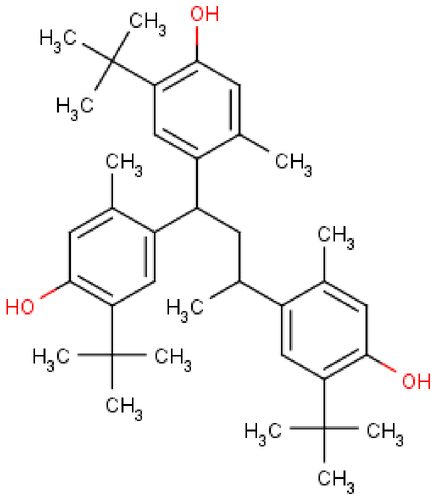
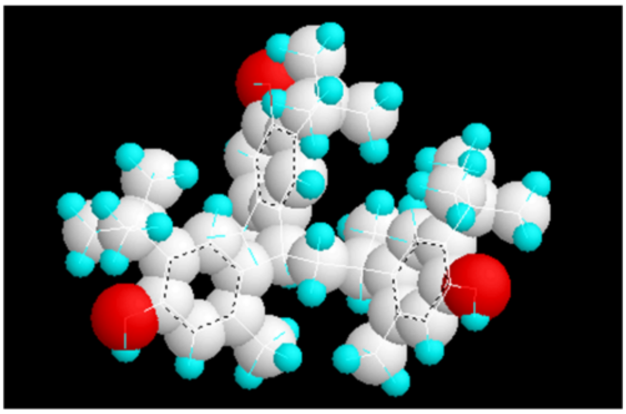
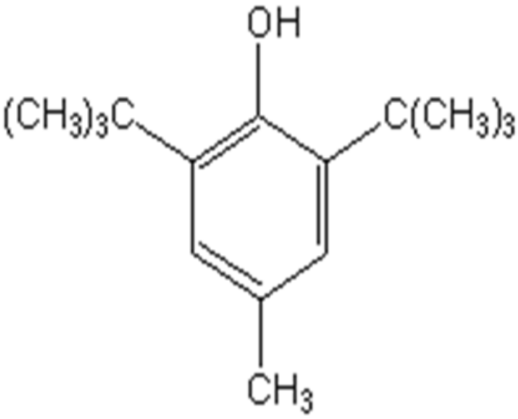
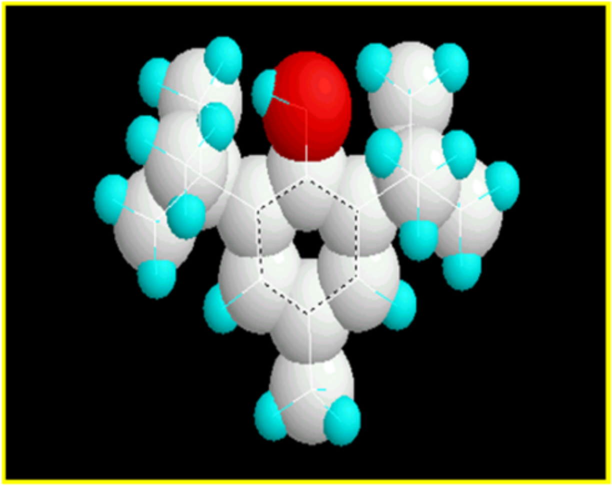
Phenolic Antioxidant Discoloration and Inhibition









1,2,3-Tris (2-methyl-4-hydroxy-5-tertiary butyl phenyl) butane versus BHT.

Historical experience with various phenolic antioxidant chemistries have led to deep rooted paradigms regarding whether one chemistry is better than another based on past experience.

Experience has shown that discoloration by many known staining antioxidants or those antioxidants prone to chromophore transformation during processing, post storage or in end use applications by multiple external sources that kick off the coloration of transformation products on the surface of fabricated plastic parts. In fact, technical brochures that claim non-staining are more prone to discoloration. It’s a matter of interpretation what the term staining truly means in context to overall discoloration.

Two examples of discoloration and inhibition will be review here today. The first is a extremely popular and used primary phenolic antioxidant referenced as 1,2,3-Tris (2-methyl-4-hydroxy-5-tertiary butyl phenyl) butane.

The photo below is a typical example of the types of discoloration observed in polypropylene used for Dupont Typar a spun bonded fabric.

