

# SarTec®



Next Generation Biodiesel Production:

**The Mcgyan Process**

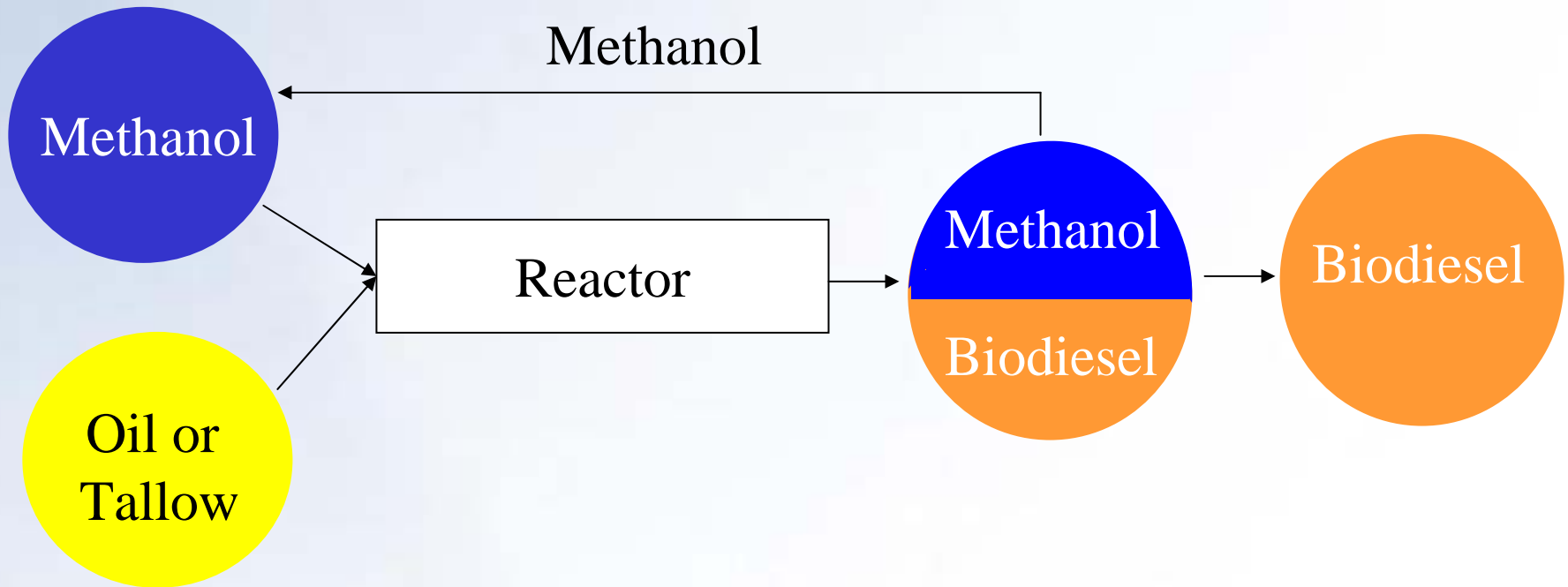
Pete Greuel, Ph.D.

General Manager

# Outline

- Introduction to The Mcgyan Process
- Connections with the University of Minnesota and Augsburg College
- Traditional Biodiesel Production
- New Breakthrough: the Chemistry of the Mcgyan Process
- Economics
- Conclusions & The Future

# The Mcgyan process: A Simple Continuous Reactor



# SarTec<sup>®</sup> University of Minnesota

## Connections

### Professor Peter W. Carr

- B.S., Polytechnic Institute of Brooklyn, 1965
- Ph.D., Penn State University, 1969
- Postdoc., Stanford University Medical School (1968-1969)
- More than 350 Peer Reviewed Publications

#### Honors and Awards :

Listed in “Who’s Who in America”, 2004

2004 Pittsburgh Conference Award in Analytical Chemistry Award, 2004

2001-2002 Award for Outstanding Contributions to Postbaccalaureate, Graduate, and Professional Education, University of Minnesota Alumni Association, 2002

2000 Award for Outstanding Achievements in Separation Science of the Eastern Analytical Symposium, 2000

1996 American Chemical Society Award in Chromatography, 1997

1996 Stephen Dal Nogare Award of the Delaware Valley Chromatography Forum, 1996

Co-chair and Program Organizer, HPLC 94, Minneapolis, 1994

Award in the Fields of Analytical Chemistry of the Eastern Analytical Symposium, 1993

Benedetti-Pichler Award, sponsored by the American Microchemical Society, 1990

Merit Award, Chicago Chromatography Discussion Group, 1987

R.S. Palmer Award, Minnesota Chromatography Forum, 1984

Research Fellow, Analytical Division of the American Chemical Society, 1967

NDEA Fellow, Pennsylvania State University, 1965-1968



*Department of Chemistry*

# Previous Work on Zirconia

	Years of research on zirconia
<b>Professor Peter W. Carr</b>	18
Professor Alon McCormick	6
Professor Michael Flickenger	6
Professor Jung Hag Park	6
Professor Paul Jackson	4
Professor Anu Sumbramanian	4
Dr. Martin Rigney	4
Dr. Tom Weber	4
Dr. Eric Funkenbusch	4
Dr. John Blackwell	4
Dr. Dan Karl	2
Wes Shafer	2
Dr. Jacek Nawrocki	2
Dr. Li Sun	4
Dr. FranciscoLorenzano Porras	4
Dr. Michael Glavanovich	4
Dr. Clayton McNeff	14
Dr. Christopher Dunlap	4
Dr. Michael Annen	4
Dr. David Reeder	4
Dr. Janwei Li	4
Dr. Arun Sathyagal	4
Dr Andrew Clausen	4
Dr. Bingwen Yan	4
Dr. Yue Hu	4
Dr. Jane Zhao	4
Dr. Ceclia Castells	4
Dr. Yun Mao	4
Dr. Brian Trammell	4
Dr. Jun Dai	4
Dr. Jon Thompson	4
Dwight Stoll	4
<b>Total</b>	<b>152</b>

