



Assessing the weatherability of plastics compounds

Understanding how to best protect a plastic part from the effects of weathering needs to include an analysis of several important factors. It should take account of the polymer type, colour and additives. An estimation of what the actual exposure will be is also critical – for example, it could be desert-like conditions, humid or rainy weather, or sunlight coming through window-glass. It is also vital to be aware of how the customer defines quality – for example, is it colour, gloss and/or the retention of physical properties?

Added to this complexity are various methods of accelerated testing, including outdoor testing and laboratory testing in a fluorescent-UV or xenon-arc test chamber, which are used to predict how a material will perform under long-term weathering. Suppliers of equipment and materials agree that accelerated laboratory weathering tests are excellent tools for comparing formulations, but they are not quantitative predictors of actual service life. However, long-term research into improving the predictive accuracy of accelerated test methods is leading to increased confidence and reliability in this area.

Weathering test methods typically use conditions specific to an application, such as artificial turf, wood-plastic composite decking, vinyl siding, or automotive coatings. Standards for one application, however, may be borrowed for other areas. For example,

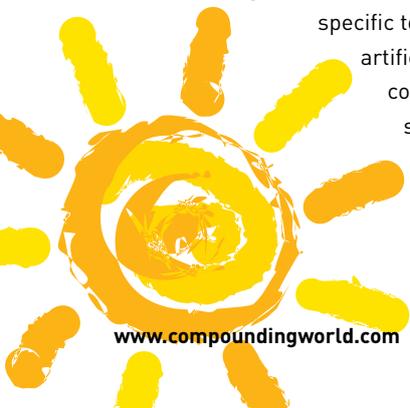
New standards, equipment and testing procedures are improving the reliability of accelerated weather testing. **Jennifer Markarian** reports

a new ASTM standard for the accelerated weathering of automotive coatings (ASTM D7869-13) is seen as relevant for the plastics industry even though it was written for automotive coatings. Tad Finnegan, plastic additives technical manager at **BASF**, which helped develop the standard, explains: "Previous automotive weathering specifications soon spread beyond the transportation industry and coatings industry to become 'general' standards for weathering materials, including plastics".

New ASTM accelerated test

Published last year, ASTM D7869-13, *Standard practice for xenon arc exposure test with enhanced light and water exposure for transportation coatings*, is designed to replace SAE J1960 and SAE J2527. These have been used since the 1980s, but are now seen as deficient in providing meaningful correlation to field results.

D7869, which is seen as a breakthrough in test development, meets the industry goal of better replicating real-world exposure. As an added benefit, the new protocol reduces testing time by 40% over SAE





Q-Lab's outdoor weather testing facility in Florida

J2527, based on the rate of UV deposited, claims Oscar Cordo, standards manager at **Ametek-Atlas Material Testing Technology**.

The ASTM standard is the culmination of 10 years of research, notes Jeffrey Quill, director of technical applications at **Q-Lab**. One of the most significant results of this initial research was a realization of the importance of the effect of moisture on the surface of coatings when trying to replicate exposure in a humid environment such as Florida, which is considered a benchmark environment. Researchers looked carefully at the outdoor environment and tried to replicate it in the lab. For example, researchers found that water spray and high humidity during a test chamber's dark cycle, followed by a dry light-cycle, best replicated the moisture absorption and drying found outdoors in Florida.

Q-Lab's Q-Sun Xe-3 was used in creating the new ASTM standard

The ASTM standard test incorporates the findings of these correlation studies. "This test, for the first time, accurately replicates several key forms of degradation (such as gloss loss, colour change, delamination and photo-oxidation) because the research thoroughly evaluated the importance of all three key weathering variables, namely light, heat and moisture. In the past, researchers thought the light spectrum was the main issue relating to correlation, but we found that accurate re-creation of outdoor moisture is another key component," explains Quill. "The

new test method required the development of a new calibration method to ensure that a minimum amount of moisture consistently reached the samples. Minimum water delivery and verification using this calibration method should be considered for all global weathering standards."

The new method also requires use of a light source with a precise spectral match to meet a tighter definition of daylight. The Atlas Right Light filter and Q-Lab's Daylight F filter meet this new definition. The method requires repositioning of the samples, which previously had been only recommended, and calls for more realistic temperature cycling.

Temperature is one of the crucial variables in testing weathering, in both laboratory and outdoor tests. In the next article in this magazine, the effects of temperature and spectral distribution in outdoor testing of vinyl using Fresnel concentrators are discussed by Henry Hardcastle of Atlas.