However, the degree of discoloration due to standard transformation during processing and interactions with other components in the polymer was well known until better alternatives came along this was common for the product and tolerated by the customer for many years as normal.

Research into inhibitors for such problems led to many solutions lost over the years to turnover in the industry and lack of proper record keeping at the time prior to computers and proper use of lab notebooks.

Today this phenolic antioxidant is not as commonly used primarily due to new alternatives and a consistent paradigm of what antioxidants should be avoided in the market.

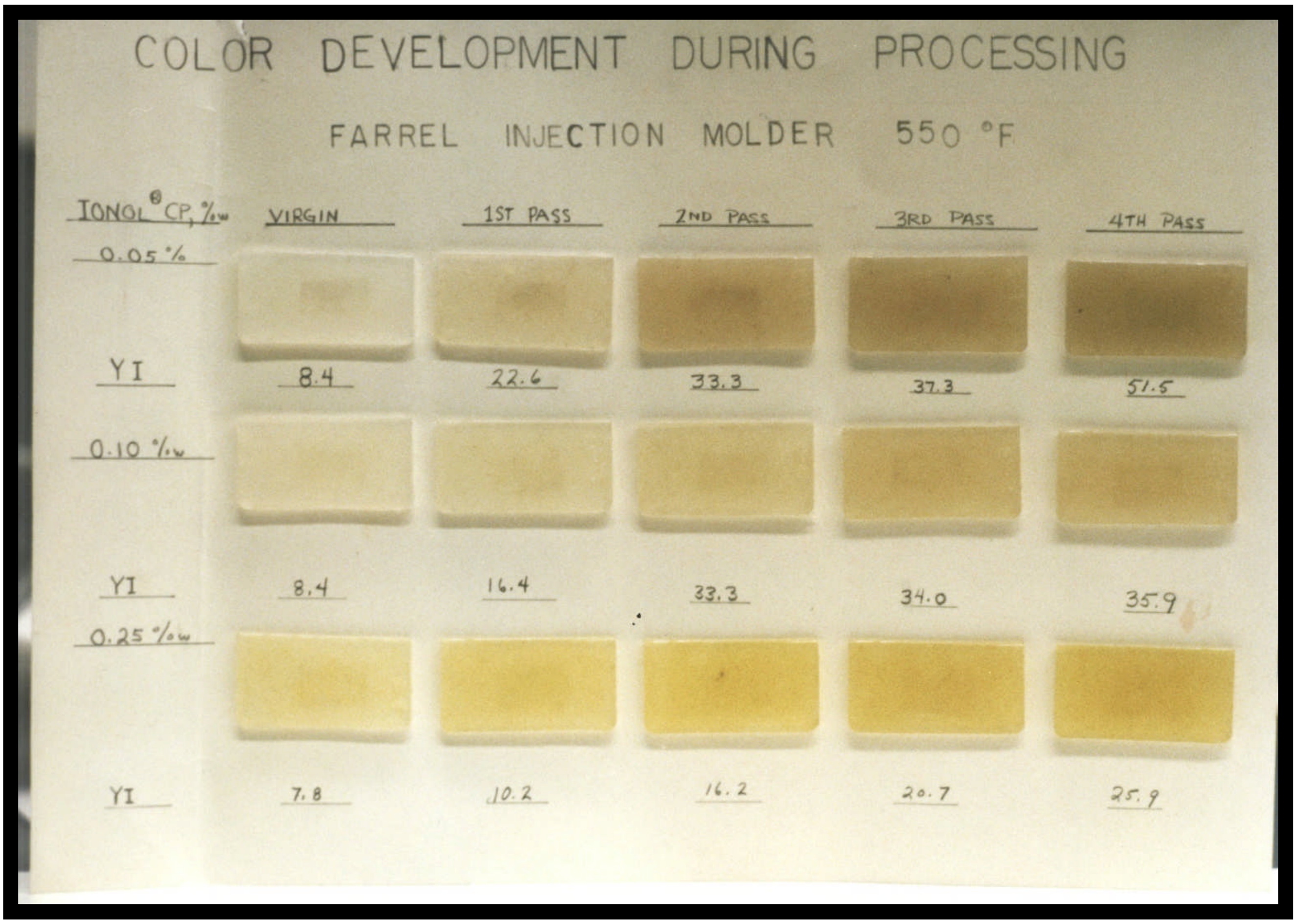
Instead of discoloration of this chemistry we now have an inexpensive inhibitor that readily suppresses the formation of color chromophores.

inhibitor-→

The addition of a small amount of inhibitor totally changes the dynamics and use of the phenolic antioxidant.

