Stabilization Technologies LLC

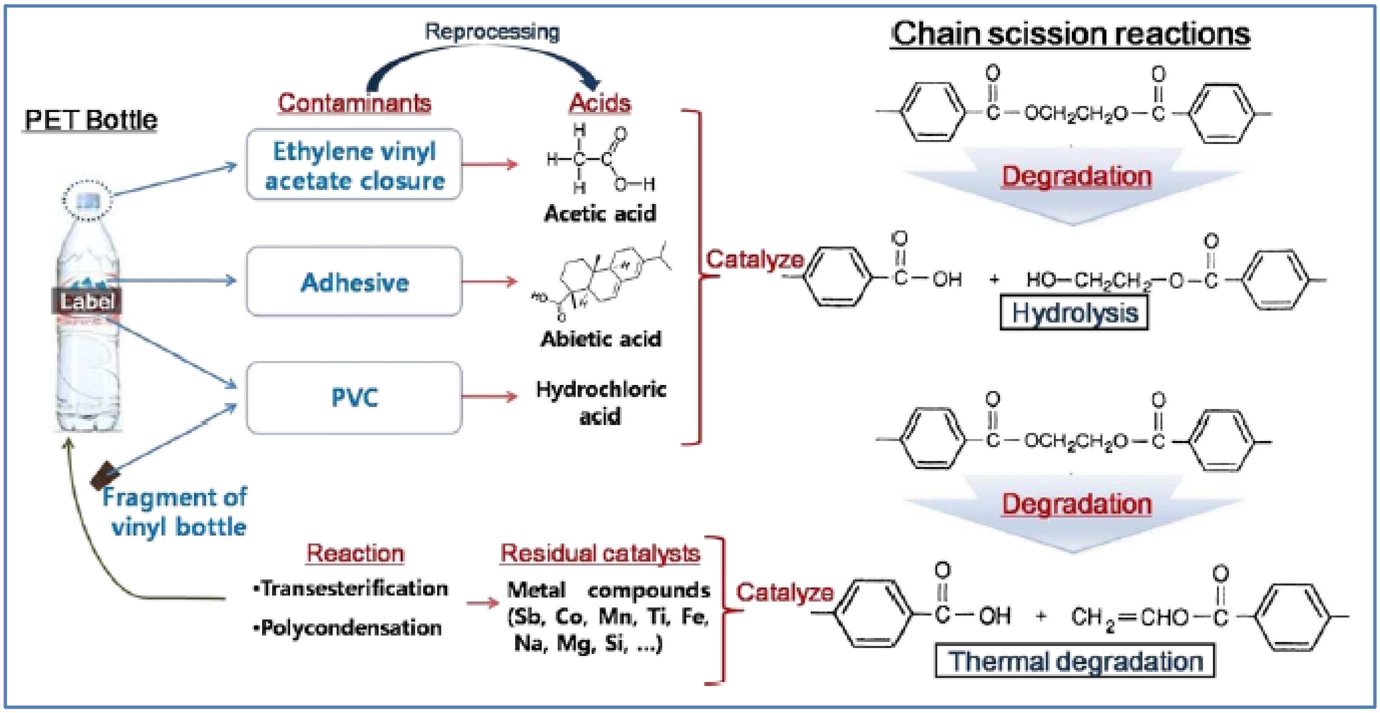
New Cross-Linking Inhibitor for Polyethylene Terephthalate

Poly(ethylene terephthalate) oxidizes on being heated in air at elevated temperatures to form a crosslinked structure. Pigment chemistries, various additives and stabilizers and cross-contamination accelerate the process. The crosslinking occurs through a reaction which causes arylation of terephthalate rings to form a biphenyltricarboxylic acid derivative. This reaction is interpreted as a free-radical cleavage generating a substituted phenyl radical which selectively attaches to a terephthalate residue via substitution.

Recycling only elevates this problem globally.

Besides polyolefin caps made of HDPE, LDPE and Polypropylene and thin polyethylene labels the plastic industry must deal with aluminum caps. Each contaminant creates its own problem with recycled PET. PVC another plastic used in bottle construction just adds to the complex nature of crosslinking of PET.

<u>**Figure 1:**</u>



<u>Koo et.al</u>

Acetaldehyde is a major by-product of PET degradation as is vinyl alcohol and other species. Metal contamination come from various catalysts and include Antimony, Cobalt, Titanium and manganese. Iron traces come from cross contamination from washing with surfactants while magnesium, sodium, silicon and chromium come from both water washing and food sources. Aluminum typically comes from caps and the caustic wash treatment. Typically metals cause discoloration while trace aluminum is a major concern for its <u>delta a (red component)</u> contribution in problems with color matching.

While the subject of recycled PET is complex we will focus on the most common problems facing those recycling companies who rather attempt to remove caps, labels, plastic boots, and caustic wash to dissolve traces of aluminum and ultimately melt extrude treated bottle waste only to experience cross-linking and loss of molecular weight integrity as measured by intrinsic viscosity (I.V).

Major concerns in Latin America were found associated with residual traces of both PVC and Polyolefin causing chain scission and post crosslinking in both fiber spinning and mechanical properties.

At typical processing conditions for PET of 270-310C in fibers trace amounts of PVC undergo dehydrochlorination forming acidic in-situ products that attack the thermoplastic polyester.

Polyethylene trace contamination also crosslinks on its own during high temperature processing and long residence times in a melt pump during fiber spinning and create their own set of problems. However, it has been reported that less than 2% polyolefin cross contamination is far less an issue than PVC contamination at 1%.

While acid neutralizers called acid acceptors are common in polyolefin resins their presence in thermoplastic polyesters like PET can cause problem with chemical interactions and loss of intrinsic viscosity. Therefore, the common approach to a solution for PET was a challenge.

With the advent of new chemistries in the field of molecular recognition and Supramolecular chemistry designing a new molecule with multi-functional properties to address dehydrochlorination while mediating cross-linking and or chain scission was a matter of fine tuning structural dynamics through a total systems approach.

The solution to this problem was not only capable of solving the free acid problem without adverse side reactions with PET but an equally important issue with color matching with both dyes and pigments in PET.

The solution eliminated the red component (Delta a), in color matching of PET fibers and found to reduce the need for color matching from 10-47% with expensive colorants and dyes.

These findings in 2018 have led us to pursue new avenues in the field of pigments and dyes. No longer does the plastic industry need to depend on very expensive pigments and dyes when the alternative factor in changes of base resin functionality can control the high cost of coloration. Therefore, new options are available today that will change the competitive nature for coloring PET at significantly lower cost.

The new product introduced in July 2018 was tested commercially

In Latin America and South East Asia and reports indicate further benefits in productivity and reduction in product loss. As new information is reported we will update this document.