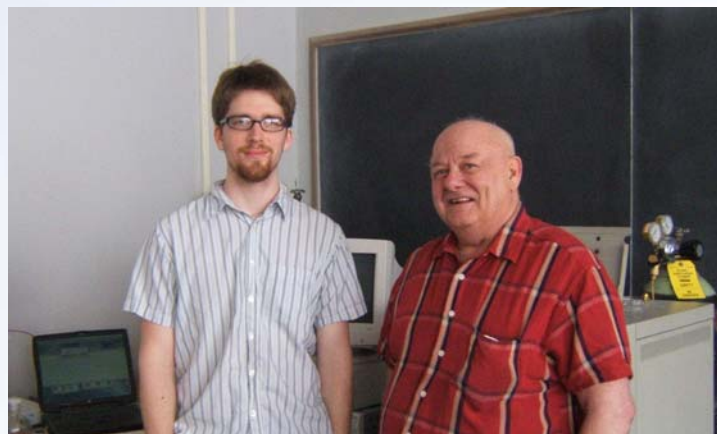
# Augsburg College Connection

## Professor Arlin E. Gyberg

### Education

B.S. Mankato State University

Ph.D University of Minnesota



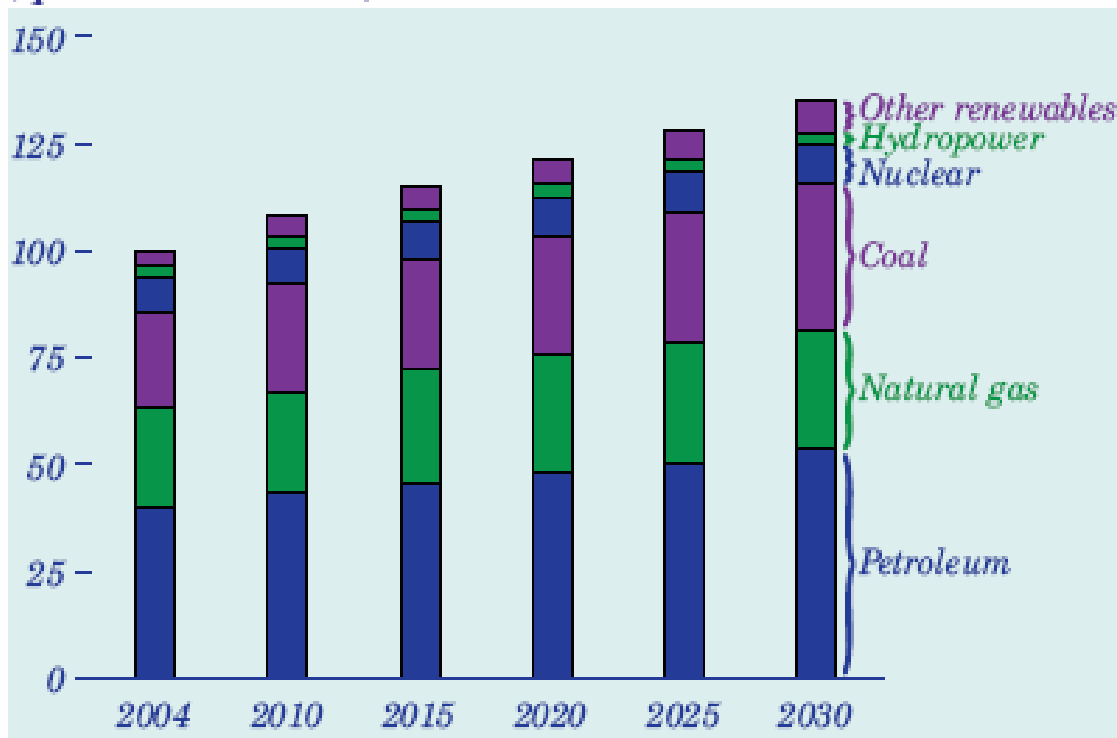
Arlin Gyberg **came to Augsburg in 1967** and throughout the years has been involved in a variety of areas, and has been very active in the Minnesota Section of the American Chemical Society including being Chair. He has **received several teaching awards** including an Outstanding Educator in America Award in 1973 and was selected twice by the graduating class at Augsburg as the Honored Faculty in the science and mathematics division.

Throughout the years **Arlin has consulted with** or did research for, and or taught specialty courses at 3M, NSP Nuclear Power Plants, St. Mary's University School of Anesthesia, Northwestern College of Chiropractic, Minneapolis Community College, Minnesota State Prison System, the University of Minnesota, Breck School and Macalester College.