In the second example 2,6 di-tertiary butyl phenol a very common processing antioxidant fell to higher molecular weight and more expensive primary antioxidants during a period of change in polymer processing and the desire to limit yellowing. However, once again this was prior to the discovery of how to inhibit this phenolic from ever yellowing during or after processing in storage.

Common examples of discoloration included processing of polyolefins and discoloration.

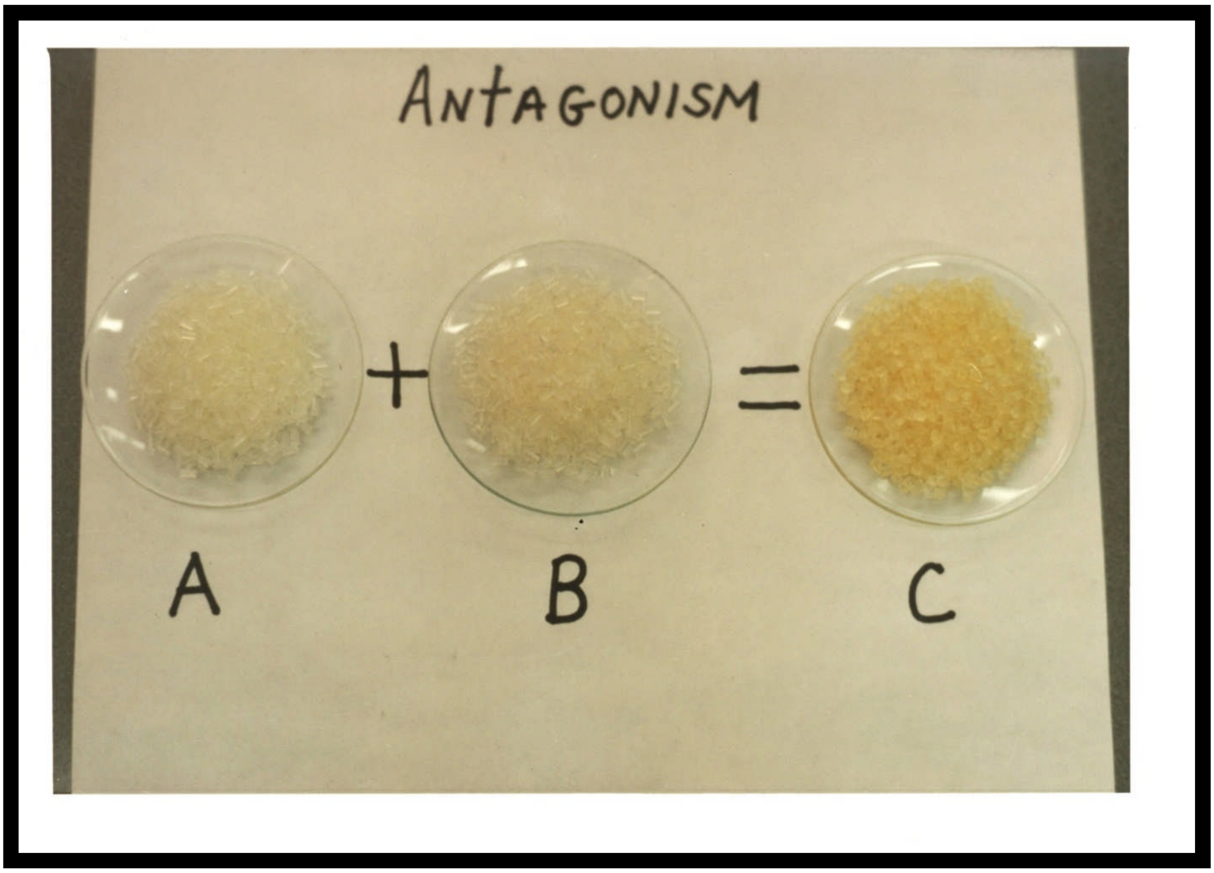


COLOR DEVELOPMENT DURING PROCESSING

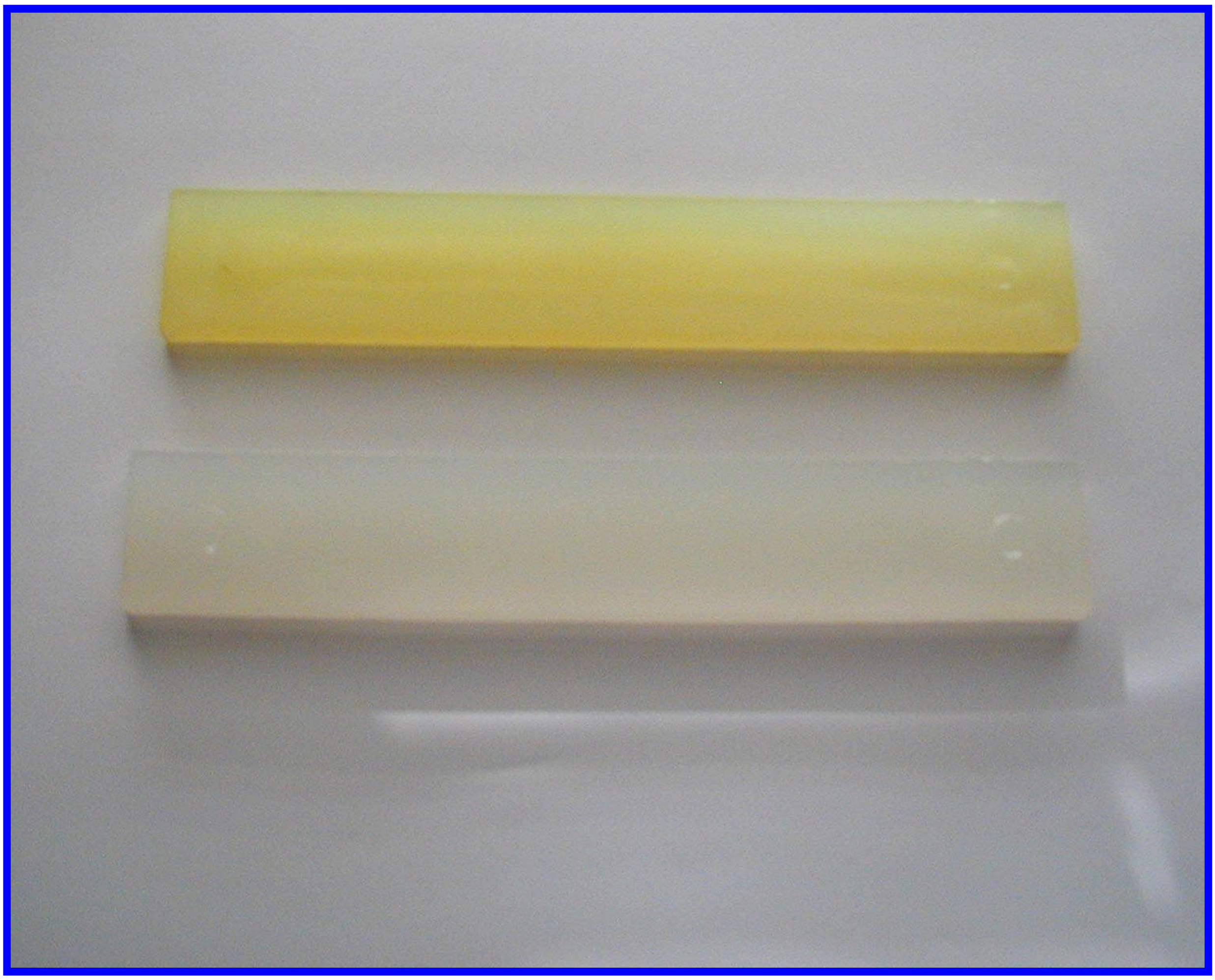
FARREL INJECTION MOLDER 550 °F

IONOL® CP, %w	VIRGIN	1ST PASS	2ND PASS	3RD PASS	4TH PASS
0.05 %					
YI	8.4	22.6	33.3	37.3	51.5
0.10 %w					
YI	8.4	16.4	33.3	34.0	35.9
0.25 %w					
YI	7.8	10.2	16.2	20.7	25.9

Another common form of discoloration was phenolic interactions with other common primary phenolics used today.

