SARTEC® CORPORATION

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REVOLUTIONARY MCGYAN® BIODIESEL PROCESS DISCOVERED BY SARTEC®

by Dr. Clayton McNeff

A novel biodiesel production process dubbed the "Mcgyan®" process has been developed by SarTec® scientists that uses chemistry and conditions that have not been previously reported and which satisfies many of the attributes of the ideal catalytic process for commercial biodiesel synthesis. "Mcgyan®" stands for the last names of the inventors of this process (McNeff, Gyberg & Yan). Simple lab experiments at Augsburg College and at SarTec Corporation resulted in the discovery of the Mcgyan® process that promises to revolutionize the way biodiesel fuel is produced worldwide. It started with the curiosity of Augsburg student, Brian Krohn, and ended with three Minnesota scientists creating the "Mcgyan Process." The catalysts used in the process were developed for use in high performance liquid chromatography and have been shown to be stable at both elevated temperature and pressure for extended use. It was this large body of scientific data on these materials that allowed the inventors of the Mcgyan® process to quickly move from initial small experiments to a pilot plant, which proved the process could be economically and efficiently scaled up.

The elegance of the patent pending Mcgyan® process lies in its simplicity. Figure 1 shows a simplified flow diagram of the process. The alcohol and lipid feedstock are combined through the use of high pressure pumps in a reactor that is maintained at elevated temperature and pressure. The contact time with the catalyst is on the order of less than a minute after which the conversion to biodiesel fuel is complete. The excess alcohol from the system is recovered by distillation and put back into the input side of the process and then the biodiesel is run through a secondary patent pending polishing system called EFAR (Easy Fatty Acid Removal system) that removes any residual free fatty acids and volatiles from the biodiesel. The recovered free fatty acids are then put back into the input side of the process in order to achieve nearly full conversion of the lipid feedstock to biodiesel fuel.

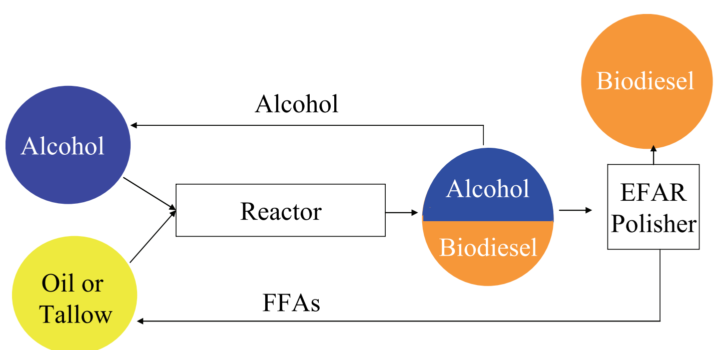

Figure 1. Schematic Diagram of the Patent Pending Mcgyan® Biodiesel Production Process Developed at SarTec®.

The biodiesel produced from the Mcgyan® process has passed all current European and American standards (from a variety of feedstocks). Most importantly, the use of longer chain alcohols such as propanol and butanol results in biodiesel fuels that have lower cloud points. Another surprise of the Mcgyan® process is that glycerol is not a main byproduct of the process. In fact, under certain conditions glycerol is completely eliminated as a byproduct. Instead the process converts the glycerol to a mixture of oxygenated organic compounds including ethers and aromatics that are incorporated in the biodiesel fuel while still passing all ASTM testing

Dr. McNeff is the Vice President of Research and co-owner of SarTec® Corporation, Chief Science Officer and co-owner of Ever Cat® Fuels, LLC and CEO and co-owner of ZirChrom® Separations, Inc and McNeff Research Consultants, LLC. He has more than 22 peer reviewed publications on the synthesis and use of metal oxide materials for separation science and catalysis and is an inventor of more than 15 issued and pending patents. He has been the principal investigator on numerous federally funded grants from the National Institutes of Health, National Science Foundation, and the United Stated Department of Agriculture. Dr. McNeff is a recipient of the 2002 National Tibbetts Award in recognition of his outstanding contributions to the federal SBIR grants Program.

Mcgyan® BIODIESEL PROCESS CONTINUED . . .

standards for B100. In addition to converting glycerol to fuel, the process also produces the ether of whatever alcohol is used in the process. For instance in the case of methanol, dimethyl ether is produced and in the case of ethanol, diethyl ether is produced. These ether-co products are valuable and add an additional revenue stream to a biodiesel production plant.

As-made biodiesel made from the Mcgyan® process is polished to remove any residual free fatty acids (FFAs) by the adsorption onto a patent pending metal oxide packed-bed polisher column system called the Easy Fatty Acid Removal (E-FAR) system. After the polisher is saturated with FFAs, it can be regenerated to its original capacity by passing nitrogen gas through it to displace the liquid, followed by passing heated air through it in order to regenerate it to its full FFA capacity. The FFAs, residual biodiesel and alcohol can then be put back into the input side of the Mcgyan® process so that 100% conversion of all available feedstock to biodiesel is achieved.

The Mcgyan® pilot plant is currently being operated at SarTec® Corporation. The pilot plant was constructed by increasing the reactor volumes from the lab model about fifty times to achieve an annualized production level of more than 40,000 gallons per year with a contact time of about 1 minute. The pilot plant has been in operation for more than half a year and has proven that the process can be scaled up and run continuously with no observed loss in conversion efficiency over that time. The reactors used in the pilot plant have also been regenerated thermally after "plugging" with organic matter to show that the reactors may be regenerated to full production capacity. The next step in production capacity is being taken by Ever Cat® Fuels, LLC (Anoka, MN www.evercatfuels.com) which is currently building a 3 million gallon per year production facility located in Isanti, MN. This commercial biodiesel facility will use corn oil from ethanol plants that has a nominal 15% free fatty acid content and 190 proof ethanol as the feedstocks. The ethyl ester produced by the Mcgyan® process has a very low cloud point of -8°C and has a lightly "fruity" smell to it.