*Department of Chemistry*

# 30% Increase in Projected Energy Demands in U.S. by 2030

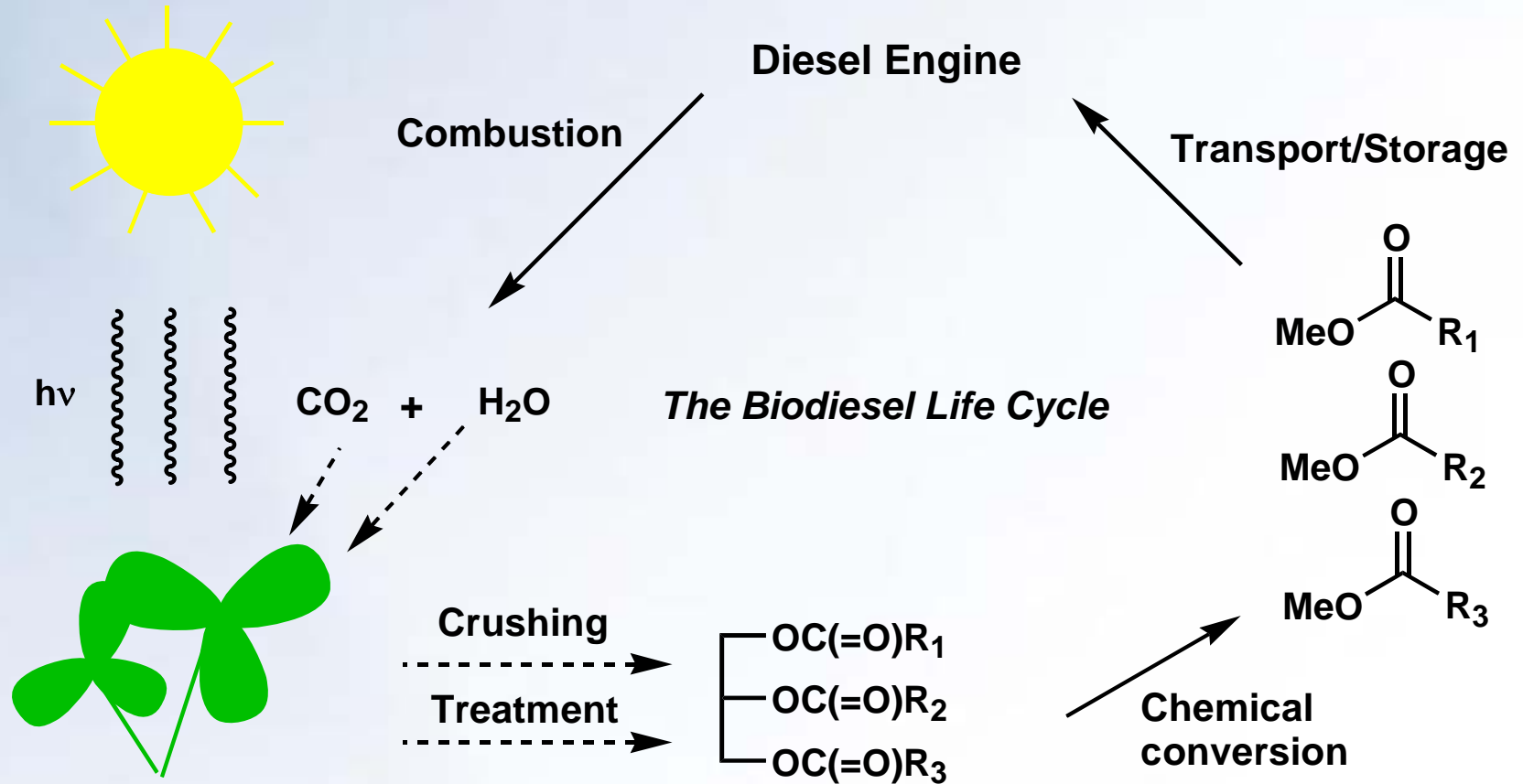
*Figure 32. Primary energy use by fuel, 2004-2030 (quadrillion Btu)*



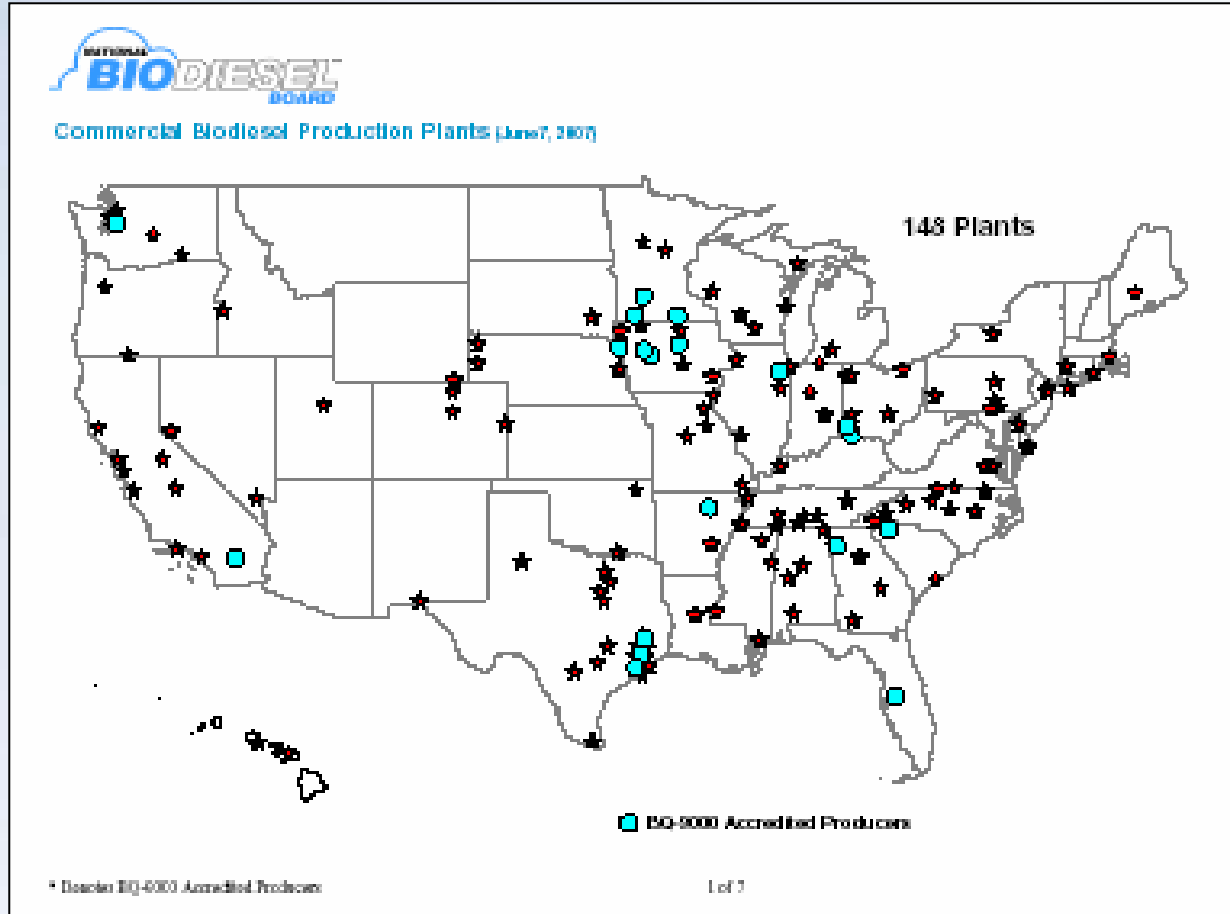
# Top 10 Benefits of Biodiesel

1. Improvement of rural economies
2. Renewable
3. Biodegradable and low toxicity
4. Environmentally friendly
5. Lower combustion emission profile
6. Lower dependence on foreign crude oil
7. Use without engine modifications
8. Good engine performance
9. Improved combustions because of its oxygen content
10. Ability to be blended with traditional petroleum-based diesel fuel

