How can CLS help you?

Fat quality is a major concern for producers and lipid oxidation is a major cause of decreased fat quality. Antioxidant systems delay the onset of oxidation to maintain optimal fat quality. Customer Laboratory Services (CLS) can assist in your customer's oxidation concerns by:

- Quantifying the level of oxidation in fats, oils, and feed.
- Evaluating the stability of a matrix to assist in choosing the proper antioxidant at the proper application rate.
- Analyzing the amount of residual antioxidant in a matrix.

When quantifying the level of oxidation in fats, oils, and feed, certain primary and secondary products of oxidation can be analyzed. By understanding the process of oxidation, it is possible to measure where in the oxidation process a sample may be.

1. **Initiation** – Unsaturated lipids react with oxygen in the presence of metal ions, heat, light, or enzymes to form peroxides.
2. **Propagation** – Peroxides can act as free radicals and accelerate the breakdown of unsaturated lipids into additional peroxides. Note the rapid increase in peroxide value (Figure 1).
3. **Termination** – Peroxides break down into secondary oxidatives (Figure 1). Note the decrease in peroxide value (PV) and increase in nonvolatile and volatile compounds (secondary oxidatives).

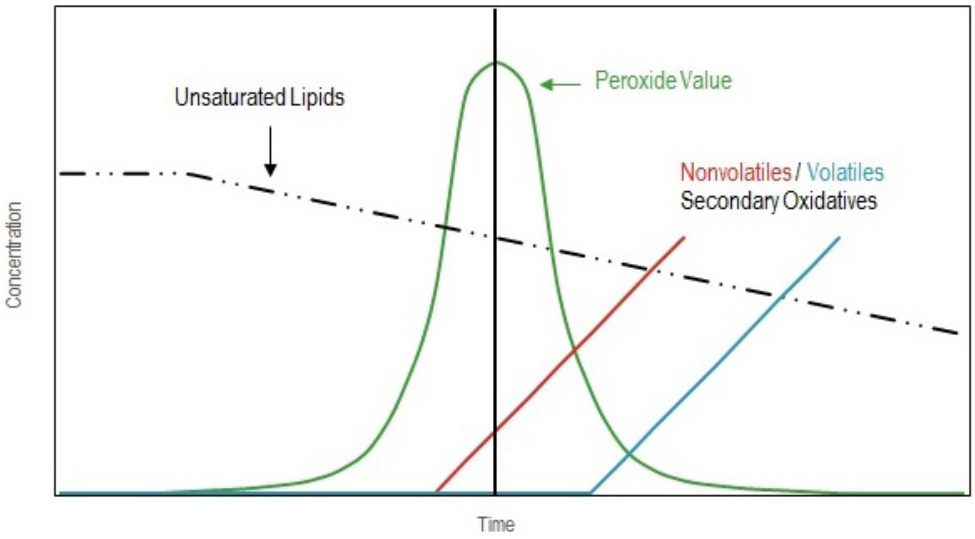

Figure 1. Theoretical image of a lipid oxidation curve showing peroxides and secondary oxidatives. Adapted from Labuza, T.P., 1971.

Evaluating the stability of the matrix can be accomplished using oxygen bomb or oxidative stability index (OSI). These methods analyze the amount of time for oxidation to occur under pro-oxidative conditions. These results can be used to choose the proper antioxidant system at the proper application level.

Identifying the level of antioxidants present allows for the determination of residual antioxidants in the matrix. As antioxidants work, they absorb free radicals and thereby sacrifice themselves to prevent the destruction of unsaturated lipids.

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Test	Sample Collection	Description	General Guidelines
The following tests analyze current oxidative state of the matrix. Please note lipid oxidation is a multi-step process. Indicators of lipid oxidation are produced and consumed during the reaction process as noted in the graph (Figure 1).			
Peroxide Value	Fats/Oil: 50 grams Feed: 100 grams	• Determines the amount of lipid peroxides (primary product of oxidation). • Results are reported as milli-equivalents (meq) of peroxide per kilogram (kg) of fat. *Note: An estimate of fat content for feed samples allows for a better understanding.*	✓ < 5 meq/kg ● 5-10 meq/kg × > 10 meq/kg
Secondary Oxidatives	25 grams	• Determines compounds resulting from oxidation of fat sources. ○ Hexanal and 2, 4-decadienal. • The compounds are volatile, so heat processing of a matrix may cause an underestimation of the extent of oxidation.	Total Value ✓ < 50 ppm × > 50 ppm
The following tests analyze the stability of the matrix under increased pro-oxidative conditions. These tests are best used comparatively.			
Oxygen Bomb	Minimum 500 grams per treatment	• Determines relative stability of a fat or fat containing matrix. ○ Most useful for solid matrices (feed and feed ingredients). • The sample is stressed under heat in a vessel pressurized with oxygen. As oxidation occurs oxygen from the headspace is lost to the oxidation reaction and pressure decreases. This rate of change is directly proportionate to the rate of oxidation. **A longer induction time represents a higher level of stability under test conditions.**	
Oxidative Stability Index (OSI)	Minimum 500 grams per treatment	• Determines relative stability of a fat or oil. ○ Most useful for liquid matrices (fat or oil). • The sample is stressed under heat and air is added to the sample. The conductivity of the sample is measured as it changes due to the volatile organic acids being produced. **A longer induction time represents a higher level of stability under test conditions.**	
The following tests analyze the amount of antioxidant in the matrix. Please note as oxidation progresses, antioxidants are consumed.			
Level of Synthetic Antioxidant	Fats/Oil: 50 grams Feed: 100 grams	• Sample is analyzed for synthetic antioxidants (BHA, BHT, TBHQ, EQ) by gas chromatography. *Note: As oxidation takes place, antioxidants are sacrificed in the matrix.*	

✓ No onset of oxidation

● Onset of oxidation

× Progressed to severe oxidative deterioration

Source: Verleyen, T. 02 Feb 2010. http://www.allaboutfeed.net/Nutrition/Raw-Materials/2010/2/Oxidation-key-issue-in-use-of-oils-and-fats-for-feed-AAF011469W/

Kemin Internal Data