energy sources. The university was recently selected by the National Science Foundation to lead a national research center tasked with revolutionizing the nation's power grid. This Engineering Research Center for Future Renewable Electric Energy Delivery and Management (FREEDM) will be headquartered on N.C. State's Centennial Campus and will be supported by an initial five-year, $18.5 million grant.

N.C. State's Office of Technology Transfer is hopeful that Centia will prove to be an important contributor to America's quest for energy independence and will prove crucial to bridging the gap between fossil fuels and the new generation of clean and renewable energy sources.

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