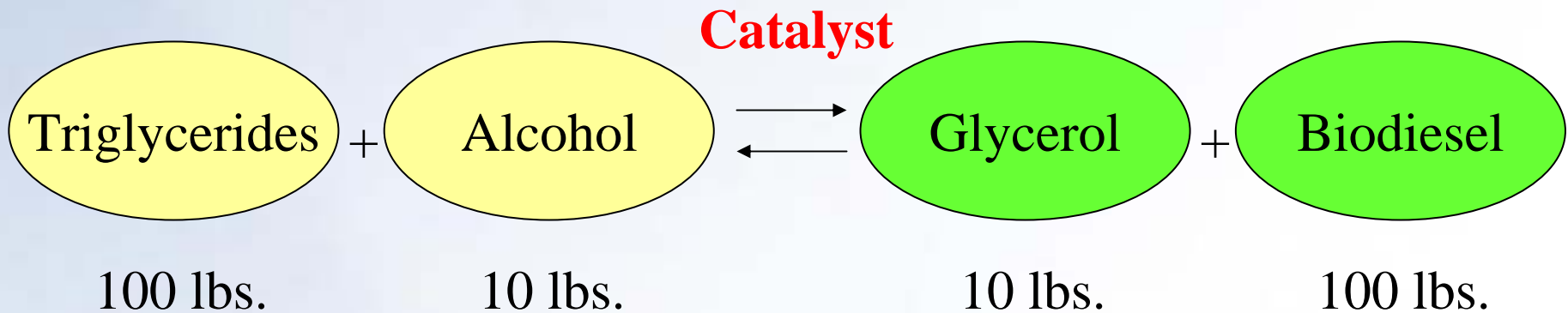
# The Biodiesel Life Cycle



# Current Biodiesel Plants

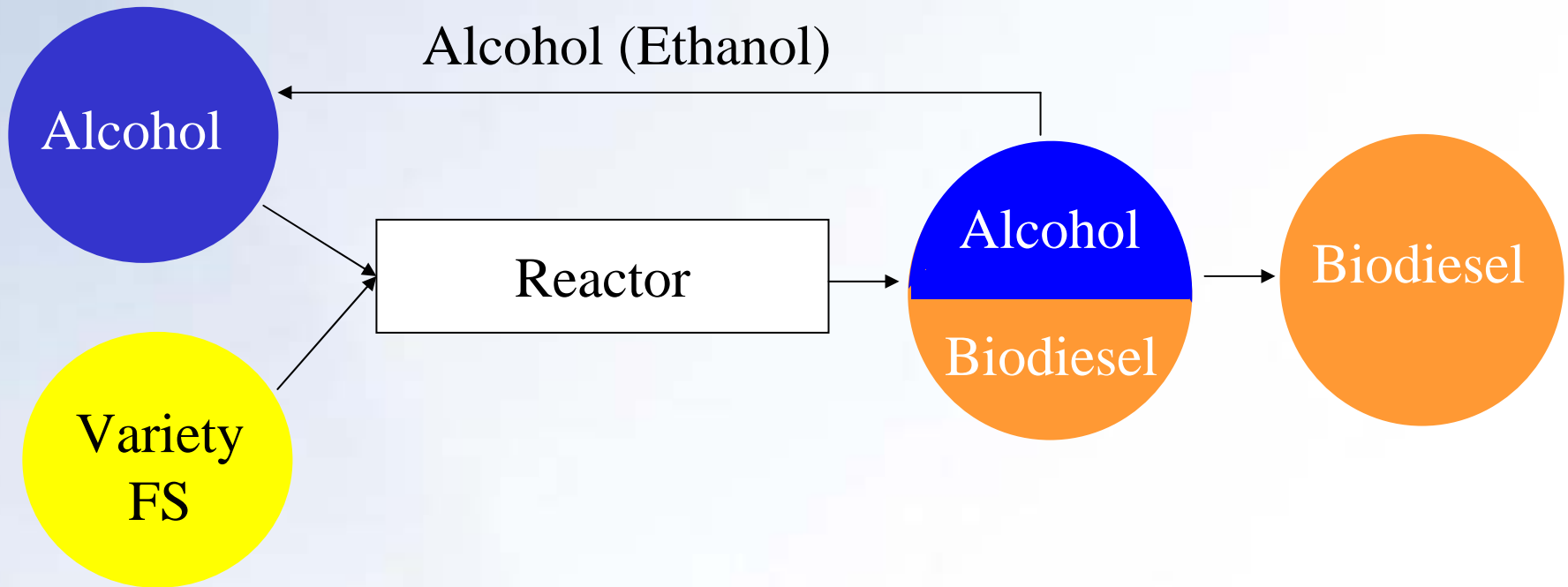


# The Traditional Biodiesel Base Catalyzed Reaction



Note: Approximately the same mass of biodiesel results from the input triglyceride .

