Strategic Biodiesel Decisions
What is Biodiesel?

- Biodiesel is defined as the mono-alkyl ester of fatty acids derived from vegetable oils or animal fats, commonly referred to as B100.
- Biodiesel must meet the specifications of ASTM D6751
- Biodiesel blends are a mixture of Biodiesel with petroleum diesel, commonly referred to as B20, B5, B2.
Transesterification

\[
\begin{align*}
\text{Triglyceride} & \quad \text{Methanol} & \quad \text{Mixture of Fatty Esters} & \quad \text{Glycerin} \\
\begin{array}{c}
\text{CH}_2 - \text{O} - \text{C} - \text{R}_1 \\
\text{CH} - \text{O} - \text{C} - \text{R}_2 + 3 \text{CH}_3\text{OH} \rightarrow \text{CH}_3 - \text{O} - \text{C} - \text{R}_2 + \text{CH} - \text{OH} \\
\text{CH}_2 - \text{O} - \text{C} - \text{R}_3
\end{array}
\end{align*}
\]

Where you find solutions
Standard Recipe

100 lb + 21.71 lb →
Oil + Methanol

100.45 lb + 10.40 lb + 10.86 lb
Biodiesel + Glycerol + Excess Methanol

Plus 1 lb of NaOH catalyst
Biodiesel Production Capacity

Commercial Biodiesel Production Plants (September 13, 2006)

Picture from National Biodiesel Board website
www.biodiesel.org
Biodiesel Production Capacity

Biodiesel Production Plants Under Construction or Expansion (September 12, 2006)

Picture from National Biodiesel Board website
www.biodiesel.org
Biodiesel Production Capacity

• As of September 2006
  - 85 existing production facilities in US
  - Approximately 581 million gal/yr of capacity

• Proposed or planned plants
  - Estimated 1.4 billion gal/yr of capacity

• Total US estimated production capacity by mid 2007 is almost 2 billion gal/yr
Feedstock Supply

Current US feedstock supply

- 29 billion pounds of vegetable oil
- 12 billion pounds of animal fats
- 41 billion pounds of total feedstock per year

US Exports of feedstock

- 3.9 billion pounds of total exports
  - Equals approximately 500 million gallons
• US Exports of feedstock
  - Of those exports, only 2.4 billion pounds are low enough in price to make biodiesel profitable
  - Will make 315 million gallons of biodiesel
  - Consist of soybean oil, palm oil, and a few rendered products
Feedstock Supply

- Supply and demand principle
- Meal constraint on additional crush
  - Ethanol industry
  - Export markets
- Competition with food industry
  - Cost differential with food grade
  - Oil is a small part of food product cost
- Oil imports
Why is Feedstock Price Important?

Distribution of Biodiesel Production Cost for 3 mm gpy Plant

- Feedstock: 71.7%
- Chemical: 6.4%
- Energy: 5.9%
- Labor: 4.3%
- Depreciation: 1.6%
- Overhead and Maintenance: 10.2%
Feedstock Strategies

Which feedstock to use?

- Soybean oil
  - Price, lowest cost vegetable oil
  - Cold flow properties
  - Major seed crop in US
  - Local sources
  - Easy to use
  - No pretreatment
Feedstock Strategies

Which feedstock to use?

• Animal Fats
  - Lowest cost feedstock
  - Poor cold flow properties
  - Includes some second use oil
  - Rendered products
  - Possible odor concerns
Feedstock Strategies

Which feedstock to use?

• Determining factors
  – Plant location
  – Feedstock availability and price
  – Biodiesel properties desired
  – Competing biodiesel producers
  – Government incentives
  – Transportation logistics
Feedstock Strategies

Which feedstock to use?

