Information Sheet

SUBJECT: DISCOLORATION OF POLYURETHANE FOAM

The color stability of polyurethane foams is affected by UV light, oxidation and temperature. The presence of BHT, a common antioxidant in many plastics, can also affect the color. The color stability of a foam can be improved by using pigments or dyes to mask any discoloration or by using UV absorbers or antioxidants to retard discoloration. The following report describes the various types of discoloration in more detail.

Discoloration from UV light exposure:

Polyurethane foams made with an aromatic isocyanate will yellow if exposed to UV light. The yellowing is caused by an oxidation reaction in the backbone of the polymer. Since it is the polymer itself which is being oxidized, the yellow color cannot be extracted and the foam will ultimately degrade.

In simple terms, polyurethane foams are made by reacting a polyol, an aromatic isocyanate and water. The isocyanate, typically toluene diisocyanate, reacts with the polyol to form the urethane polymer. If an amine forms on one of the isocyanate groups instead of a urethane linkage, this resulting aromatic amine is capable of being oxidized to a quinone. Quinones are yellow and their formation will make the foam appear more and more yellow as the oxidation proceeds over time. Since the quinone structure is part of the backbone of the polymer, the foam will appear discolored before there is any degradation of the foam. Once the oxidation starts breaking chemical bonds, the foam will lose strength. UV light accelerates this oxidation process.

Quinones are only formed from aromatic isocyanates. If an aliphatic isocyanate is used, quinones can not form and the foam will not discolor. Aliphatic isocyanates are difficult to process and expensive. They are rarely used to make flexible polyurethane foam.

Discoloration from oxidation (Gas induced):

Polyurethane foams will discolor if oxidized. Oxides of nitrogen from tow motor emissions, gas fired furnaces or pollution can cause a foam to oxidize and become yellow. This phenomenon may be more observable in the winter when warehouses are closed up and gas furnaces are in operation. Ozone exposure can also oxidize foam and cause discoloration.

Discoloration from heat:

Polyurethane foams can also become discolored from exposure to heat. This can occur during the foaming process or if the foam is exposed to heat in end use.

The foam making process is exothermic, that is, the reaction produces heat. If an elevated temperature is reached and sustained, the foam can scorch in the center. The cooling foam draws oxygen rich air inside and the foam oxidizes. Scorching is more common in the summer than in the winter.

FOAMEX INNOVATIONS

SUBJECT: DISCOLORATION OF POLYURETHANE FOAM (Cont'd)

Discoloration from additives:

Fire retardants can increase the risk of discoloration.

Discoloration from BHT:

Polyurethane foams, carpets, fabrics and other material can exhibit yellowing induced by the presence of butylated hydroxy toluene (BHT). BHT is a commonly used antioxidant in many plastics and foods although its use in the production of polyols for making polyurethane foams is being phased out.

BHT is volatile. It can deposit on the materials, whether or not direct contact exists. Under the right conditions, BHT will oxidize and form yellow chromophores, a colored chemical species. The formation of these chromophores causes the surface of the material containing the BHT to turn a bright yellow.

Reaction with oxides of nitrogen from sources such as air pollution, tow motor emissions, and gas furnaces will convert BHT to the colored form. The reaction is promoted by alkaline conditions and retarded by acidic environments. The formation of the yellow colored chromophores is reversible. The BHT can revert to a colorless form if treated with an acidic rinse such as dilute acetic or citric acid.

Other Facts:

- Ethers discolor faster than esters.
- The higher the density, the faster the UV discoloration occurs.
- There is a difference between UV, gas-caused fading & BHT discoloration.
- UV & gas fading caused by oxidation is permanent.
- BHT discoloration by oxidation can be reversed using acid. Base solutions will further enhance the yellowing.
- Foams discolor before they exhibit physical property loss. Continued exposure to UV & certain gases will ultimately degrade the foam.

FOAMEX INNOVATIONS