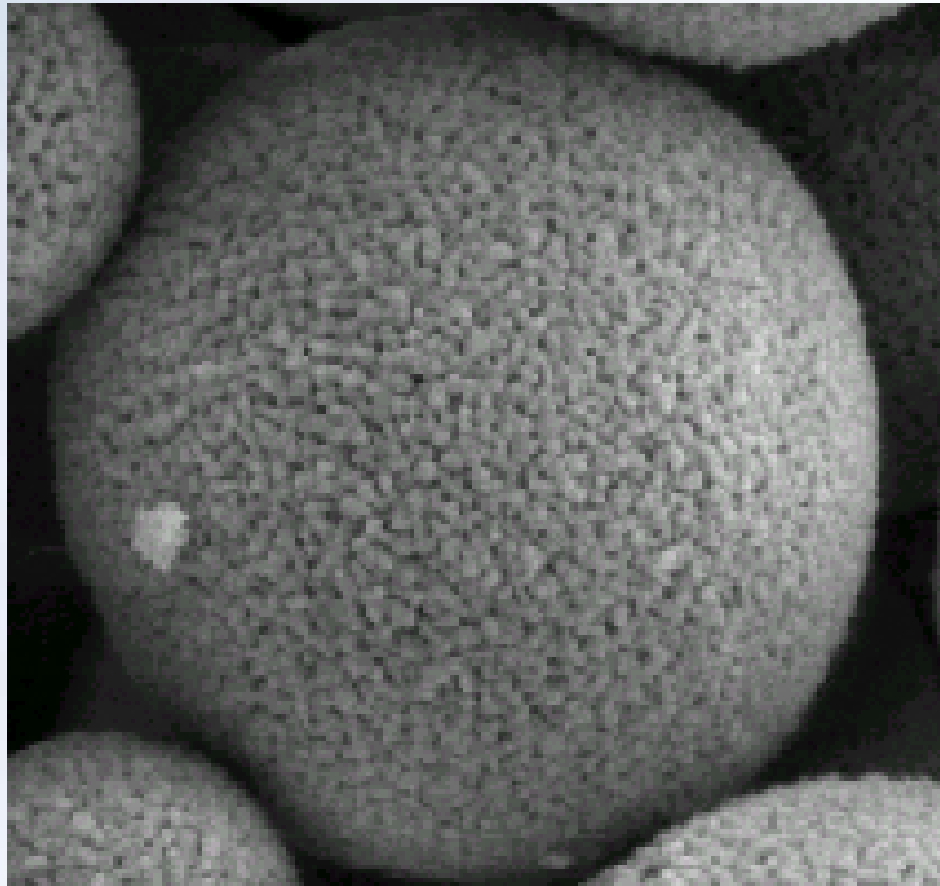
# The Mcgyan process: A Simple Continuous Reactor



# The Mcgyan Process vs. Current Technology

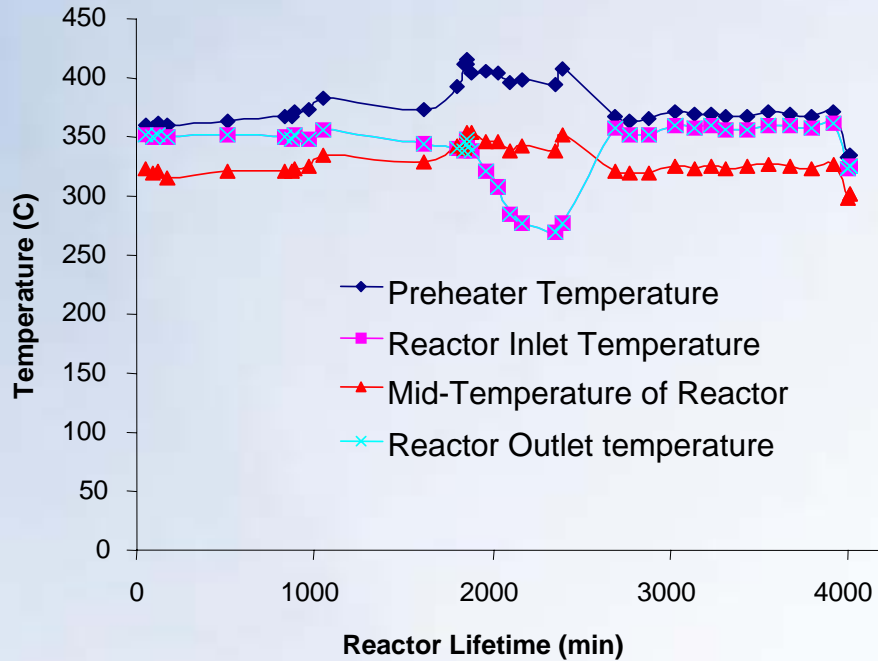
PRODUCTION CHARACTERISTIC	PROCESS	
	Traditional Process	Mcgyan
Consumes catalyst	Yes	No
Uses large amounts of water	Yes	No
Produces waste products	Yes	No
Produces soap byproducts	Yes	No
Requires large footprint	Yes	No
Sensitive to water	Yes	No
Sensitive to free fatty acid content	Yes	No
Uses large quantities of strong acids or bases	Yes	No
Conversion rate	Hours	Seconds
Converts free fatty acids to biodiesel	No	Yes
Can use a variety of feedstocks	No	Yes
Produces glycerol as a byproduct	Yes	No
Is a continuous process	No	Yes

# SEM of Porous Metal Oxide



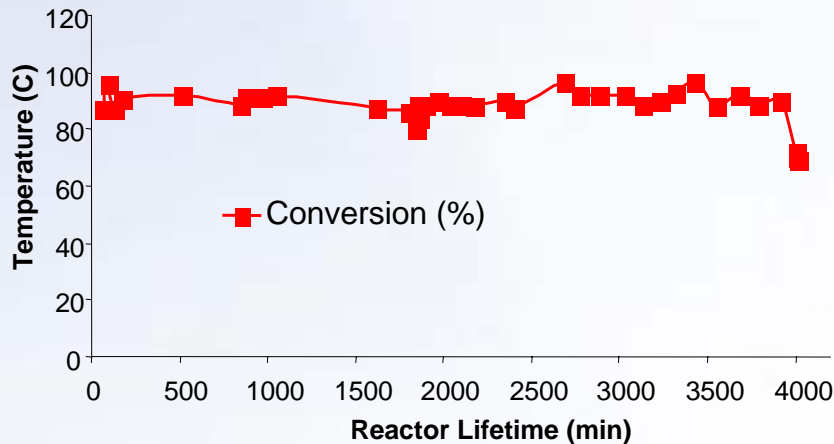
**1μm 25000X**

# Mcgyan Reactor Conditions



- Mcgyan reactor: 60 Å, washed Titania. Two 1cm i.d. x 15cm reactors in series.

