Table 1. Selected Properties of Typical No. 2 Diesel and Biodiesel Fuels.

Fuel Property	Diesel	Biodiesel
Fuel Standard	ASTM D975	ASTM D6751
Lower Heating Value, Btu/gal	~129,050	~118,170
Kinematic Viscosity, @ 40°C	1.3-4.1	4.0-6.0
Specific Gravity kg/l @ 60°F	0.85	0.88
Density, lb/gal @ 15°C	7.079	7.328
Water and Sediment, vol%	0.05 max	0.05 max
Carbon, wt %	87	77
Hydrogen, wt %	13	12
Oxygen, by dif. Wt %	0	11
Sulfur, wt %*	0.05 max	0.0 to 0.0024
Boiling Point, °C	180 to 340	315 to 350
Flash Point, °C	60 to 80	100 to 170
Cloud Point, °C	-15 to 5	-3 to 12
Pour Point, °C	-35 to -15	-15 to 10
Cetane Number	40-55	48-65
Lubricity SLBOCLE, grams	2000-5000	>7,000
Lubricity HFRR, microns	300-600	<300

*Sulfur content for on-road fuel will be lowered to 15 ppm maximum in 2006.

"There are [...] physical or chemical properties where biodiesel is substantially different from petroleum diesel and where these differences provide significant benefits. Biodiesel has significantly lower sulfur than today's diesel fuel, while providing a significant increase in lubricity. Most B100 already meets the EPA's new rule requiring all on-road diesel fuel to contain less than 15 ppm sulfur in 2006. The future 15 ppm diesel—Ultra low sulfur diesel or ULSD—can create lubricity problems as the new refining processes tends to reduce the natural lubricity of diesel. Pure biodiesel, or biodiesel blended with ULSD restores fuel lubricity in levels as low as 1% or 2% biodiesel. Biodiesel also contains 11% oxygen by weight, as well as a slightly higher cetane number, which provides for more complete combustion and a reduction in most emissions."

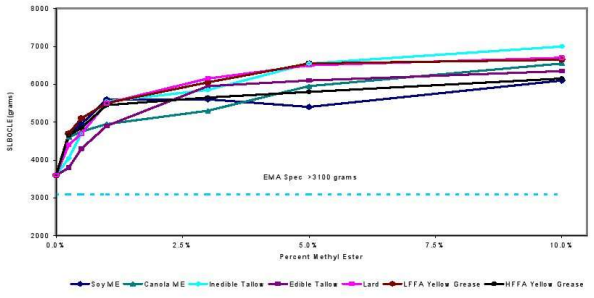


Figure 18. Scuffing Load Ball on Cylinder (SCBOCLE) lubricity data for various biodiesel fuels

"The University of Minnesota Center for Diesel

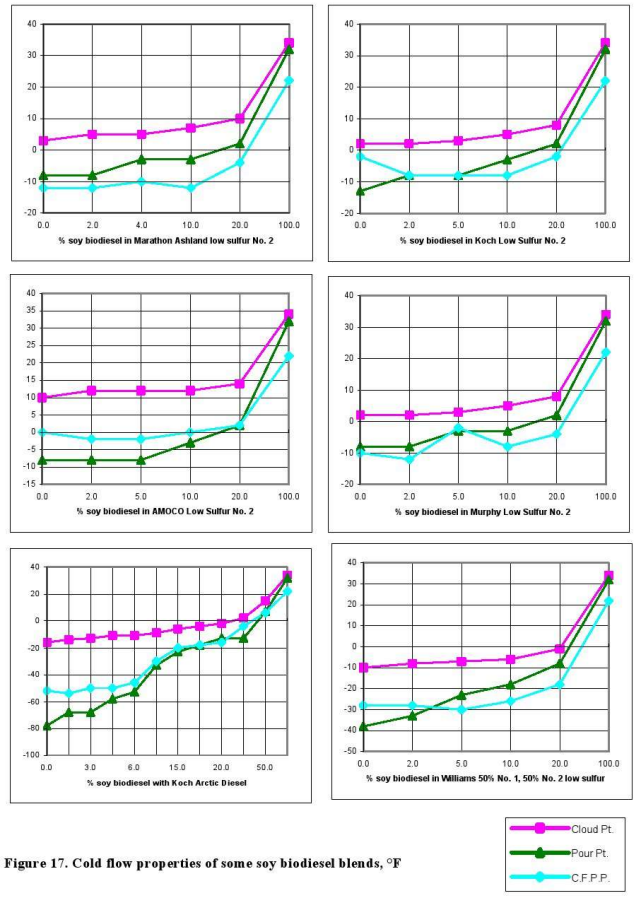
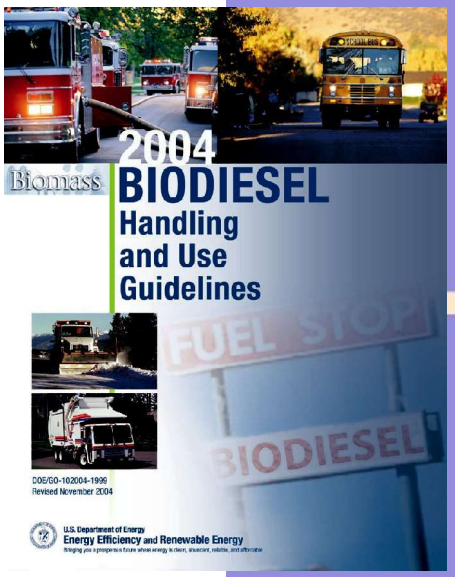


Figure 17. Cold flow properties of some soy biodiesel blends, °F

Research tested soy B20 made with various diesel fuels available in their region. The database of biodiesel blends (0%, 2%, 5%, 10%, 20%, 100%) show how different diesel fuels and soy biodiesel blends alter cold flow properties (cloud, pour, and CFPP). Some of the data are shown on [...] (Figure 17, all in °F)"

