Strategic Biodiesel Decisions

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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

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

Where you find solutions

Commercial Biodiesel Plants
April 2006

65 Plants

BQ-9000 Accredited Producers
Biodiesel Production Capacity

Plants under construction
April 2006
Biodiesel Production Capacity

• As of April 2006
  – 65 existing production facilities in US
  – Approximately 395 million gal/yr of capacity

• Proposed or planned plants
  – Estimated 714 million gal/yr of capacity

• Total US estimated production capacity by mid 2007 is over 1.1 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
Feedstock Supply

- 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: 4.3%
- Energy: 6.4%
- Labor: 5.9%
- 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

Installed Cost ($)

Capacity (millions of gal/yr)

- 30% FFA
- 10% FFA
- <2% FFA
- <0.1% FFA Modular
- 10% 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 without losing 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

Where you find solutions
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
Resources


Available from www.biodieselbasics.com