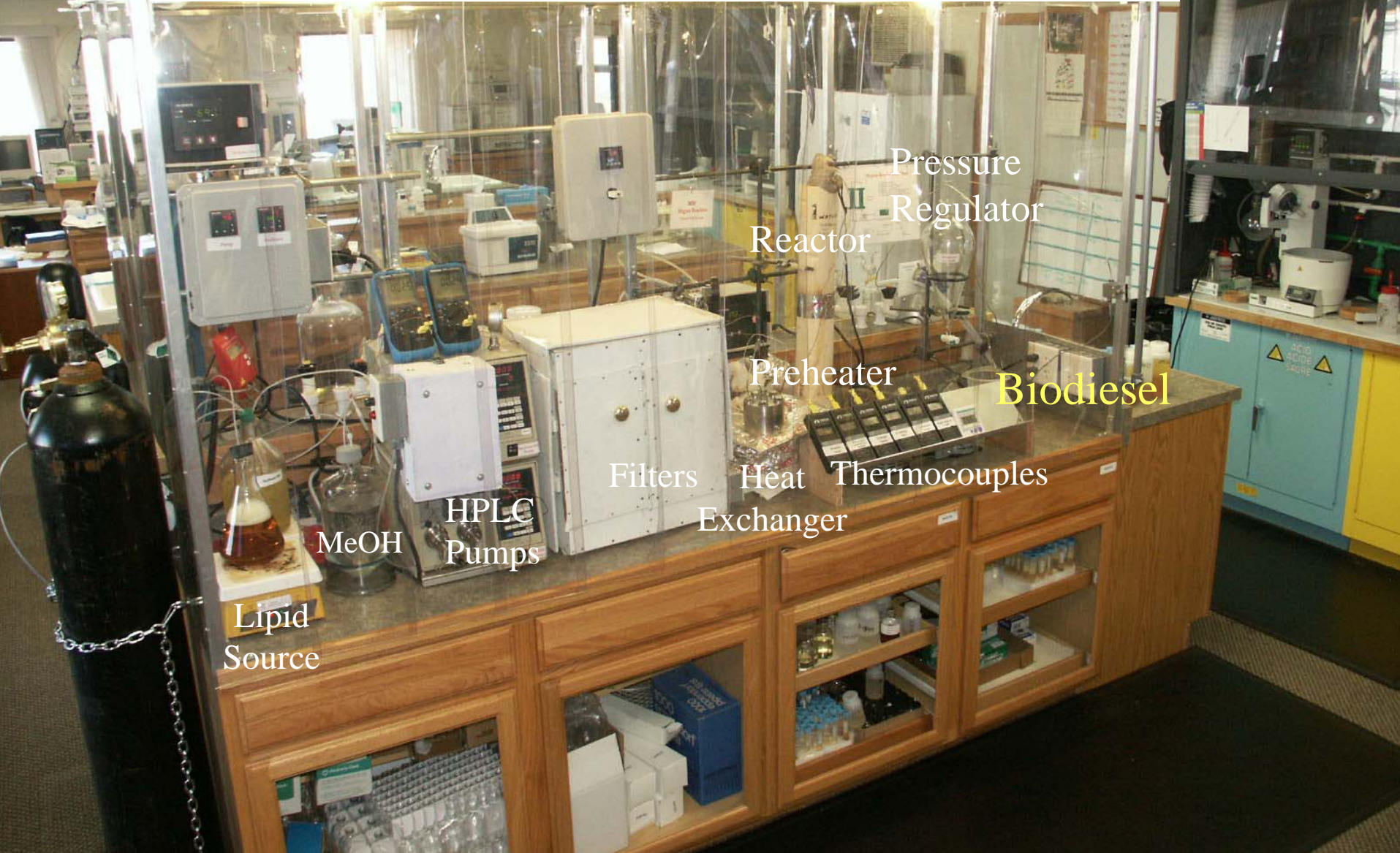
- Conditions: Soybean oil flow: 3.904 g/min, MeOH: 5.737 g/min



- Mol ratio MeOH/Oil: 40.5 (measured)

- Contact Time: 63.5 seconds

# Mcgyan Process - Laboratory



Lipid  
Source

MeOH

HPLC  
Pumps

Filters

Heat  
Exchanger

Preheater

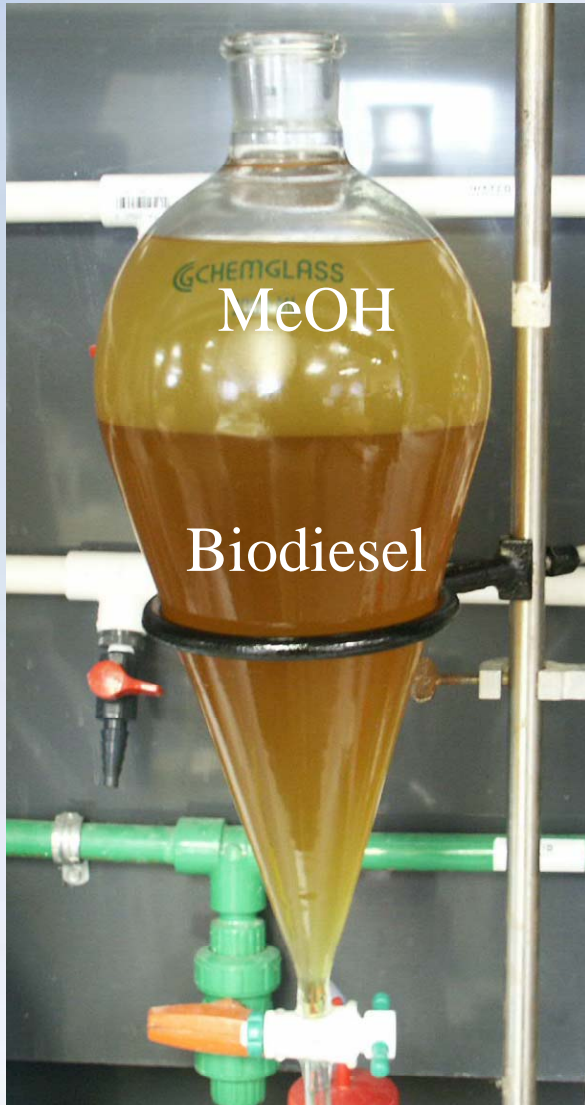
Reactor

Pressure  
Regulator

Biodiesel

Thermocouples

# As-Made Biodiesel Fuel



- No catalyst removal is necessary
- Methanol and Biodiesel spontaneously separate
- Flexible chemistry
- No water needed for washing steps
- Small plant footprint

