Background on Biodiesel

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Outline

- What is biodiesel?
- Where does it come from?
- Advantages and disadvantages
- How much does it cost?
- Summary

What is biodiesel?

- Definition:
  - Biodiesel consists of the alkyl monoesters of fatty acids derived from vegetable oils or animal fats.
  - Must meet ASTM D 6751

- Soydiesel is biodiesel made from soybean oil
- Methyl soyate = soydiesel = soy methyl esters

The biodiesel reaction

- Produced by a chemical reaction between methanol (or ethanol) and an oil or fat.
- 100 lb Soybean or canola oil + 10 lb methanol

  ➔100 lb biodiesel + 10 lb glycerin

- Requires a catalyst (such as caustic soda)
- Producers add extra alcohol to drive the reaction to completion (sometimes 100% more)

Biodiesel: What is it not?

- **Unprocessed vegetable oil.** Vegetable oil can be used in some diesel engines (especially if heated) but tends to cause performance to deteriorate over time.
- **Mixtures or emulsions of vegetable oil and alcohol.** Major advances have been made in alleviating concerns about cetane number and lubricity. Flash point is still the primary obstacle.
- **Other products** produced by thermal processing of biomass such as thermal depolymerization or pyrolysis oils

Applications of biodiesel

- As a neat fuel (B100). 100% biodiesel qualifies as an alternative fuel for fleet alternatively fueled vehicle mandates.
- As a medium-level blend (B20-B50). Blends can be used to meet Energy Policy Act mandates (B20 essentially = 1/5 vehicle). Qualifies for federal tax credit of $0.01 per % of biodiesel.
- As a low-level blend (1% - 2%). Small amounts of biodiesel can restore lubricity to low-sulfur fuels. Minnesota required 2% in 2005.

University of Idaho Test Vehicles

Currently operating on 100% mustard ethyl esters

Advantages of Biodiesel

- Biodegradable, nontoxic, renewable
- Very favorable energy balance, 3.2 to 1.
- Lower emissions (Example: DDC Series 50)
  - Carbon monoxide: 38% lower
  - Unburned HC: 83% lower
  - Oxides of Nitrogen: 12.7% higher
  - Particulates: 52% lower
  - Smoke and odor are much better

Advantages of Biodiesel

- Requires no engine modifications (except replacing some fuel lines on older engines).
- Can be blended in any proportion with petroleum diesel fuel.
- High cetane number and excellent lubricity.
- Very high flashpoint (>300°F)
- Can be made from waste restaurant oils and animal fats.

Disadvantages of biodiesel

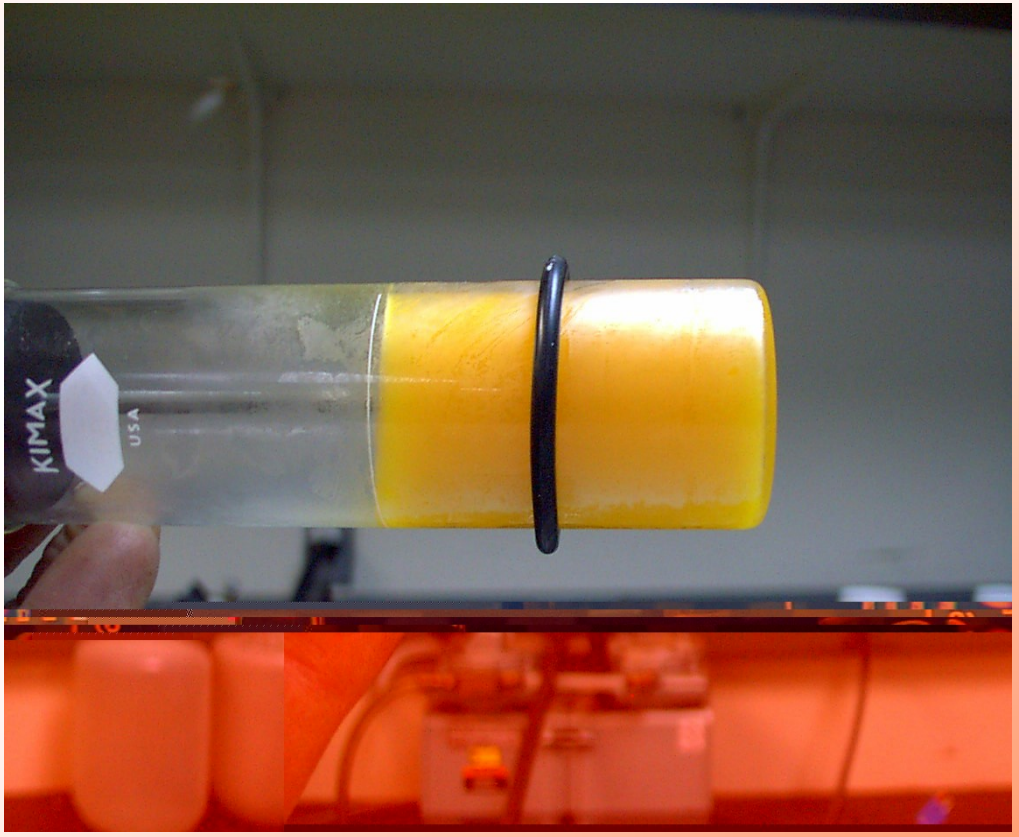
- 11% oxygen in biodiesel helps reduce soot but does not contribute energy.
- Biodiesel has lower energy content

	Btu/lb	Btu/gal
No. 2 Diesel	18,300	129,050
Biodiesel	16,000	118,170
	(12.5% less)	(8% less)

- Since diesel engines will inject equal volumes of fuel, power will drop 8%.

Disadvantages of biodiesel

- Soybean oil-based biodiesel will start to crystallize at around 0°C. This can be mitigated by blending with diesel fuel or with additives.



Disadvantages of biodiesel

- Biodiesel is less oxidatively stable than petroleum diesel fuel. Old fuel can become acidic and form sediments and varnish. Additives can prevent this.
- Biodiesel can cause filter plugging (at low temps, due to polymers, fuel tank deposits, other contaminants). Frequent filtering can keep fuel clean.
- Cost and feedstock supply are problems. Soybean oil is widely available but expensive. Inedible animal fats and waste greases are inexpensive but have limited supply.

Cost of Biodiesel

- Cost is very feedstock sensitive (first-use oils such as soybean are more expensive than recycled oils).
- Production cost is cost of oil + processing cost. Processing cost is generally estimated to be $0.20 - $0.50/gallon.
- Current subsidies:
  - CCC program (buys feedstock for 1st year, 50% in 2nd year, 30% in 3rd year, 15% in 4th year)
  - Federal tax credit ($1./gallon of biodiesel)
  - Small producer credit ($0.10/gallon if less than 15 million gallons)
- Current price: $2.30 -$3.00/gallon depending on location and how much of the subsidy is passed on to the consumer.

Summary

- Biodiesel is an alternative fuel for diesel engines that can be produced from renewable materials.
- Biodiesel can be used neat, as a blend such as B20, or as a low-level lubricity additive.
- Biodiesel's advantages include lower black smoke and particulate emissions.
- Biodiesel's disadvantages include higher cost and lower energy content per gallon.