

Does Long Term Exposure to Sunlight Degrade Poly Vinyl Chloride



The simple answer is yes! Yet, with proper formulation, the plastic can have a long lifespan in many products exposed to sunlight. Foremost, let us talk about the PVC material! PVC can be formulated from a soft “suede” artificial leather, to a hard plastic used for bowling balls. For example, most people know that PVC is used in vinyl flooring, windows, siding and PVC pipe. Many people are unaware that PVC is also used extensively in tablecloths, electrical wire jacket, hospital IVs and blood bags, food wrap, shower curtains, wallpaper, swimming pool liners, garden hoses, potable water tank liners, vinyl roof membranes, geo-membranes many of those exposed to direct sunlight.

To understand how Ultra Violet protection works, we must analyze the structure of plastics at the molecular level. Simply! The molecules of plastics, PVC included, can be imagined as marbles. Their color or composition cannot be altered without destroying the marble. The PVC molecule is clear, so by adding white Titanium Dioxide marbles, the plastic appears as White. Gray, Tan, or Purple color PVC pipes have an additional colorant mixed with the Titanium Dioxide (TiO₂) to achieve a color which identifies its intended use.

When UV strikes the clear marbles it changes them chemically to a molecule called Polyene (not Polyethylene). The low energy of UV is then blocked by the combination of the Polyene and Titanium Dioxide surface molecules. The resulting reaction occurs only on the exposed surface and to extremely shallow depths of .001 to .003 inches. It is important to understand that the degradation does not continue when exposure to sunlight is blocked or ended.

Titanium Dioxide is the most widely used white pigment because of its brightness and high refractive

index, in which is surpassed only by a few other materials. TiO₂ also has an effective opacity in powder form, where it is used as a pigment to provide whiteness and opacity to products such as paints, papers, foods, and most toothpastes. Titanium Dioxide is used extensively in plastics and other applications not only as a white pigment for opacity, but also for its UV resistant properties. For moderate climates, PVC is generally stabilized to resist UV weathering by using about 4% TiO₂, but PVC for tropical climates needs around 8% for adequate stabilization. This change delivers an important effect on costs and processing of the product. But, using a mild climate PVC mix in a tropic climate can lead to significant and rapid weathering of the plastic.

As the UV reacts with the surface layer of the plastic material, the clear PVC molecules are converted to Polyene, which along with the Titanium Dioxide, is gradually released and may form a surface layer loose enough to be rubbed off. This is responsible for "chalking" of extensively exposed PVC siding, window frames and pipes. Yet, the layer of Polyene and Titanium powder create a protective coating to the material below, much as Aluminum Oxide protects its substrate.

A two-year study by Uni-Bell found that exposure to UV radiation results in a change in the pipe's surface color and a slight reduction in impact strength. Other properties such as tensile strength (pressure rating) and modulus of elasticity (pipe stiffness), are not adversely affected.

Since the ratio of the surface layer thickness to the wall thickness of the pipe is minimal, any reduction in impact resistance is only noticed in thin wall pipes, such as those below Class 200. Surface scratches caused by handling, pulling or plowing pipe during installation can lower impact strength by as much as what is done by UV radiation.