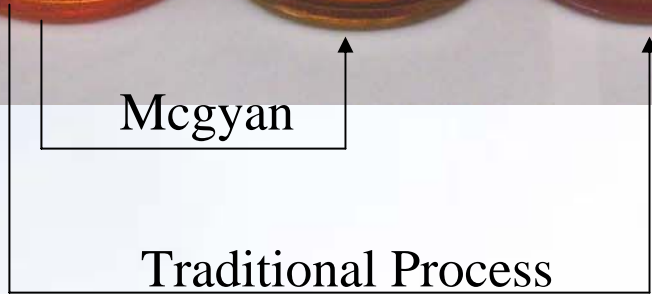
# Mcgyan Process - Biodiesel from Various Feedstocks

Including:

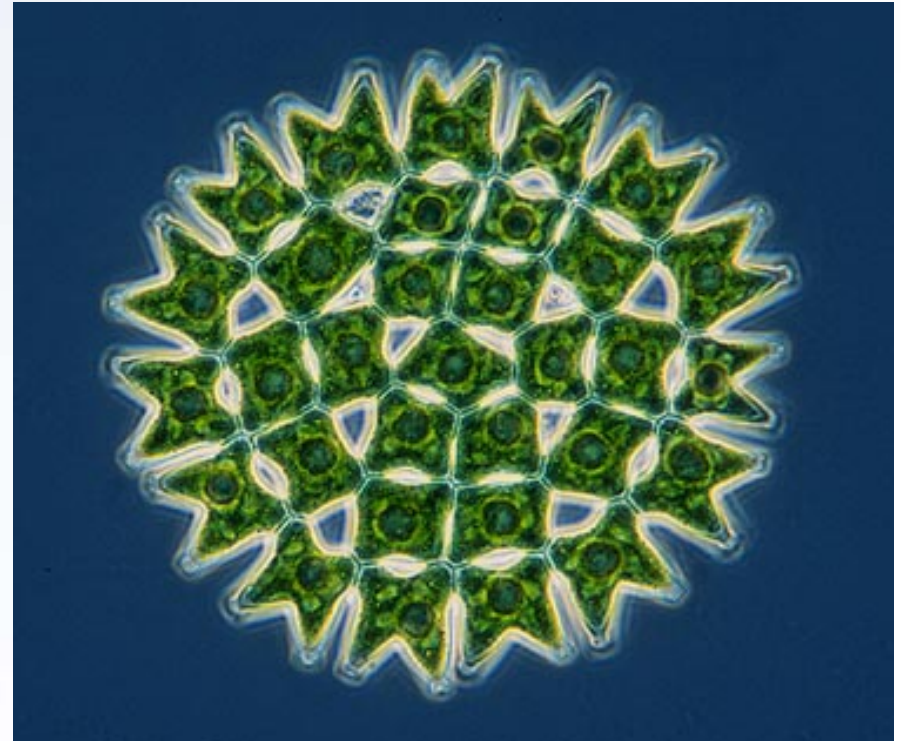
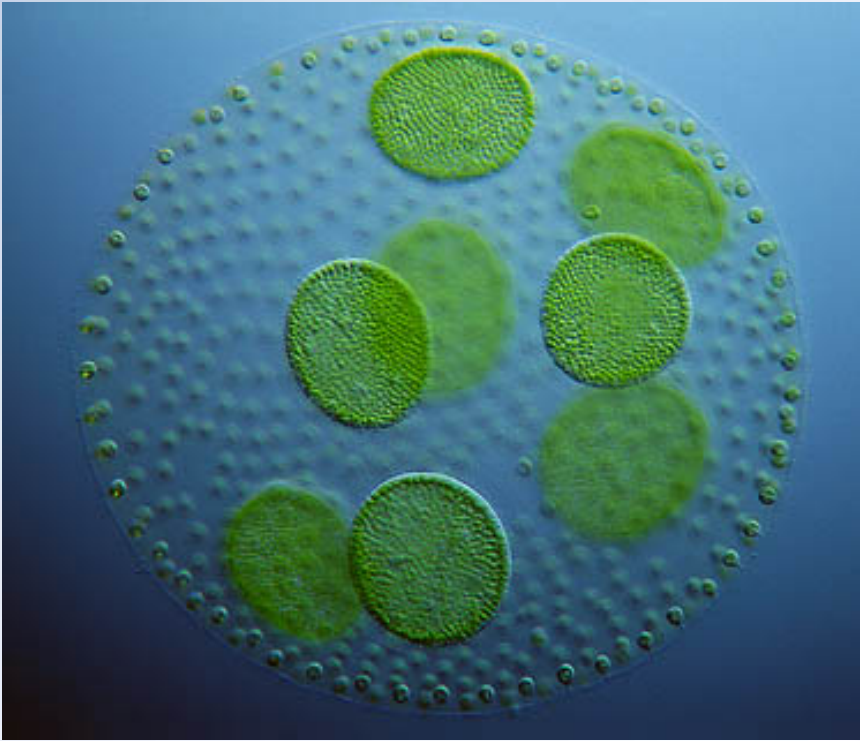
- Yellow & Brown Grease
- Beef and Pork Tallow
- Tall Oil
- Acidulated Soapstock
- Soybean, Corn, Safflower, Peanut, Sesame, Rice, Palm, Canola, Grape Seed, Olive, Sunflower, Almond, Cottonseed & Coconut Oil
- Algae Oil



# Corn Oil – Extracted from Distiller's Syrup



# Biodiesel Production from Algae



# Economics of Biodiesel\*

Traditional  
Process →

30 M Gallon Per Year Summary	
Soybean Oil Feedstock Price/lb.	\$ 0.33
Operating Costs Per Gallon	\$ <b>2.83</b>
Sale Price Per Gallon	\$ <b>2.10</b>
Blending Tax Credit	\$ 1.00
Net Gross Profit Per Gallon	\$ 0.27

Mcgyan Process →

30 M Gallon Per Year Summary	
Tallow Feedstock Price/lb.	\$ 0.16
Operating Costs Per Gallon	\$ <b>1.57</b>
Sale Price Per Gallon	\$ <b>2.10</b>
Blending Tax Credit	\$ 1.00
Net Gross Profit Per Gallon	\$ 1.53

\* Adapted from: Haas, M. J., McAloon, A. J., Yee, W. C., Foglia, T. A., A Process Model to Estimate Biodiesel Production Costs, Biosource Technology, 97 (2006), 671-678.

