Tech Note: UV Resistance

The UV Light Resistance of plastics involves a number of factors that can affect your material choice.

Of all the factors involved in UV resistance, there are three that figure most prominently; thickness, opacity, and the use of stabilizers. These three factors are combined to defend plastics against Ultraviolet (UV) light.

Ultraviolet (UV) light is the light at shorter wavelengths than visible light, past the violet end of the spectrum (ultra, or beyond violet). There are three categories of UV light, UVA, UVB, and UVC. UVA light is not normally strong enough to harm plastics. UVB usually does the most damage to plastics and is the type of light we need to test when checking plastic's UV resistance. UVC light contains even more damaging energy but it is fortunately filtered out by the earth's ozone layer.

Light degrades plastics by transferring its energy into the plastic. This energy can cause damage by creating heat, or can actually break molecular bonds in a plastic's structure. Both the heat and the breaking of bonds can create a loss of physical properties in the plastic. The higher energy of the UVB rays causes almost all UV damage in plastics. Regular visible light causes almost no degradation even over many years of exposure.

Opaque plastics are plastics that light does not pass through. In an opaque plastic the light has to break down the outer layer before it can break down the inner section of the plastic. The inner layer of plastic can retain its strength much longer the more opaque the plastic. If a plastic is completely black (or another opaque colour) then the light only acts on the surface and much less damage will occur over time.

In a clear plastic film, the UVB light acts on the entire thickness at once, and failure occurs at the same time throughout the thickness of the plastic (clear films degrade rapidly). So our first step is to make plastics that will be exposed as opaque as possible. Most lining materials used for exposed linings are heavily loaded with carbon black or other pigments to make them opaque.

The thickness of the lining material is also a factor in UV resistance. Thicker materials allow the surface to suffer some UV degradation while still retaining the strength in the inner core material. In exposed lining materials a thickness over 40 mil (1.0 mm) is usually recommended for long term UV resistance.

In materials where the strength is provided by a fabric (supported materials) an opaque coating of typically 0.4 mm (15 mils) on each side is required to prevent UV degradation of the fabric's strength.

The UVB light that attacks plastics creates reactive degradation byproducts that can cause a chain reaction of molecule damage that can accelerate the breakdown of the material. UV stabilizers are added to plastics to prevent these degradation byproducts from causing additional damage. UV stabilizers act as "sponges" to soak up these reactive byproducts and to stop the chain reaction before additional damage occurs.

One of the most common questions about geomembranes is, "how long will it last in exposed service?" Each liner material is tested for UV resistance; however each location where a liner is installed has a different UV exposure level. No two locations will get exactly the same amount of sunshine, and most locations do not get the same amount of sunshine from year-to-year. A test performed in Arizona or Florida may not be typical of the service life in your area. This makes it difficult to make general statements about UV resistance of lining materials.

Typical UV tests quote ASTM G53, and state 500 hours or 2000 hours with 70% or 90% strength retained. Some tests will also state that a Xenon arc was used. Unfortunately this is not enough information to make a reasonable correlation to exposed life. There are a number of variations on the UV test methods, and there are many sources of UV light used in the test (Xenon light uses a number of different filters that can change the results). The best source of information is to look at actual exposure data collected from outdoor exposure tests.

There are two main outdoor exposure facilities in North America, one in Florida, and one in Arizona. At each of these facilities they expose plastic materials to the sun for extended periods of time, often with a series of mirrors of magnifying glasses to concentrate the sun onto the sample. The sun's intensity is measured (in Langley's) and a rating is given to the plastic material based on the number of Langley's it receives. Laboratory UV tests, such as ASTM G53 allow us to perform quality control checks on materials without having to perform 5 and 10 year tests outdoors.

On the attached chart is an approximation of what kind of exposed lifetimes can be expected from a number of different lining materials. Each material contains UV stabilizers and has been carefully formulated for the maximum exposed lifetime. Please note that the values given are only approximate. The actual UV resistance of the material you receive may vary considerably and is heavily dependant on the amount of sunshine received at the installation location.

One final note; the lifetime of any material can be increased dramatically by backfilling the liner. (See the Contain Enviro's Tech Note on Backfill). Values shown in the chart are for exposed use only.

Approximate UV Lifetimes	
Material	**Life (approx.)**
Geotextiles	3-5 months
WCPE	5 years
PVC 30	5 years
LLDPE 30 and 40 mil	8years
HAZGARD® 5000	10 years
HDPE 60	20 years

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