

# BIOX Technology Makes Biodiesel Faster To Manufacture, Cheaper

University of Toronto



A University of Toronto chemistry professor's research that began with sewage sludge oils has led to breakthroughs in producing biodiesel — a cleaner form of fuel for diesel engines.

Oil and water don't mix, as any elementary school science teacher will tell you. That basic concept is the foundation of a University of Toronto chemistry professor's discovery.

“ *This innovation significantly cuts the time and cost for creating biodiesel — a renewable fuel for diesel engines derived from natural oils like soybean oil and a variety of other feedstocks such as animal fats, greases and used cooking oils.* ”

It also led to the creation of an Ontario firm called BIOX Corp., which has 33 employees and is headed by Chief Executive Officer Tim Haig. BIOX recently built a \$24 million plant in the steel-making city of Hamilton.

The facility is capable of producing 60 million liters (18 million gallons) of biodiesel a year and shipped its first batch of fuel to the United States in late 2006. Over time, the company hopes to build plants throughout North America and

Europe.

## **BIOX's Beginnings**

The BIOX story goes back more than a decade to when David Boocock, Ph.D., then head of the University of Toronto chemical engineering department, was looking into the oils that were produced when sewage sludge was heated. He is now a professor emeritus at the school.

"I was investigating the technology of using pyrolysis to turn the sludge into a liquid fuel," he recalls. Pyrolysis is the use of heat to break down complex chemical substances into simpler substances.

"I identified that there were good oils and bad oils," he explains. "The bad came from the proteins and the good came from the lipids." Lipids are also known as fats.

That led Boocock — an organic chemist by training — to biodiesel that was being manufactured in Germany.

"I knew that it was lipid-like, so I looked at the literature and came to the conclusion that most of what was being published was wrong," he notes.

The people making biodiesel believed that methanol and vegetable oils and animal fats, plus a catalyst, would mix, he said.

"They don't," says Boocock. "Chemical engineers call this a mass transfer problem. They were trying to measure the rates of reactions, but it was based on a faulty premise."

To cut to the quick, Boocock came up with an inert co-solvent to add to the oil and methanol. The three melded and became one.

"It was clear and you could see through it," he comments. "And when it was mixed, the reactions speed up and go a lot further."

That, in a nutshell, was the technology that launched BIOX. Boocock continued to refine his discovery, and in 1999, it began to look like the technology had a business application. The Natural Sciences and Engineering Research Council of Canada provided funding for Boocock's research underlying BIOX.

## **Biodiesel's Growing Importance**

Cyril Gibbons is the commercialization director for physical sciences and engineering for Innovations at University of Toronto (IUT), a group of professionals charged with commercializing innovations developed by University of Toronto researchers and its health care partners. He commented that there was not a lot of interest in the technology until the cost of fuel began its upward swing.

Boocock said the discovery of mad cow disease in Canadian cattle several years ago also made producing biodiesel cheaper.

"It is the cost of the feedstocks that largely control what it costs to make biodiesel," he says. "And when mad cow disease appeared, this resulted in a dramatic falling in prices of 'refurbished' waste fats and oils (from animals)."

Regulations cut off transfer of those materials between countries, essentially wiping out the foreign market, so the BIOX process also helps solve a waste problem, he said.

Gibbons adds: “From the environmental side, there are many reasons to use biodiesel because it is significantly cleaner, emitting 80 percent fewer hydrocarbons, 60 percent less carbon dioxide and 50 percent less particulate matter than petroleum diesel.”

He says that Innovations helped Boocock patent his discovery and retains a small interest in BIOX.

Moreover, scientists say high quality biodiesel blends easily with petroleum diesel in any proportion, requires no engine modification, and is actually good for the engine.

“Before 1999, biodiesel was considered too expensive to produce,” he says. “But the cost of oil is now about double what it was back then, so the economics shifted strongly in our favor.”

### **Growth Opportunities for BIOX**

In 2000, Innovations found a Toronto investor willing to put up the money to build a prototype plant. The company, Madison Ventures Ltd., introduced Haig to Innovations, and BIOX was off and running.

Haig, an engineer who had worked with wind farms and other renewable energy sources, said he was fascinated by the simplicity of Dr. Boocock’s discovery. Instead of applying more heat or pressure to the process — what Haig called the “sledgehammer” approach — Boocock went back to the first principles.

“David is a finesse guy,” says Haig. “Rather than using brute force, he found a way to make the liquids — oil and alcohol — go together by adding a co-solvent that made the two want to stay in one phase until the reaction was complete.”

Haig worked with Scott and Joe Monteith, the principals behind Madison Ventures, who also happened to make grease traps for restaurants.

“It was a lot for what was then just an idea,” says Haig. “But Joe Monteith was a chemist, too, and he saw elegance in the technology.”

Haig also got about \$500,000 in grant money from the Canadian government to help build the pilot plant.

“Prior to that, we had no idea if it would be scalable,” explains Haig, adding that the pilot was finished in April of 2001.

“We ran that for some time and found out there was a fine line between making soap and biodiesel,” he recalls. “As you would expect, we had some issues. But our first plant, in Oakville, ultimately proved the chemistry.”

Haig then “beat the pavement” to find more high net worth investors so the company could buy the University of Toronto biodiesel intellectual property outright and build another plant in Boston.

“The second plant proved efficient separation,” he says. “In the first, you had a concoction of a whole batch of carbon chains. In the second, we proved we could separate carbon chains into the right bucket at the right price.”

With that hurdle passed, they scaled up to build the big new plant in Hamilton.

“We finished it this summer and it is working well,” Haig says confidently. “We raised another \$48 million this summer and we intend to build three, four or five more plants in the next few years, selling to companies that want to mix what we are producing with regular diesel — probably at blends of 2 to 5 percent.

“And you know the ironic thing about all this?” Haig asks. “Rudolph Diesel invented the diesel engine to run on

vegetable oil.”

Pierre Schuurmans, chief operating officer of Birch Hill Equity Partners Management, Inc., said his company put up \$48 million so BIOX can continue to grow.

“We think they have a low-cost technology in process that puts them in a good position to meet the growing demand,” Schuurmans explains. “With mandates and subsidies in some places, BIOX is very competitive.”

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