# Mcgyan Process - Pilot Plant



# Biodiesel - Manufactured with the Mcgyan Process



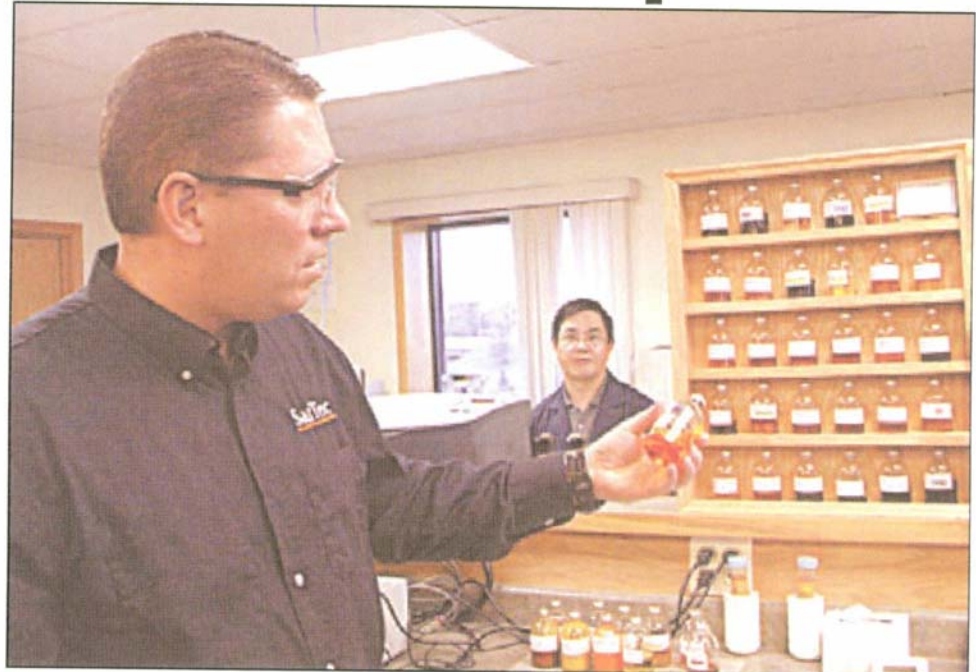
# Future Isanti facility to use revolutionary biodiesel process

*The plant will be the first of its kind in the world*

by Benjamin Sobieck

Staff writer

The Mcgyan process might sound foreign to many outside the realms of science, but the residents of Isanti may soon be very familiar with it when it elevates that city to the world stage. // That is because the Mcgyan process, a revolutionary method of producing biodiesel, will be used at a first-of-its-kind alternative energy plant in Isanti that is slated to be operational in May or June of 2008. // The plant will be built near the wastewater treatment facility, and it will include rail siding for delivery of necessary materials. This may trigger additional development around the plant.



DR. CLAYTON MCNEFF, who co-developed the Mcgyan process with Dr. Arlin Gyberg and Dr. Bingwen Yan, explains the difference between kinds of fuels during a tour of the Anoka facility that houses Ever Cat and SarTec on Friday, Oct. 12, 2007. (Photo by Benjamin Sobieck)

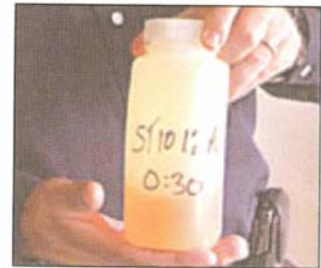
In order to get a sense of what the Mcgyan process is, why it is so ground-breaking and what effects it will bring to the community, a tour was arranged on Friday, Oct. 12, 2007 for the facility that is developing the technology.

That facility is operated in Anoka by SarTec in cooperation with Ever Cat Fuels. On the tour were Isanti Mayor George Wimmer, Isanti Economic Development Coordina-

tor Carla Vita, Jeff Kolb of the Isanti County EDA and members of the local media.

The Anoka facility houses a smaller version of what will later be built in Isanti, offering a miniaturized perspective on what can be expected in the future.

**FUTURE ISANTI FACILITY**  
Continued on page 20



DR. MCNEFF holds a bottle of the end result of the Mcgyan process. The bottom layer biodiesel and the top is methane.

The Next Step:

3 MGY

Biodiesel Facility  
in Isanti

# Dr. McNeff in Washington DC

- Enact a **2% national mandate** for the use of biodiesel fuel that goes to 20% by 2020.
  - Current production of biodiesel fuel and the addition of biodiesel made from the corn oil current not captured at ethanol production facilities will allow for an immediate 2% mandate.
  - 20% mandate can then be reached by the development of the production of algae at coal burning power stations and on the farm.
- **Continue long-term support** (tax incentives) of the **ethanol and biodiesel** industries to encourage continued support by the private sector.
- **Algae farming** will result in carbohydrates for ethanol, protein for livestock production and oil for biodiesel production.
  - If 2.5% of the cropland in the U.S. was used for algae production we could produce enough oil to satisfy the 63 billion gallons of petroleum diesel currently consumed.
  - Continue to encourage the development of alternative feedstocks (e.g. cellulose) for ethanol production that do not compete for food production.
- **Algae production needs to be moved to the farm** where we will get a true reduction in CO<sub>2</sub> levels from the environment.

# Conclusions

- The Mcgyan process can use variety of *renewable feedstocks*.
- The Mcgyan process *does not consume the catalyst*.
- The Mcgyan process *is not water intensive* like current production methods.
- The Mcgyan process *has virtually no waste stream*.
- The Mcgyan process *is insensitive to water and does not produce soap byproducts*.
- The Mcgyan process *has a small footprint and can potentially be run at the farm*.
- The Mcgyan process *does not require large quantities of strong acids or bases*.
- The Mcgyan process may be used for *continuous hydrolysis of complex carbohydrates to simple sugars* that may be fermented to produce bioethanol.