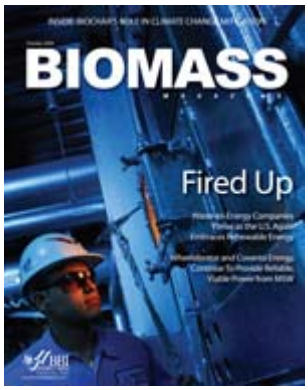
BIOMASS MAGAZINE The World



The Fischer-Tropsch/Fat Connection

The Syntroleum Corp. team and its investors always knew their technology was solid. That confidence was renewed when the company signed a deal with Tyson Foods Inc. to commercialize its refining technology—turning animal fat into renewable diesel and jet fuels. With that process under its belt, Syntroleum plans to turn to biomass gasification.

By Susanne Retka Schill

Syntroleum CEO Jack Holmes black rendered poultry fat an Tropsch wax. Both can be re synthetic diesel or j
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Ken Agee was working as a chemical engineer for a pipeline company 23 years ago when he first became interested in finding a way to use surplus natural gas. He read about Fischer-Tropsch (F-T) technology during his lunch breaks and built a homemade reactor in a garden shed in his back yard. Three years later, he quit his job to work on the project full time.

Agee assembled a team and formed GTG Inc., which later became Syntroleum Corp. To date, the Tulsa, Okla.-based company has amassed nearly 160 patents on its work. “In the early days, we tested 1,000 different catalyst combinations,” Agee says. In the past decade, the company has come close to seeing its technologies commercialized, particularly when oil prices were high enough to make the capital-intensive F-T process cost effective. The U.S. DOE helped fund a demonstration plant to scale up the Syntroleum process and produce 400,000 gallons of synfuels for testing in military jets and diesel applications. Syntroleum supplied 100,000 gallons of the synthetic JP8 jet fuel it produced from natural gas in the Cartoosa facility to the U. S. Air Force. It passed the tests and is now certified for use in a 50 perce petroleum-based jet fuel in B52 bombers. The Air Force intends to certify all of its aircraft by 2011.

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With that project complete, Syntroleum was in the process of mothballing the demonstrati management challenged its team of chemists and chemical engineers to come up with oth technology. In one of those “ah-ha” moments, the group realized the chemical structure of similar to the F-T waxes refined in the company’s patented and trademarked Synfining pro confirmed that fats and oils could be refined into high-quality synthetic fuels, and identified adaptations to create what the company has trademarked as Biofining.

In making the fat connection, Syntroleum has identified an application for the simplest and process—the refining step that follows the Fischer-Tropsch reaction. “We couldn’t do a $1 says Agee, referring to the estimated cost to complete an F-T Synfining facility. “We can project.” The company’s business development group created a short list of potential part summer closed a deal with Tyson Foods Inc. The joint venture promises to bring two deca and development to commercialization, giving Syntroleum a positive cash flow for the first most wonderful shot in the arm for the employees and investors to be not just a technical financial success,” CEO Jack Holmes says.

In June, Syntroleum and Tyson announced a joint venture to create Dynamic Fuels LLC. T building multiple, stand-alone facilities producing “ultra-clean, high-quality, next generation fuels using Syntroleum’s patented Biofining process, a ‘flexible feed/flexible synthetic fuels according to Tyson. The first facility expected to be built somewhere in the mid-South will MMgy of fuel from low-grade animal fats, greases and vegetable oils supplied by Tyson. project is targeted to be on line by 2010. The price tag includes a contingency for unantici building the first facility. Then the work will begin to add biomass gasification capabilities t the Biofining plant. A third-party will be recruited to supply the gasification technology and technology will be added to convert the biogas into F-T products that can be refined in the plant as the fats.

In the Spotlight

Syntroleum has been riding a wave of publicity created when it inked the deal with Tyson, television, making a presention on Wall Street and providing tours of its Tulsa facilities as the work of raising its share of funding for the joint venture. Standing beside the structure Sid Schmoker, manager of facilities maintenance, explains how the company’s F-T techno guides a tour of Syntroleum’s demonstration plant for Biomass Magazine. The $60 million the company’s technology using natural gas as the feedstock to manufacture synfuels. Bio coal-to-liquid will require adding a gasifier and syngas clean-up to the front end of the Syn

Jim Engman, manager of catalyst testing, continues the tour at the Syntroleum F-T labora

of Tulsa, where a bank of small reactors and a room full of monitors permit multiple test r researchers tweak process conditions to see how well they can control the outcome. Acr Syntroleum headquarters, researchers in another set of laboratories are running tests on samples from Tyson.

F-T is not a new process. The Germans used the technology to produce fuel from coal du power its military. Sasol Ltd., based in South Africa, became the world leaders in F-T tec international embargo during the country's apartheid regime stopped oil imports. In the re cheap oil has discouraged the development of F-T technology, which requires oil prices a to make it economical. Syntroleum targeted its F-T innovations to stranded gas reserves– that gets flared off oil wells in areas where there's no access to natural gas infrastructure has climbed, the economics of recovering stranded gas has improved.