"Temperature of the material will affect rates of chemical changes and, ultimately, the actual physical or appearance changes as a result of weathering," explains Matt McGreer, product manager at Atlas. "Knowing the surface temperature of a specimen during exposure can allow for a better understanding of degradation rate and service-life prediction." Atlas offers the S3T (Specific Specimen Surface Temperature) system, which provides real-time temperatures of each sample during exposure.

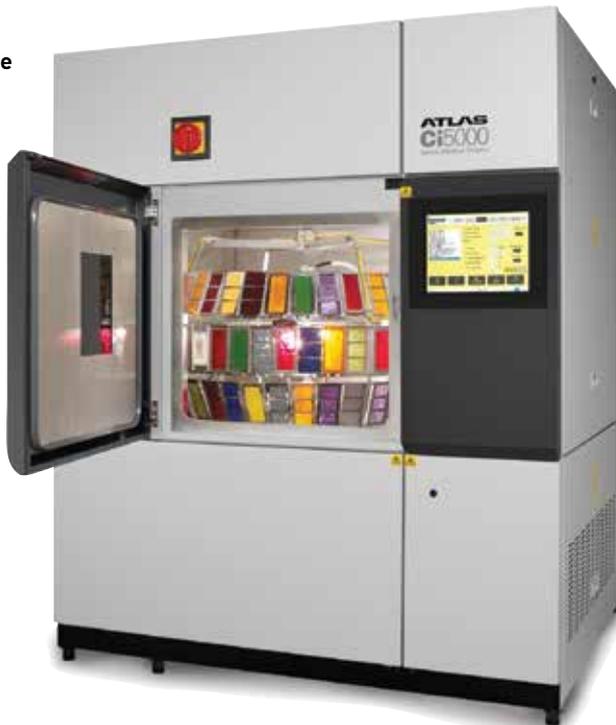
An appendix to the ASTM D7869 method delineates the steps taken to develop the method and provides justification for each test segment. "This text provides a benchmark for future standards development and a template for future research of similar

methods for other industries," notes Cordo. "More importantly, as the background research done to develop this cycle was unprecedented, it now serves as the *de facto* standard justifying the work required to develop adequate test methodology. The work demonstrates that good scientific methodology and an understanding of both material sensitivities and details of the natural environment can be used to develop better artificial test cycles. Ultimately, the intent is to provide faster test results and fewer field failures, both of which will reduce costs in the long run."

"Weathering is not an exact,



The Atlas Ci5000 tests the weatherability of materials to the D7869 standard



quantitative science,” says Quill. “It is, however, predictive and comparative. The new test is a tool that allows accurate prediction of what coating will perform better than another in the field.” Companies, such as Ford and Honda, have adopted the ASTM method into their material specifications, and other companies are considering it. “We have seen an unbelievable response to the new method. After a webinar, we gave away 1,000 copies of the method in just a few hours,” enthuses Quill.

Because D7869 gives better approximations of real-world weathering, it could lead to refinements in polymer stabilization systems, says Finnegan. He notes that another new standard, ASTM D7356-13, which BASF also helped create, simulates the effects of acid rain on automotive clearcoats using xenon-arc weathering devices. “This standard is interesting since many plastics are also exposed to acid rain not only in automotive applications, but other areas as well, such as building roofing membranes,” comments Finnegan. “We know that acid rain negatively impacts light-stabilizer performance in plastics, but haven’t had a standard way of demonstrating this effect. Now we may see this standard being adopted for application areas outside of automotive coatings, and formulations shifting towards less interactive light stabilizer formulas.”

Siding and decking

Weatherability testing is a crucial part of formulation development in building and construction applications, and much work has been done to better understand

how tests apply to specific applications.

The **Vinyl Siding Institute** (VSI), for example, certifies its products based on outdoor weathering studies and uses comparative accelerated weathering as an interim step between required outdoor weathering studies as a check. “We did a number of studies comparing the results of different accelerated cycles with the results of outdoor weathering, and several were promising. But in the end we were not able to achieve a degree of confidence in the correlation between the two that would be needed to certify resistance to colour change based on accelerated weathering,” says Dave Johnston, senior technical director at VSI. “Manufacturers do use accelerated weathering for screening and internal quality control, but we do not yet use it for industry-wide standards.”

Correlating outdoor weathering with accelerated lab testing is particularly difficult for exterior products, such as siding profiles, agrees Chris Piazza, technical development director for plastics at **Americhem**. “Factors such as the freeze/thaw cycle and humidity affect weathering outdoors,” he notes. Americhem is currently compiling data comparing outdoor and lab tests for a range of polymer and colour combinations. “This study will give us a better idea of testing conditions to use to increase the confidence we can have in accelerated testing.” The compounder uses accelerated testing to screen and compare formulations.

