BIODIESEL PROPERTIES

- Emissions

The chemistry of biodiesel emissions, when mixed with conventional diesel fuel was extensively researched. Data was gathered from the engine tests in the USA, the tests made by Volkswagen in Brazil, as well as other tests in Europe. Such information was used to ascertain the chemistry of biodiesel emissions in order to avoid further engine tests.

a) Fuel chemistry.
b) Engine design.
c) Engine performance or cycles.

In short, strict emission test protocols are required to provide accurate and repeatable results. For these reasons, a specific engine test or a single test protocol will not be representative of all biodiesel samples.
- Transient emissions The results found by Southwest Research Institute clearly represent B20 emissions. Southwest Research Institute is a major engine test center in North America. Their results are described below. Test results match research results from other parts of the world. These results include in average over ten different transient emission tests from an engine using USE EPA dynamometers. The average properties of B20 and petrodiesel are also indicated. Unburnt hydrocarbon, carbon monoxide and particulate matter levels are reduced by 15% with B20. - Particulate matter emissions Particulate emissions from conventional diesel engines can be divided into three components. Each component is present in varying degrees depending on fuel properties, engine design and operating parameters.

The first component, and the one most closely related to the visible smoke often associated with diesel exhaust, is the carbonaceous material. This material is in the form of sub-micron sized carbon particles which are formed during the diesel combustion process and is especially prevalent under conditions when the fuel-air ratio is overly rich. This can occur as a result of insufficient combustion air, overfueling or poor in-cylinder fuel-air mixing.

The second component is hydrocarbon or PAH material which is absorbed on the carbon particles. A portion of this material is the result of incomplete combustion of the fuel, and the remainder is derived from the engine lube oil.

Finally, the third particulate component is comprised of sulfates and bound water. The amount of this material is directly related to the fuel sulfur content.

The use of biodiesel decreases the solid carbon fraction of particulate matter, eliminates the sulfate fraction (as there is no sulfur in the fuel), while the soluble, or hydrocarbon, fraction stays the same or is increased. Therefore, biodiesel works well with new technologies such as catalysts (which reduces the soluble fraction of diesel particulate), particulate traps, and exhaust gas recirculation (potentially longer engine life due to less carbon).

Catalytic oxidation converters are used in some diesel engine applications to reduce the soluble particulate fraction even further as well as carbon monoxide and unburnt gas hydrocarbons. As biodiesel reduces the solid carbon portion of particulate emissions, with the soluble organic fraction at the same (or slightly higher) level, the catalysts used for the biodiesel gas emissions have a kinetic effect. Southwest Research data confirmed that the catalyst efficiency increases from 33 to 44% with a B-20 blend.

Biodiesel's particulate reduction has been verified in both lab and field testing completed by the former US Bureau of Mines (USBOM). Lab testing was conducted with a power pack from a Jeffrey 4110 RamCar powered by a Deutz/MWM 6.3 liter naturally aspirated IDI engine with a water scrubber. The test was performed both with and without a prototype diesel oxidation catalyst. Particulate matter reductions of 50% were obtained when using neat biodiesel compared to conventional diesel fuel. The addition of the catalyst reduced the biodiesel SOF by an additional 48%. In this test, the addition of a catalyst to the diesel fueled engine increased DPM due to sulfate aerosol formation.

The USBOM conducted field tests at Homestake Mines in South Dakota and measured both energy specific DPM using ambient air samplers as well as time weighted DPM on samplers attached to the equipment itself. These results demonstrated an energy specific DPM reduction of 75% and a time weighted DPM reduction of 55%. These reductions were greater than that of the laboratory, most likely due to the heavier duty cycle used in the mine compared to that used in the lab testing. Equipment operators also commented on the distinct absence of black smoke upon acceleration when using biodiesel.

-Summary emissions

Harmful particulate matter, visible smoke, unburned hydrocarbons and carbon monoxide levels in exhaust emissions are reduced using B20. NOx emissions remain mostly unchanged.

In addition to the above reduction, B20 also reduces reactivity and the ozone potential of speciated hydrocarbon, thus contributing to environmental protection.

Properties of biodiesel used by Southwest Research Institute

	DIESEL (2-D)	B-20
Cetane number	40/48	48/52
Sulphur (%age)	0,3/0,05	0,02/0,03
Oxygen (%age)	0	2/2,5
Heating value (BTU/LB)	18.500	17.900
Density (G/ML)	0,84/0,865	0,85/0,86