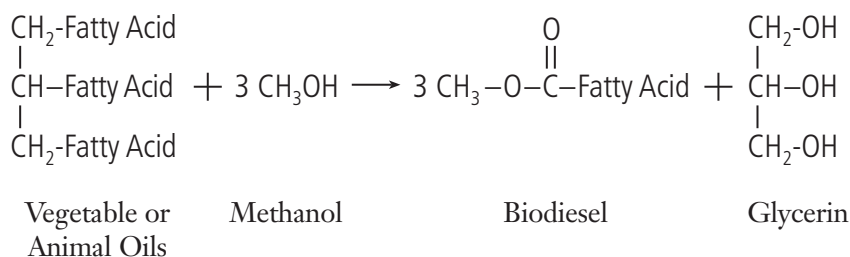




Biodiesel's Need for Antioxidants

What Is Biodiesel?

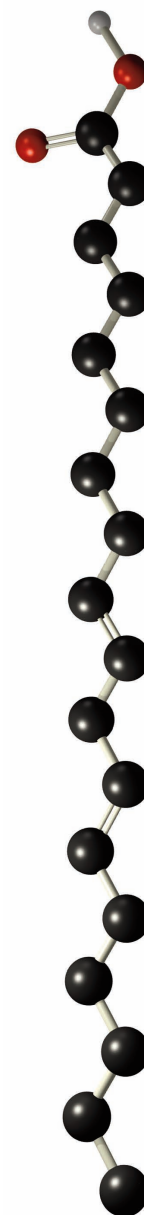
Biodiesel is a renewable fuel derived from vegetable oils and animal fats. It is the product of the transesterification of these fats and oils, where the glycerol backbone of the fat is substituted with methanol to form the fatty acid methyl ester.



The naturally occurring fatty acids contain 16-22 carbon atoms with 0-3 double bonds present along the length of the alkyl chain. The most common fatty acid in soy oil has a chain length of 18 carbons and two double bonds. Its common name is linoleic acid.

The table below gives typical fatty acid content of seed oils that are commonly used in the production of biodiesel. The numbers in the header row indicate the chain length and number of double bonds in the fatty acids. Linoleic acid would be designated as 18:2.

	16:0	18:3	18:2	18:1	18:0	22:1
Corn			59	24	17	
Cottonseed			50	21	25	
Palm	85		2	13		
Rapeseed		7	30	54	7	10
Soybean	9	7	50	26	6	



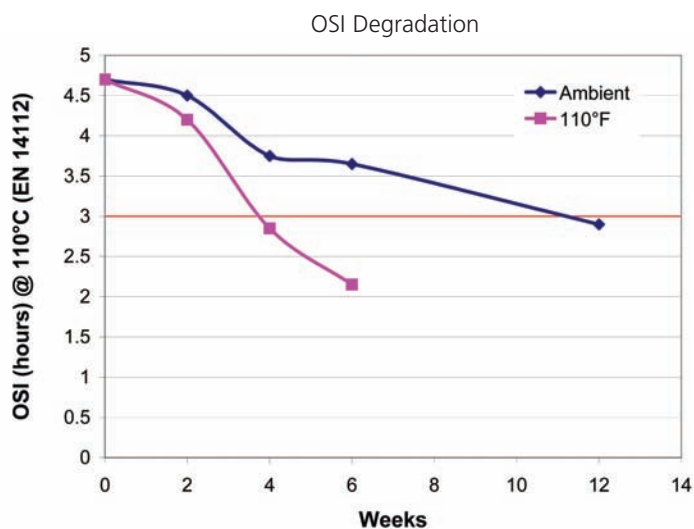
Linoleic Acid

What Is Oxidation?

The processes responsible for oil and butter rancidity also occur with biodiesel. All fatty acids and fatty acid methyl esters are oxidized by a free radical oxidation process. The oxidation process consists of three phases: an initiation phase, in which the free radicals are formed; a propagation phase in which the free radicals react with oxygen to produce peroxides which attack other fat molecules; and a termination phase in which stable decomposition products are formed.

How Is Oxidation Measured?

