Biodiesel, Biomethanol, and Other Biochemicals

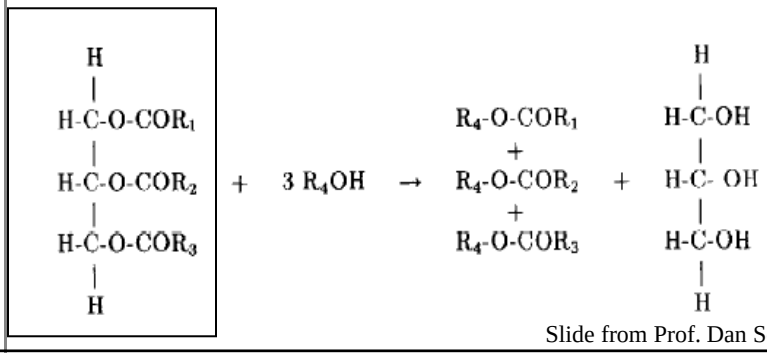
Diesel

- 75% Saturated hydrocarbons
  - Average of C12, ranging from C10 to C15
  - "Saturated": no double bonds; saturated with hydrogens
- 25% aromatics (PAHs, benzenes)

Biodiesel

Triglyceride + alcohol ---> alkyl ester + glycerine

vegetable oil or animal fat | methanol | biodiesel | glycerol



Slide from Prof. Dan Schwartz

Chemical Composition of Vegetable Oils

Chemical composition of vegetable oils[a]

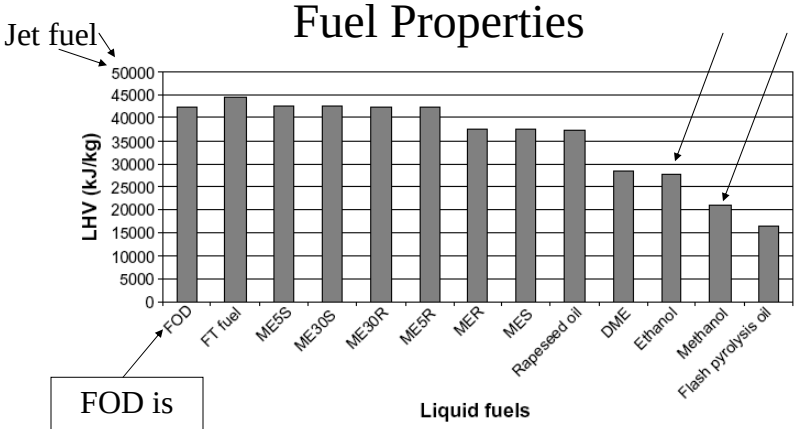
Vegetable oil	Fatty acid composition, wt.%									
	14:0	16:0	18:0	20:0	22:0	24:0	18:1	22:1	18:2	18:3
Corn	0	12	2	Tr	0	0	25	0	6	Tr
Cottonseed	0	28	1	0	0	0	13	0	58	0
Crambe	0	2	1	2	1	1	19	59	9	7
Linseed	0	5	2	0	0	0	20	0	18	55
Peanut	0	11	2	1	2	1	48	0	32	1
Rapeseed	0	3	1	0	0	0	64	0	22	8
Safflower	0	9	2	0	0	0	12	0	78	0
H.O. Safflower	Tr	5	2	Tr	0	0	79	0	13	0
Sesame	0	13	4	0	0	0	53	0	30	0
Soya bean	0	12	3	0	0	0	23	0	55	6
Sunflower	0	6	3	0	0	0	17	0	74	0

[a] Tr = traces.

Palm Oil: 1 (14:0), 45 (16:0), 4 (18:0), 40 (18:1), 10 (18:2)
Diesel: Saturated (avg 12:0); carbon chains of 10-15

A. Srivastava, R. Prasad, *Renewable & Sustainable Energy Rev.* **4** (2000)

Fuel Properties



FOD is diesel fuel

Biodiesel mixes are close to diesel

Fig. 1. Low heating values of liquid fuels.

FOD domestic fuel oil
FT Fuel Fisher–Tropsh fuel
MES sunflower methyl ester
ME5S mixture of 5% sunflower methyl ester in FOD
ME30S mixture of 30% sunflower methyl ester in FOD
MER rapeseed methyl ester
ME5R mixture of 5% rapeseed methyl ester in FOD
ME30R mixture of 30% rapeseed methyl ester in FOD
DME di-methyl ether

Gokalp I, Lebas E, APPLIED THERMAL ENGINEERING 24 (11-12): 1655-1663 AUG 2004

Biodiesel properties depend on which oil is used

Chemical composition of vegetable oils[a]

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Rapeseed	0	3	1	0	0	0	64	0	22	8
Safflower	0	9	2	0	0	0	12	0	78	0
H.O. Safflower	Tr	5	2	Tr	0	0	79	0	13	0
Sesame	0	13	4	0	0	0	53	0	30	0
Soya bean	0	12	3	0	0	0	23	0	55	6
Sunflower	0	6	3	0	0	0	17	0	74	0

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BioFuel Properties: Lower Heating Value

Table IV.A.2.b-1
Fuel economy impacts of biodiesel use

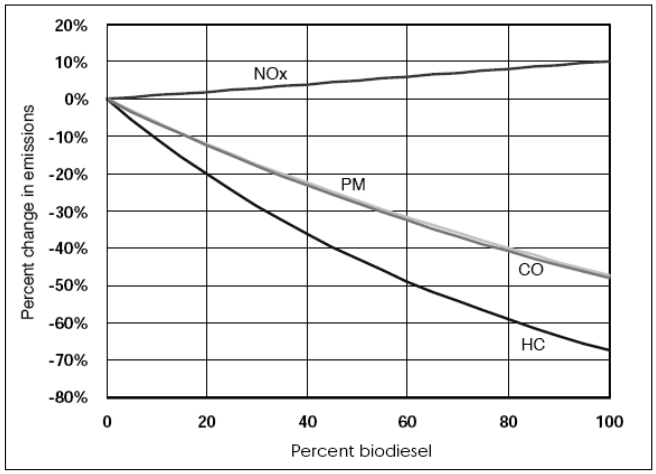
	% reduction in miles/gallon
20% biodiesel	0.9 - 2.1
100% biodiesel	4.6 - 10.6

Because of the lower heating values, biodiesel increases CO_2 emission from engine (but <u>not</u> Life Cycle emissions)
-For the same distance, you need to use more fuel

"A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions," October 2002 (EPA420-P-02-001)

Overall Emissions vs. Average Blend

Figure IV.A.1-1
Basic emission correlations



PM: particulate matter

CO: carbon monoxide

HC: Hydrocarbons