• Important considerations
  – Find feedstock sources early
  – Look for opportunity feedstocks
  – Develop a risk management policy
  – Design flexibility into your plant so that different feedstocks can be used
  – Do feedstock sensitivity calculations
Plant Cost

- Processing plant estimates vs. Complete plant estimates
- Installation Cost + Equipment Cost = Installed Cost
- Installation cost equals 1 ½ to 2 times the equipment cost
- New versus used equipment
Biodiesel Plant Budget Installed Cost

- 30% FFA
- 10% FFA
- <2% FFA
- 10% FFA Modular
- <0.1% FFA Modular

Where you find solutions
Plant Size Considerations

• Batch plant cost less than a continuous plant
• Batch plant footprint is larger than continuous plant footprint
• Batch can be operated for short periods of time with out loosing efficiencies
• Continuous plant equipment must have the same flow rate or throughput
• Rule of thumb $1 per gallon of capacity
Plant Size Strategies

What plant size to build?

• Advantages of Large Plants
  - Large plant > 5 million gpy
  - Equipment cost per gallon produced are less as size increases
  - Operator expenses are usually less
  - Volume discounts on chemicals and feedstock
  - Transportation discounts for volume
Plant Size Strategies

What plant size to build?

• Advantages of Small Plants
  - Small plant < or = 5 million gpy
  - Smaller customer base needed
  - Less total feedstock required
  - Lower capital cost: Less capital investment
  - Can be a batch process
  - Capitalize on local and regional markets
  - Lower transportation cost: feedstock/products
Plant Size Strategies

What plant size to build?

• Determining factors
  – Market size and demand
  – Marketing abilities
  – Feedstock supplies
  – Site locations and infrastructure
  – Risk tolerance
  – Capital or financial resources
Plant Size Strategies

What plant size to build?

• Important considerations
  – Don’t discount local market loyalty
  – Don’t only look at the numbers
  – A large plant operating at less than capacity cost more to operate than a small plant running at capacity
  – The last million is always the hardest to raise
Plant Efficiencies and Capacities

- Operating at less than capacity means lower efficiencies therefore higher cost per gallon produced and possible lower quality.
- A 30 mm gpy plant at 2/3 capacity is less profitable than a 5 mm gpy plant at capacity.
- In order to operate at capacity, higher feedstock cost or lower selling price may be necessary – hence lower profits.
Technology & Technology Providers

- Compare apples to apples
- Years in service
- Design vs. design with construction
- Partnership opportunities
- Work load and time line
Technology & Technology Providers

- Other services
  - Marketing assistance
  - Fund raising assistance
  - Management assistance
- Number of working plants
- Performance guarantees
- Environmental issues
Technology Strategies

Which technology is best?

• Continuous vs. Batch processing
• Solid catalyst vs. homogeneous catalyst
• Water wash vs. absorbent
• Feedstock pretreatment or soap removal
Technology Strategies

Which technology is best?

• Technology provider dependant
  – Knowledge level
  – Breadth of experience

• Turnkey vs. construction managed

• Skid mounted vs. site erected
Technology Strategies

Which technology is best?

- Determining factors
  - Feedstock consideration
  - Experience level of the technology provider
  - Ability to validate the technology
  - Size of plant to be built
Technology Strategies

Which technology is best?

• Important considerations
  – Financial stability of technology provider
  – Is the technology proven?
  – Use technology providers knowledgeable in all facets of the plant
  – What is your expertise level?
  – Obtain references and visit a plant
Resources

• Biodiesel Workshop, material from the Biodiesel Production, Analytical, and Business workshops in Iowa and Idaho, 2006, http://www.me.iastate.edu/biodiesel

• National Biodiesel Board, http://www.biodiesel.org

• USDA

• CI RAS and Iowa State University
Where you find solutions

Resources


Available from

www.biodieselbasics.com
Rudy Pruszko

Center for Industrial Research and Service
Iowa State University Extension
Dubuque, Iowa 52001
Phone 563-557-8271 ext 251
Email: rpruszko@iastate.edu

CIRAS website:
http://www.ciras.iastate.edu