The biodiesel industry uses the Oil Stability Index (OSI) as a measure of the tendency of biodiesel to undergo oxidation. This test is an accelerated test in which a biodiesel sample is subjected to a flow of air at elevated temperatures (110°C). In Europe, biodiesel is required to have an OSI of at least 6 hours when it reaches the hands of the consumer. An OSI of 9 or so might be needed at the manufacturing source to ensure that the consumer required 6 hours standard is met, as all biodiesel is subject to continued degradation over its lifetime, given air contact. The following graph shows the OSI deterioration over time when a soy biodiesel sample was stored in an unstirred jar at ambient conditions, and at 43°C (110°F) for six weeks. It is likely that agitation or mixing that might be present in a storage tank would further hasten the oxidative process.



How Can You Prevent Oxidation?

Oxidation can not truly be prevented, but the process can be significantly slowed, by use of antioxidants. Antioxidants are compounds which interrupt the oxidation process by preferentially reacting with the fat radical to form a stable radical which does not quickly react with oxygen. Antioxidants serve to stall the propagation phase of the oxidation cycle. Antioxidants cannot “fix” oxidized materials. They are only effective if they are added early in the life of biodiesel. Antioxidants are virtually ineffective in retarding deterioration of biodiesel when added to already oxidized systems.

In addition, certain compounds are found to work with the antioxidant to further retard the oxidation process. The initiation phase of the oxidation process may be catalyzed by metal ions. Chelating agents bind metal ions making them unavailable for catalyzing the initiation phase, thus slowing oxidation process.

How Does *BioExtend* Work?

Eastman’s new antioxidant solution for biodiesel, *BioExtend* 30, is a dual functionality system. It combines one of the most effective antioxidants, with a chelating agent, both of which are known to be effective in vegetable oils, with the biodiesel feedstock. Thus the key mechanisms for the oxidation process, initiation and propagation, are significantly slowed by *BioExtend*. The synergistic effect observed in the inhibition of oxidation is greater than the sum of the two effects alone.

Are All Antioxidants Equal?

While all aim to address the same concern and extend the shelf life of biodiesel they do not perform equally. *Eastman BioExtend* is highly effective at low concentration—making it an ideal choice to meet European standards and the US suggested OSI. Unlike other antioxidants *BioExtend* is a dual system, acting in the initiation phase as well as the propagation phase and, therefore, is highly efficient in slowing down the oxidation process. Furthermore, *BioExtend* comes in a solution so it’s unnecessary to dissolve it. *BioExtend* remains a solution at low temperatures (to -25°F) so there is no need to worry about storage in cooler climates.

Eastman BioExtend

Antioxidant Solutions for Biodiesel

- Outstanding Antioxidative Power
- Superior Results at Low Concentrations
- Increased Performance as a Result of The Dual Antioxidative System
- Excellent Resistance to Low Temperatures

If I Have A Short Delivery Time, Can I Assume No Antioxidant Is Needed?

False. It really depends on the initial OSI of the biodiesel, how quickly the biodiesel is used, the raw material used to make the biodiesel, the storage conditions and even how warm it is outside. All these factors, and others, can affect the oxidation process. The point of use OSI can be very different than the OSI at manufacture. *BioExtend* used in the right amounts will provide the desired protection—and very little might be enough.

How Do I Determine The OSI Of My Biodiesel?

Several independent laboratories can measure the OSI of biodiesel. Large biodiesel producers have their own equipment in-house to make this determination. If you do not have access to the right equipment, Eastman has the capabilities to analyze your samples and recommend the right amount of antioxidant.

How Does Eastman Know So Much About Antioxidants ?

From food to cosmetics markets, Eastman has produced innovative antioxidants for more than 50 years, including a variety of easy-to use solutions. Eastman has leveraged these years of experience and its expertise in our exploration of the biodiesel market. The introduction of *BioExtend* 30 is another example of Eastman's drive to develop innovative antioxidant solutions.



+ outstanding antioxidant
effective chelating agent
superior antioxidative power

Contact Nancy Kinkade at
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nekinkade@eastman.com
to learn more about
Eastman BioExtend antioxidant.

Consider contacting
Eastman for a free evaluation
of the oxidative stability of
your biodiesel.

Visit www.EastmanBioExtend.com for more information.

initiation phase • propagation phase • termination phase





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