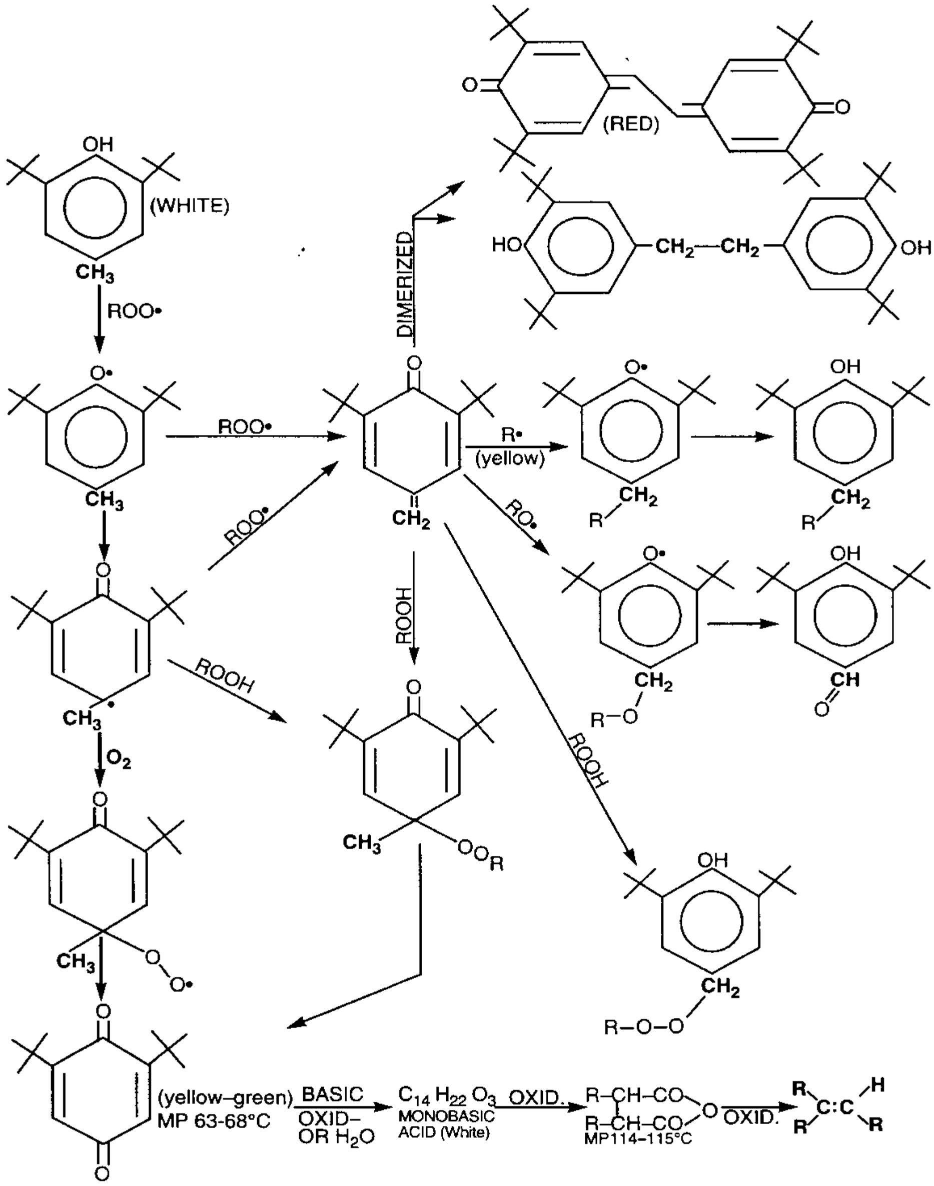


The problem solved by the addition of another inhibitor found that suppresses discoloration initially and long term.



The following photo is the same polymer. Top photo is the antioxidant alone and the bottom photo with the same antioxidant with inhibitor added. This sample is over 25 years old and never discolored in the dark.

Inhibitors interrupt the following mechanism to form alternative intermediate species that are unreactive.



OXIDATIVE DEGRADATION MECHANISM

The mistakes made by vendors who promote acid acceptors or acid buffers with their antioxidants to exploit opportunity rarely understand that in many cases they are creating more problems than they are trying to exploit to sell more additives.

Therefore, one solution rarely works for all phenolic antioxidant chemistries and becomes a case by case resolution for each polymer.

JRW