Stabilizing Polyolefins Against the Influences of Weathering

Polyolefins used outdoors must be stabilized against the degradative effects of Mother Nature, such as ultraviolet (UV) light, moisture, oxygen, and heat. Proper stabilization is paramount when the polyolefin product is expected to provide durability over months or years of service.

Several types of UV and antioxidant additives can help counteract the effects of outdoor exposure. Recommendations for optimum UV and antioxidant additives can be made provided basic information is made available, including -

- Expected service life, e.g. the product must maintain physical properties for 6 or 12 months in South Florida under constant outdoor exposure.
- Thickness of the film or molded part
- Will the plastic contain pigmentation such as TiO₂ or carbon black,
- Will the part be subjected to chemical exposure, like the harsh agrochemicals used in farming that may react with the additives used to protect the part.

Variations in Weathering

Factors that influence the weather resistance of polymers are:

- Solar radiation (UV)
- Moisture (dew, humidity, rain)
- Heat (surface temperature of the material)
- Pollutants (ozone, acid rain)
- Microbiologic attack
- Salt water

Solar radiation varies with region, season and local atmospheric conditions. Exposure to a tropical climate, e.g. South Florida, can be twice as severe as exposure in a northern climate. This is due to the increase in UV radiation caused by the higher average sun angle and the region's exceptionally moist climate. On the flip side, Arizona and other southwestern locations have very high daily average temperatures, which, when combined with UV radiation, can be very stressful to the plastic.

Seasonal variations such as higher temperature and increased UV radiation can cause summer exposure to be 2 - 7 times more severe than during other seasons of the year. Polymer degradation also occurs from localized atmospheric conditions such as air pollution, salt water, and airborne microbes.
UV Radiation

The energy from sunlight is mainly visible light and infrared. UV radiation makes up less than 5% of sunlight. However, UV light is the main cause of photo degradation of polymeric materials. The solar UV radiation spectrum is divided into three ranges (see table 1), which affect polymers differently.

<table>
<thead>
<tr>
<th>Wavelength Regions of UV</th>
<th>Characteristics</th>
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<tbody>
<tr>
<td>UV-A / 315-400nm</td>
<td>Always present in sunlight; 400nm is the boundary between visible light and ultraviolet light; 315nm begins to cause adverse affects to human skin and some polymers.</td>
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<tr>
<td>UV-B / 290-315nm</td>
<td>Includes the shortest wavelengths at the earth’s surface; responsible for severe polymer damage.</td>
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<tr>
<td>UV-C / 100-290nm</td>
<td>The UV-C boundary is a sharp cut-off of solar radiation at the earth's surface due to complete absorption by ozone, found only in outer space.</td>
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Moisture

In most cases, water is not destructive by itself. However, rain water and dew can cause damage by bringing oxygen into intimate contact with the polymer, thereby accelerating oxidation. In Florida, for example, materials are exposed to rain and dew an average of eight hours per day, or about 2,900 hours per year. In contrast, materials in Arizona are exposed to rain and dew less than 1000 hours per year. Materials are wet from dew or condensation more frequently and for longer durations than from rain. Dew is saturated with oxygen and lies on materials for hours at a time, allowing for permeation and thus oxidation. The severity of attack by rain and dew increases with increasing temperature.
Surface Temperature

Surface temperature is the most variable factor in weather. Pigments are a contributing factor in surface temperature. White pigmented materials typically attain a maximum temperature 10-15 deg. C lower than black-pigmented materials.

Testing for Weatherability

Weather resistance is determined by real-time outdoor testing and accelerated testing

- Outdoor Testing
  Real-time weathering data, from natural environment exposure, remain the standard to which all other weathering data are compared. The two most commonly used harsh aging sites in the United States are Florida and Arizona. Real-time weathering tests expose samples to sunlight at a 45-degree tilt from horizontal. Tests generally are conducted, for 6, 12, 24 and 48 months at several different geographic locations. Sometimes, the real-time tests are modified to include water spray. The test specimens are sprayed with water for four hours preceding sunrise and up to 20 times during the day.

- Accelerated Testing
  There are two common methods for accelerated UV testing of plastic parts. One is the QUV Weatherometer and the other is a Xenon Arc Weatherometer. The QUV simulates the effect of sunlight with fluorescent lamps and it simulates rain and dew with constant humidity. The exposure conditions can be varied. The QUV is a good screening tool. However, the correlation between QUV generated data and actual outdoor exposure data is not good.
The Xenon Arc Weatherometer uses a series of filters to simulate the short-wave UV radiation down to 275nm, which is the most harmful part of the UV spectrum on plastics. Exposure conditions can be varied. The Xenon Arc data correlates fairly well with actual outdoor exposure data. The main disadvantage of a Xenon Arc Weatherometer is the limited number of samples that can be tested at any one time.

**Let Ampacet Work for You**

To simulate your end-use conditions, Ampacet laboratories are equipped with QUV and Xenon Arc weatherometers. Ampacet R&D professionals can subject your samples or prototype parts to simulated exposure conditions and study them for physical property changes using state-of-the-art testing equipment. Ampacet's Technical Service and Development staff will work with you to design or balance additive and pigment systems to meet your technical challenges.

Ampacet offers a wide variety of UV and antioxidant additive masterbatch products in a broad range of carrier resin systems. We can work with you to customize a combination of UV, antioxidant, and pigment to achieve leading edge stabilization performance in your application. Please visit Ampacet's web site for more detail on the entire line of product offerings. In addition, be sure to link into our user-friendly tutorial section for greater insight on additive systems such as Hindered Amine Light Stabilizers (HALS), Antioxidant types, and Ultra Violet Light Absorbers.

Ampacet's knowledge and experience globally allows us to be a leader in environmental stabilization of plastic products. Over the past 10 years, Ampacet has conducted environmental weathering research throughout the world. Products including color mulch films, greenhouse films, silage wrap and drip irrigation tubings have been tested. These products were exposed in areas as diverse as Scandinavia, France, the Middle East, Mexico and Honduras.
Please contact your local sales representative for the appropriate forms to be used to select the best product for your specific outdoor application.

For more information, please contact Ampacet’s technical support team at 888-822-7546 or 812-466-9828.

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