From Incomplete Combustion to Liquids

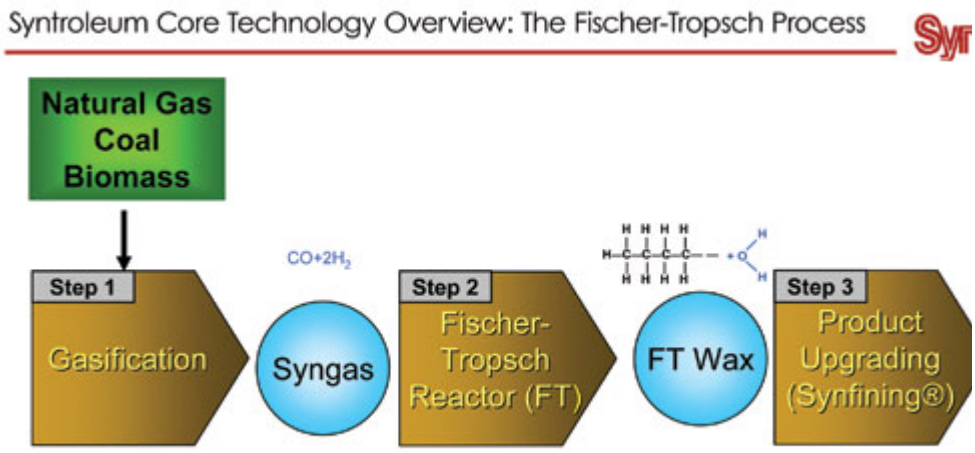
The process starts with syngas coming from a gasifier. The incomplete combustion in the carbon monoxide and hydrogen, along with tars and particulates that have to be scrubbed Earlier this year, the company took two bench-scale reactors to Eastman Chemical Co.'s Tennessee for a 100-day trial. Agee considers gasified coal, which contains sulfur, arseni other metals, the ultimate test of whether syngas from multiple sources of biomass can b to avoid killing the F-T catalyst. Unfortunately, there is no commercially operating biomass theory. However, with the results from the coal gasifier in hand, Agee is confident that bio biomass source can be cleaned adequately. "We consider coal the worst case scenario,"

Once it's cleaned the syngas is piped to the F-T reactor. One of Agee's breakthroughs w catalyst that would not be killed by nitrogen. In the case of gas-to-liquids, the innovation p compressed air and eliminates the need for oxygen purification, thus reducing capital cost safety. Another unique feature of the Syntroleum F-T technology is its ability to remove a catalyst to be regenerated while the plant is running. The Syntroleum process uses a slur Clean syngas is introduced at the bottom of the reactor and bubbles up through the cataly catalyst facilitates a chemical reaction which reorganizes the carbon and hydrogen molecu chains of paraffinic waxes along with light oils and water.

After auto-thermal reforming and the F-T reactor, the liquids enter the final process which patented and trademarked as Synfining. This last step uses hydrocracking and hydroisom the long chains in the waxes into the desired fuels—diesel or jet fuel. When processing sy coproduct is 20 percent naptha, and if synthetic jet fuel is the end product it results in 40 Agee says.

Targeting the Jet Fuel Market

Jet fuel is Syntroleum's target market. The U.S. Air Force's goal is to replace half of the 1 domestic fuel it uses per year with alternative fuels by 2016, Holmes says. "The current a ethanol and biodiesel can't meet the [Department of Defense] specs," he says. "Our tech summer, Syntroleum signed a contract to supply 500 gallons of the synthetic jet fuel made it performs the same as its synthetic JP8 jet fuel. "It will," Holmes says, adding that in thei from renewable fats exactly match the fuels from natural gas.



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Property	Refined Crude #2 ULSD	BIOFINING™ ALL FEEDSTOCKS R-2 Diesel	Refined Crude JP-8	BIOFI ALL FEE R J
Cloud Point (°F)	5°	-9°	na	
Freeze Pt (°F)	na	na	-53°	-5
Sulfur (ppm)	15 max	<1	3000	<
Aromatics (vol%)	35% max	nd	25%	
Cetane - index	40 min	>75	~ 45	>6
Heat of Combustion	42.2	43.8	42.8	43
Smoke Pt (mm)	na	na	25 min	3

- Superior emissions and performance characteristics
- Fully blendable with petroleum based diesel and jet

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Flying high after its success with the Air Force and its deal with Tyson, Syntroleum has ra million, matched by Tyson, to conduct site selection studies and prepare the process desi front-end engineering. The challenge will be to raise the next $70.75 million, which is the r share of the capital required to build the first plant. In the meantime, Syntroleum executive the joint venture. “Tyson has turned out to be a wonderful partner,” Holmes says.

One resource Tyson brings to the table is its governmental relations division which is helpi negotiations as sites are considered. Government support of renewable diesel will be an i component for Syntroleum’s success. The biodiesel industry protested this summer when supply fats to Conoco-Phillips to produce renewable diesel and collect a $1-per-gallon tax supporters are concerned that refinery-scaled projects will dominate feedstock supplies a credits that were intended to aid the fledgling biodiesel industry. Holmes makes a distincti companies’ plans to coprocess a small amount of fats with crude oil in the refinery and Sy renewable diesel. “We are different,” Holmes says. “We are stand-alone, new constructio jobs, and we’re making 100 percent renewable diesel.” He’s hoping the attempts to rewrit prevent oil companies from getting the federal biodiesel incentive will not rule out incentive

companies like Syntroleum developing new technologies and utilizing 100 percent renewal current prices, the biodiesel tax credits are crucial, he says. “Our cash margins are about which includes the $1 tax credit,” he adds. In the company’s projections, the first plant ma year should net $60 million per year to cash flow, which will be used to pay off the investn

Detailed projections for the biomass system have not yet been worked out, but initial num Agee estimates the biomass gasifier and F-T reactor will cost two to three times more tha needed to build the first Biofining facility. However, the higher capital investment will be of feedstock costs, he says. While fats cost about 20 cents per pound, biomass is expected per ton. “I think all the components are there to make biomass diesel,” he says. “But they commercial scale yet.” After 23 years of working out the details in Syntroleum’s process, hasn’t waned. “Part of the demonstration process is working out the bugs,” he says with c

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