



# AG INNOVATION NEWS®

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*years of*  
**innovating**

AURI begins third decade  
of service to Minnesota

Clayton McNeff, vice president of Sar Tec Corporation in Anoka, is pictured in his company's lab where a revolutionary process to quickly convert unrefined oil into biodiesel was first tested.



PHOTOS BY ROLF HAGBERG

# Zirconia

— a fuel's gem

Minnesota chemists' invention quickly converts unrefined oils to biodiesel

BY CINDY GREEN

*Isanti, Minn.* — Biodiesel can be made from almost anything that has fats or oils — beans, pine trees, beef tallow, chicken fat, restaurant grease. With current technologies, pure soy oil is most efficiently converted to fuel. But breakthrough technology may make waste grease and even algae "pond scum" the fuels of the future.

Minnesota chemists have invented a way to use metal oxides to quickly and cleanly convert unrefined oils to biodiesel. The "Mcgyan" process will be tested commercially in a biodiesel demonstration plant opening this spring in Isanti. Ever Cat Fuels will produce 3 million gallons of biodiesel annually.

"This process can use feedstocks that the traditional biodiesel process cannot use," says Dave Wendorf, marketing director of McNeff Research Consultants, which holds intellectual property rights to the patent-pending Mcgyan process.

Traditional biodiesel processing requires first removing free fatty acids from oils or fats, adding alkali catalysts to convert triglycerides

to fuel, then washing the biodiesel with water to remove the neutralized catalyst. The Mcgyan process doesn't require any of those steps.

## College chemist's idea

The revolutionary process started as a college chemistry project in the summer 2006. Augsburg student Brian Krohn investigated biodiesel processes and found research on zirconium-based catalysts.

Krohn consulted his chemistry professor, Arlin Gyberg, who contacted a former student, Clayton McNeff, a zirconia expert and vice president of SarTec Corporation in Anoka. With the help of SarTec chemist Ben Yan, they added zirconia-based catalyst to some soybean oil and alcohol and added some heat to see what would happen.

It didn't work.

"Clayton then suggested, 'If you add more heat to the catalytic material and run the reaction under pressure in a continuous reactor, something might happen.' And voila

— it did. It changed color so they knew they had done something; it turned out they had made biodiesel."

After further development, the chemists titled their invention "Mcgyan," using a combination of their names. Mcgyan is a one-step process that "converts feedstock to biodiesel in seconds versus hours" that the traditional biodiesel batch process takes, Wendorf says.

The team discovered their process could convert anything with triglycerides or free fatty acids into fuel — without refining the fats and oils first. "To make biodiesel, they (current processors) have to remove fatty acids from the oil; otherwise it makes soap," Wendorf says. "With our process, it's just the opposite. We need feedstocks with fatty acids, the higher the better ... beef tallow, chicken fat. ... It gets us away from the food versus fuel debate. We don't have to worry

about using food-grade soy oil; we can use something else."

Oil or tallow and alcohol are fed into one end of a cylinder-shaped reactor. Biodiesel comes out the other end, along with a small amount of methanol that quickly separates from biodiesel in a fractioning still. In the traditional biodiesel batch process, "you put soy oil in a big tank and add a strong-base catalyst that has to be neutralized and washed out of the biodiesel. This is a much simpler process that requires no chemicals, no washing."

## Pilot to full-scale plant

A year after building an experimental reactor in SarTec's lab, McNeff decided to build a pilot plant at SarTec that can produce 50,000 gallons of diesel per year. Because the pilot plant produced almost no regulated emissions, the Minnesota Pollution Control Agency said an emissions permit wasn't needed when McNeff planned a larger facility. "Our actual footprint is very small compared to a traditional biodiesel plant, so you can put

it almost anywhere," Wendorf says.

Construction is now being completed on the 10,000-square-foot Ever Cat Fuels facility. The plant will initially use extracted corn oil from distiller's dry grains, an ethanol byproduct that contains 2.5 to 5 percent rancid oil, and the defatted grains will be sold for livestock feed. Distiller's grain oil is about half the cost of soy oil.

"In our lab, we've tested probably 20 to 30 different feedstocks," Wendorf says. Tall oil from paper processing looks promising, as does palm-oil waste. But more high-oil commodities are needed to keep up with escalating demands for biodiesel. "If you took all the feedstock available today — soy oil and waste greases — and made biodiesel, you'd still only make a small percentage of our need in the United States."

Minnesota was the first state in the nation to mandate biodiesel blends, and the current two-percent biodiesel mandate will increase to 20 percent by 2015. Not only is biodiesel homegrown and renewable, it emits far less sulfur dioxide, carbon dioxide and smoke particulate than petrodiesel. It can be used like petrodiesel without any engine modifications, and gelling in cold temperatures can be prevented by using the right blends and fuel grade.

AURI has tested biodiesel fuel and low-temperature additives from all Minnesota producers, including Ever Cat Fuels. "Our tests show there shouldn't be any problems with their biodiesel in cold temperatures," says Doug Root, AURI scientist in Marshall.

Nationwide, there are now 175 biodiesel plants and markets are soaring. Annual U.S. biodiesel sales jumped from 2 million gallons in 2000 to 25 million gallons in 2004. Today demand approaches 450 million gallons.

## Algae fuel

What high-oil commodity could meet growing biodiesel demands? Algae, known in the wild as pond scum, Wendorf says. Cultivated algae can produce 1,200 to 9,000 gallons of oil per acre, compared to 48 gallons per acre for soy oil. "When we get algae commercialized, that essentially could settle our biodiesel dilemma. We need something like algae that grows very rapidly."

"A decade from now, algae will be a major farming crop," Wendorf says. "All you need are shallow ponds. You don't have to take your prime land or hay fields."

"Algae has been around for millions of years; there are millions of species." While high-oil algae hybrids are being cultivated, "the ones in nature that have survived are what we're going to use. They're the winners."



ALGAE PHOTO BY ERIC GUINTEHER, WIKIMEDIA COMMONS.

## Modular future

Ever Cat Fuels, owned by the McNeff family, is the first licensed to use the Mcgyan process. If the facility proves successful, "we intend to increase the capacity to 10 million gallons per year, then we'll probably go to 30 million," which is feasible because Ever Cat's three-acre site is on a rail line, Wendorf says.

McNeff Research Consultants is also designing a reactor that can be fit in a truck and transported to a feedstock's location, such as a large slaughtering facility with animal tallow or an industrial plant with waste grease. "The key to this whole thing is the feedstock. If you have an adequate source, you could locate a nice plant there."

Eventually the Mcgyan process will be global, Wendorf says. "India grows jatropha, which is ideal for biodiesel. There are huge palm oil plantations in Indonesia and some South American countries that make an excellent biodiesel."

"Germany is the largest biodiesel consumer and producer in the world — 80 percent of their cars are diesel," he says.

"We see tremendous potential for biodiesel growth."

Visit [www.evercatfuels.com](http://www.evercatfuels.com) for more information. ■

**AT RIGHT:** Sar Tec chemist Ben Yan pours zirconia-based catalyst into a long-tube reactor that, along with alcohol, will convert oil into biodiesel. Inventors of the one-step Mcgyan process, pictured below from the left are: Arlin Gyberg, Augsburg College professor and his former student Clayton McNeff, Yan and Brian Krohn, the Augsburg student whose chemistry project led to the Mcgyan invention.