The core chemical process that is used in biodiesel production today is more than six decades old. During World War II in the 1940s the chemical process was patented by Colgate-Palmolive-Peet Company and Dupont who obtained patents on the transesterification process (US patents, 2271619, 2360844, 2383579, 2383580, etc). Derived from this origin, the three main synthetic routes for biodiesel production include base catalyzed transesterification, acid catalyzed transesterification (with simultaneous esterification of free fatty acids) and noncatalytic conversion via transesterification and esterification under supercritical alcohol conditions. This chemical process converts the triglycerides (TGs) found in vegetable oils and animal fats into fatty acid methyl esters (FAMEs) in a multistep synthesis with glycerol being liberated as a byproduct. The primary advantage of the acid catalytic route is that it may be used for conversion of high free fatty acid content feedstocks that are usually less expensive than pure, low free fatty acid feedstocks. However, today the main commercial synthetic route currently used is the nearly 70-year old base catalyzed transesterification of triglycerides. This synthesis is typically carried out using refined soybean and canola vegetable oils due to the high cost of running the acid-catalyzed reaction at large scale. Although this transesterification reaction is simple and very well understood, its major limitation is its severe sensitivity to free fatty acids and water content of reaction mixture, both of which consume the catalyst and reduce conversion efficiency.

Because the base-catalyzed method is the most widely used, the majority (>90%) of biodiesel currently produced in the U.S. is derived from high purity virgin soybean oil, which has a very low free fatty acid content (e.g. < 0.5%). The current practice of using highly refined oils makes feedstock price a dominating economic factor (ca. 88% of the production cost) in biodiesel production. As a result, production costs currently make the United States biodiesel industry commercially nonviable without government supports, tax incentives, and other mandates for consumption. Furthermore, biodiesel plants must also compete with food, industrial, and livestock feed demands for the feedstock oils. The use of lower cost lipid feedstocks such as animal tallow (e.g. swine, beef and poultry), and waste oils (e.g., brown and yellow grease), and acidulated soapstocks would vastly improve the economics of biodiesel production and make good use of these low value commodities.

Over the past two decades, the major focus of researchers in the production of biodiesel has been the use of solid heterogeneous catalysts, which might provide a way to convert both triglycerides and free fatty acids to biodiesel fuel. A wide range of catalytic materials have been investigated for use.

A significant amount of work has been previously reported on the possibility of using algae to produce oil for biodiesel production. Algae are fast growing and they can be grown and harvested on a continuous basis throughout the year under controlled cultural conditions. Algae have a high capacity for CO2 fixation and can be grown in intensive culture on limited areas of land. Research conducted by the U.S. Department of Energy in their Aquatic Species Program during the 1970's and 1980's and other research has provided an extensive basis of work for the potential use of algae to produce biodiesel and to capture CO2 from coal burning power plants. An important conclusion of this previous work was that algae have the potential to produce more than two orders of magnitude higher oil production per acre than conventional crops such as soybeans and canola. Furthermore, algae are not a food crop like most vegetable oil sources currently used for biodiesel production. Most importantly, algae oil typically has a free fatty acid content from 20-50%, which is problematic for conventional biodiesel production processes due to unwanted byproduct formation (soap formation). In contrast, the Mcgyan® process described here can convert both triglycerides and free fatty acids into biodiesel (with high efficiency) thereby enabling commercial algae based fuel production to finally be realized. SarTec® is currently working on new systems for algae production that could one day be implemented along with the Mcgyan® process to allow for complete biodiesel production at the farm. ***Investors looking to participate in this novel production process of biodiesel can call Dave Wendorf at 800-472-7832.***

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SARTEC EMPLOYEE HIGHLIGHT: JOEL SCHUMACHER, P.E.

This issue's employee highlight is about Joel Schumacher. Joel was born in St.Paul, MN and joined SarTec Corporation in mid-2007 as a Chemical Process Engineer. Joel received a degree in Chemical Engineering with a Chemistry minor from the University of Minnesota at Duluth. He worked as a consulting engineer for seven years before joining SarTec Corporation. Since joining SarTec, Joel has completed his Professional Engineering requirements and is currently a certified Professional Engineer. Joel has a wife (Jeanie) and two children (Alyssa, 5 years old and Tyler, 3 years old) and they are expecting a new addition in mid June. Joel's hobbies include hunting and fishing as well as photography and motorcycles and it would be remiss to not include hockey as Joel is a devout Minnesota Wild and Gopher supporter.

Picture: SarTec Chemical Process Engineer Joel Schumacher.

Joel's efforts at SarTec Corporation are currently focused on the design and detailed engineering for a 3 million gallon per year biodiesel production facility being built in Isanti, MN (for Ever Cat® Fuels, LLC). This plant features the new Mcgyan® technology which was developed at SarTec Corporation (see the article on page 1). Joel is in charge of the complete engineering of this new facility which is expected to be fully operational and producing biodiesel in the last quarter of 2008. In fact, it was Joel's interest in this project which brought him to SarTec Corporation. Previously, Joel worked for an engineering firm which was doing consulting work for SarTec Corporation on the biodiesel plant project in Isanti. After working as a consultant on the biodiesel plant project for a while, Joel approached us about becoming a member of the SarTec team to work on the biodiesel project full time, and he was hired as a full time SarTec employee shortly thereafter.

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