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March 8, 2004

Mr. Vince Self
Turbo Products Inc.
1 W. Cameron
Kellogg, ID 83837

Dear Vince,

Testing for your Turbo Liner 11is as followed:
The QUV testing with a UV313 bulb, running a cycle of 8 hours of UV exposure and 4 hours *of* condensation. During a 24 hour period, the samples are exposed to 16 hours of UV exposure and 8 hours of condensation. During a 30 day month period, the samples are exposed to 480 hours of UV exposure and 240 hours of condensation. As a comparison, sample in the QUV testing for a period of one month is equivalent to being outdoors for approximately 6 months of outdoor weathering.
We have tested Turbo Liner 11 black film samples in the QUV for 4800 hours of UV exposure, which equals to about 5 years of outdoor weathering,

We have also tested Turbo Liner 11 black film samples in the QUV for 9600 hours of UV exposure, this equals to about 10 years of outdoor weathering.

The results for both time period of exposure show that Turbo Liner 11 film has lost gloss, chalked, and discolored, but did not crack or disintegrate. This result is because of the nature of an aromatic product.

If you have any other concerns or questions, do not hesitate to contact us. Thank you.

Regards,

Deepak Mittal

Deepak Mittal

TECHNICAL BULLETIN LU-0833

Correlation Questions If Answers

A discussion of the most frequently asked questions about accelerated weathering

Q. HOW MANY HOURS IN A QUV WEATHERING. TESTER EQUALS A YEAR OF OUTDOOR EXPOSURE?

This is a simple question, but unfortunately there is no simple answer. It is theoretically impossible to have a single magic number that you can multiply by QUV exposure hours to compute years of outdoor exposure. The problem is not that we just haven't developed the perfect weathering tester yet - no matter how sophisticated or .expensive you make your weathering tester *you* still won't find the magic factor. The biggest problem is the inherent variability and complexity of outdoor exposure situations, the relationship between QUV exposure and outdoor exposure depends on a number of variables including:

1. The geographical latitude of the exposure site (closer to the equator means more UV).
2. Altitude (higher means more UV).
3. Local geographical features such as wind to dry the test samples or the proximity of a body of water to promote dew formation,
4. Random year-to-year variations in the weather, which can cause degradation to vary as much as 2: 1 in successive years at the same location.
5. Seasonal variations 0.8., winter exposure may be only 1/7th as severe as summer exposure),
6. Orientation or the sample (5' South, vs. vertical North).
7. Sample insulation (outdoor samples with insulated backing often degrade 50% faster than un-insulated samples).
8. Operating cycle of the QUV (hours of UV and hours of Condensation.
9. QUV operating temperatures (hotter is faster).
10. The particular material tested

Obviously, it is logically meaningless to talk about. a conversion factor between hours of accelerated weathering and months of outdoor exposure. The one is a constant condition, whereas the other Is v3Jiable. Looking for a conversion factor requires pushing the data beyond the limits of its validity.

In other words: *Weathering* data *is comparative data.*

Nevertheless, you still can get excellent durability data from the OW. But you must realize that the data you get Is *comparative,* data, not absolute data. The most you can ask from laboratory weathering is reliable indications of the 'Illative ranking of a material's durability compared to other materials. In fact, the same thing can be said about Florida exposure tests. Nobody knows how a year on an outdoor "Black Box" exposure at 5' South compares to a year on a house or a car. Even outdoor testing gives you only relative indications of actual service life.

Comparative data, however, can be very powerful. For instance, you might find that a slightly altered formulation has over twice the durability of your standard material. Or you might find that among several suppliers offering what look like identical materials, some fall vet) quickly, most fail in a medium length of time, and a few fail only after prolonged exposure might find that a less expensive formulation has equivalent durability to your standard material which has given acceptable performance over, say 5 years.

Here is a good example of the power of (Comparative data. A coatings manufacturer was developing" new type of clear coating. Initial QUV tests caused Severe cracking In 200 to 4CO hour9--1'Tluch sooner than conventional coatings used for the same purpose. However, after 3 years of continual reformulation and re-testing in the QUV, the coating was Improved 80 that various formulations could withstand 2,000 to 4,000 hours In the OUV - much better than the conventional coatings. Subsequent parallel tests in Florida showed a similar 10:1 increase in durability, yet if the coatings chemists had waited for the Florida. data before changing their formulations, they would today still be back In the early stages of reformulation and the coating wouldn't be the commercial success that It now is,

The World's Most Widely Used Weathering Tester

On the other hand: *If you still insist* Oft a *"Rule of Thumb" conversion factor, find it empirically.*

Despite the impossibility of a universal conversion factor I hundreds of labs have successfully developed their own internal "Rule of Thumb" for converting their QUV hours into outdoor exposure hours. However, it is important to remember that these rules of thumb were developed from empirical comparisons of the lab's own QUV tests with their own outdoor exposures.

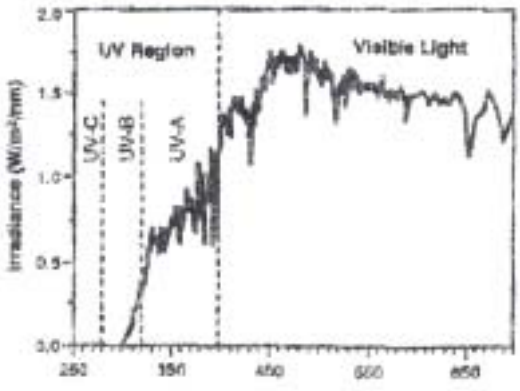
Furthermore, the rule of thumb conversions are valid only for:

1. The specific material tested.
2. The specific set of QUV time cycles and temperature.
3. The specific outdoor exposure site and sample mounting procedure.

If you have outdoor experience with your materials, It shouldn't take more tl1an a few months to develop your own QUV rule of thumb. If you don't have experience with your own materials, it may be possible to work with competitive materials that do have a history of outdoor service.

In addition, it is important to remember: *"Correlation" means -Rank Correlation".*

When someone asks "How does the QUV correlate with outdoors?", what they really should ask IS, 'How well do rankings of materials' durability in the QUV duplicate the rankings of materials outdoors?". To measure rank correlation we recommend Spearman's Rho,a statistical measure which is easy to compute and which does not require the type of strong assumptions about the data that are required by linear correlation measures. A study of QUV and Florida durability rankings of 27 automotive coatings produced rank correlations of up to .89 between QUV rankings and Florida rankings. The rank correlation between different Florida exposures was .8a to .95. In other words, the QUV can reproduce Florida rankings almost as welt as Florida can reproduce Itself.



The Sunlight Spectrum