



BEST
ENERGIES

ESSENTIAL TECHNOLOGIES POWERING BIOFUELS

Biodiesel Primer

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What is Biodiesel?

- **Natural-sourced substitute for petroleum-sourced diesel fuel. Similar fuel value, volatility, viscosity, etc.**
- **Natural oils cannot be used directly without significant engine modification. Glycerin causes carbon deposits, the oil will freeze in winter, the viscosity is too high, and the volatility is too low.**
- **Used frying oil has lots of animal fats and solids from the frying, and the long time at heat results in high free fatty acids which make biodiesel chemistry difficult.**
- **Currently most biodiesel is burned in 2% to 10% mixtures in petro-diesel. Biodiesel has about 93% of the energy in petro diesel (gallon basis), but some users report higher MPG's.**

Chemistry

- **Vegetable oils are made of “triglycerides”, long carbon chain fatty acids which are esterified to glycerin. There are three free fatty acids attached to each glycerin, sort of looking like an E with very long horizontals.**
- **We add three molecules of methanol and a trace of a catalyst and get three molecules of biodiesel and a molecule of glycerin.**
- **The glycerin decants out as a byproduct, and we strip off the surplus methanol and recycle it back to the reactor. The biodiesel is washed and dried, and it is ready for use.**

Recipe

Ingredient	Lb per Lb Biodiesel	Gal per Gal Biodiesel
Refined Soy Oil	1.018	0.974
Methanol	0.090	0.101
Glycerin Byproduct	0.135	0.166

Notes:

- Methanol based on 1% loss in the glycerin
- Glycerin includes some water and other residues.

Biodiesel History and Forecast

- 2004 production capacity was 100 million gallons, most plants less than 10 million gallons/year. **Production was only 25 million gallons.**
- 2006 capacity about 800 million gallons capacity, **production was 200 to 250 million gallons.**
- 55 new and expanded plants have been announced (not all will be built). Total increase is 1200 million gallons.
- National Diesel Board has goal to produce 2 billion gallons by 2015. If the stated capacity of existing plants is true and if all the announced plans are realized, will reach this goal in 2008. This target is 5% of on-road diesel market.

Feedstocks

- **Almost all biodiesel is being produced from refined soybean oil. Some plants use canola, some import palm oil from outside the USA.**
- **For all of the hype, little used cooking oil is converted to biodiesel.**
- **There are huge supplies of animal fats (tallow and other), at attractive prices.**
- **Free fatty acids (FFA) is a major problem. The simple process for triglycerides does not work for the FFA, but technology does exist to use these low-cost fats.**
- **Imported tropical oils cannot be used in winter weather in the USA—saturated oils freeze.**

Soybean Requirements

Biodiesel Plant Size Million gal/yr	Required soybean supply-- bushels/yr	
	22% oil recovered from beans	15% oil recovered from beans
2	1.1 million	1.7 million
10	5.7 million	8.3 million
30	17 million	25 million
100	57 million	83 million

Soybean Oil as Feedstock

Note: I am not an expert, but this is what I hear and surmise.

- **In the past, soy meal was in higher demand than the oil. So the refined oil was relatively cheap (23 to 30 cents/lb).**
- **The bean crushing and extraction are very large plants operated by the large agro companies. As oil demand rises, the price will rise. Current refined oil prices are 35 cent/lb.**
- **The current Midwest biodiesel wholesale price of biodiesel is about \$2.80/gal. You cannot make money if your soybean oil costs 35 cents/lb. (Soybean cost is \$2.61/gal biodiesel and methanol, utilities, and return on investment puts you in the hole.)**

Future of Biodiesel

The industry understands the problem and many companies are looking for lower cost feedstock.

The major biodiesel client of MATRIC is considering these options:

- Use crude soybean oil, this reduces the cost by 4 to 5 cents/lb, which puts the plant back in the black ink.
- Pursue new technology to crush and recover the major amount of oil from the soybeans on a small scale with investment per lb about the same as a large plant.
- Move to other oils, especially corn oil recovered from the distillers grain from ethanol plants. 100 million gal ethanol plant = 10 million gallons of corn oil.