Data from National Renewable Energy Laboratory, Advanced Vehicles & Fuels Research, 2004 Biodiesel Handling and Use Guidelines:
http://www.nrel.gov/vehiclesandfuels/npbf/feature_guidelines.html

Arranged in pamphlet form by Riverstones Biodiesel
http://RiverstonesBiodiesel.com/



biodiesel

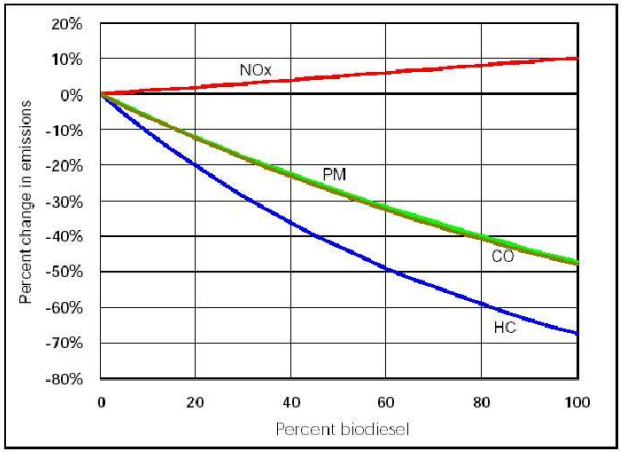


Figure 1. Average emission impacts of biodiesel fuels in CI engines[6]

"The composition of the biodiesel will affect how much NOx biodiesel will produce from a CI engine. [...] Figure 9 [...] shows the percentage increase in NOx from B100 compared to diesel fuel with engines representative of what is on the road today. Some kinds of B100, such as those high in polyunsaturated fatty acids, produce more NOx than B100 high in saturated fatty acids. Of course, highly saturated biodiesel starts to freeze at a higher temperature..."

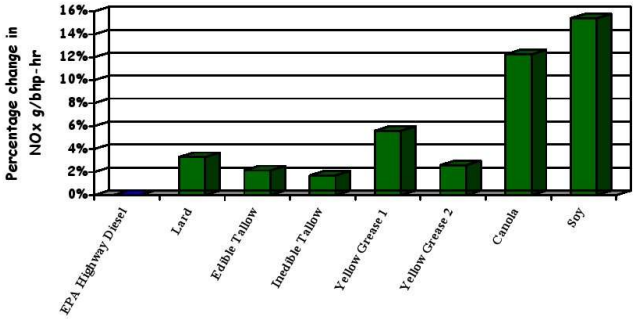


Figure 9. Increase in NOx emissions from CI engines using various B100 fuels

"What makes each of these feedstocks different from the others is that they are made of different proportions of saturated, monounsaturated, and polyunsaturated fatty acids (Figure 2). A "perfect" biodiesel would be made only from monounsaturated fatty acids."

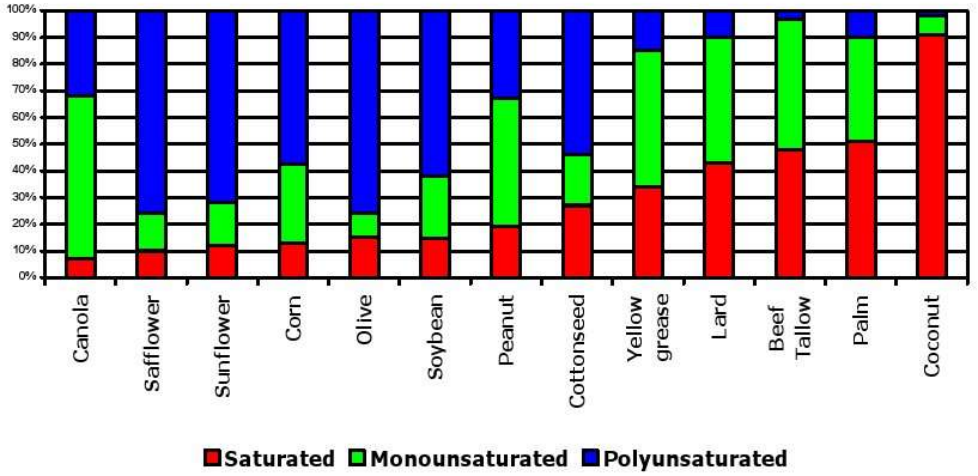


Figure 2. Composition of various biodiesel feedstocks

Table 4. Cold Flow Data for Various B100 Fuels

Test Method	Cloud Point ASTM D2500		Pour Point ASTM D97		Cold Filter Plug Point IP 309	
B100 Fuel	**°F**	**°C**	**°F**	**°C**	**°F**	**°C**
Soy Methyl Ester	38	3	25	-4	28	-2
Canola Methyl Ester	26	-3	25	-4	24	-4
Lard Methyl Ester	56	13	55	13	52	11
Edible Tallow Methyl Ester	66	19	60	16	58	14
Inedible Tallow Methyl Ester	61	16	59	15	50	10
Yellow Grease 1 Methyl Ester	--	--	48	9	52	11
Yellow Grease 2 Methyl Ester	46	8	43	6	34	1

"The cloud point of B100 starts at 30°F to 32°F for most of the vegetable oils that are made up primarily of mono- or poly-unsaturated fatty acid chains and can go as high as 80°F or higher for animal fats or frying oils that are highly saturated. Some examples of the cloud, pour, and cold filter plug point of B100 made from various sources can be found in Table 4. It should be noted that the pour point of B100 is usually only a few degrees lower than the cloud point, so once biodiesel "begins to freeze," gelling can proceed rapidly if the temperature drops only a few degrees further. "