Wood-plastic composite (WPC) decking is another application in which weathering is critical. The decking market has evolved to widespread use of coextruded structures, in which the top layer is designed to protect the board from weathering, notes Piazza. The top layer may be a weatherable acrylic, acrylic blend, or heavily stabilized PVC or polyolefin. Americhem introduced its eCap capstock compounds, which can be used with either PVC or polyolefins in such structures. The cap layer also helps prevent “moisture whitening,” in which voids in the deck boards absorb moisture, which then reflects light and appears whiter than other areas.

Weathering of ASA polymers

Acrylonitrile styrene acrylate (ASA) polymers have a reputation for good weathering resistance, but still must be formulated to provide desirable weathering performance. “The appropriately fine-tuned combination of polymer, UV stabilizer, colour, and other additives is what makes an ASA polymer weatherable,” says Steve Blazey, senior technology fellow at **Network Polymers**, now part of **A. Schulman**.

ASA is used as capstock for sheet and profile, such as siding or decking, and also in injection-moulded applications, such as vehicle mirror housings. “Custom-

ers in some applications, such as siding, want actual outdoor weathering tests, but in most applications, customers can't wait years and request accelerated testing," says Blazey.

"In some cases, accelerated testing is more brutal than outdoor testing because it also causes heat aging of the polymer," he adds. "OEMs may have their own specifications that tweak an industry-specified method to be what they believe is more meaningful for their needs. Compounders, therefore, need to know how to formulate to pass a specific accelerated weathering test."

At the recent SPE ANTEC conference, Blazey presented colour-shift results from the accelerated weathering testing of ASA formulations. Network Polymers performed a 12-factorial experiment using four different ASA formulations from high- to low-impact and high- to low-gloss in three colours (white, almond and black).

"The colour shift results varied by ASA formulation, testing method, and colour. Although quantitative colour shift results differed between methods, overall colour shifts were within the overall acceptable limits for ASA.



Outdoor tests are currently underway in Florida and Arizona to further evaluate and compare the QUV and xenon testing colour-change results," reports Blazey.

"Accelerated testing is a good comparative tool for screening formulations, and the designed experiment gave us more insight into how to optimize formulations to pass customer-specified weathering tests. Real-world success, of course, goes beyond passing the accelerated weathering specification, but passing the test is the first hurdle," he concludes. 

The Vinyl Siding Institute certifies its products based on outdoor weathering studies

Synthetic turf has special weathering concerns related to wear and orientation



Synthetic turf

Synthetic turf is an application that has special weathering concerns related to wear and orientation. Late last year, **Americhem** updated its Field and Logo Color Selector guide, a sample book showing how various colours will weather based on 6,000-10,000 hours of accelerated testing. This length of exposure gives more comprehensive data than the FIFA standard, which is 3,000 hours accelerated testing, the company notes.

Americhem's Larry Campbell spoke about the weathering and durability of synthetic turf at AMI's Grass Yarn and Tufters Forum 2014 in February and noted that location of the field (i.e., light exposure, climate) plays a significant role in real-life weathering.

Test standards should match the industry demands for 5 to 10 years outdoor performance, and 9,000-17,000 hours of accelerated testing should be considered depending on the test method and the location and expected life of the field, Campbell said. "Cool colours" that incorporate IR-reflective pigment] are increasingly

used to reduce heat build for reducing expansion/contraction extremes and providing a more comfortable touch. The reflective pigments can also help protect against damaging light to extend product life, adds Piazza.

Longer life for plastics

Enhanced durability is an ongoing opportunity for plastics to grow in various applications as replacements of traditional materials, says Rick King, technical manager for BASF's Plastic Additives business. He highlights the use of TPO in roofing membranes as one example of plastics' success.

"We continue to see end users push for longer service life for plastic articles used outdoors, particularly in the area of building and construction," adds BASF's Finnegan. "This push is driven largely by two key factors: differentiation and sustainability. Manufacturers who can offer their customers extended warranties on their products, backed by performance data, are differentiated from their competitors and have an edge in the marketplace. And in many cases, plastics become more ecologically and economically attractive over traditional materials with relatively small increases in their lifespan. We've seen this with artificial turf, where improving the field life by 10% has a dramatic effect on its sustainability profile relative to natural turf."

The growing understanding of weathering testing, improvements in the predictive accuracy of test methods, and subsequent improvements to plastic formulations can thus be expected to play a significant role in the continuing growth of plastics.

This low-energy house in Nottingham, UK, uses BASF's heat-reflecting pigments to reduce temperatures



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