Flexible Intermediate Bulk Container Association

Ultra-Violet Radiation Exposure to Flexible Intermediate Bulk Containers

Introduction

The purpose of this paper is to educate FIBCA members about the damaging effects of ultra-violet (UV) radiation to polypropylene containers and how to effectively store flexible intermediate bulk containers (FIBC) to minimize UV damage.

History of UV Protection in Polypropylene Fabrics

The first widespread use of woven polypropylene (PP) fabrics was in the cotton bale wrap industry, and much of that industry and its associated packaging was standardized by the government. Early in the FIBC industry, PP fabrics that had UV stabilization utilized a nickel additive for protection; thus, the reason early fabrics were green. Several years later, the first UV stabilizer other than nickel was used in the fabrics. Subsequently, Hindered Amine Light Stabilizers (HALS) were developed, which were far more effective in limiting the photo-degradation caused by UV radiation. The PP fabrics made using HALS inhibitors were able to retain 70% of their tensile strength after 1200 hours exposure in a Xenon Arc Weatherometer, as tested per ASTM D-4355.

Currently, most fabrics used in the FIBC industry are white and have UV additives that provide extended protection against the harmful effects of damaging UV radiation. These fabrics are designed to retain 50% of their tensile strength after 200 hours of UV exposure in a QUV Accelerated Weathering Tester, as tested per the ISO 21898 Standard.

Problem Statement

Polypropylene fabrics without UV additives (blockers or inhibitors) degrade very rapidly when exposed to UV radiation. The most common damage PP fabrics realize as a result of UV radiation is a reduction in the impact and tensile strengths and elongation.

Although PP fabrics used in the FIBC industry today are protected with UV additives, they are still subject to degradation with prolonged exposure to UV radiation. The UV additive level is designed to give short term protection for situations such as when bags are staged near an open shipping door or on a loading dock at port. Some filled bags may be temporarily staged outdoors with no protection, while others may be covered with opaque black tarps. While covering the bags will slow the degradation process, some deterioration will still occur.

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Part 1: Technical Information

FIBCA conducted extensive studies with both indoor accelerated laboratory testing and actual outdoor weathering exposure to determine the correlation between the two. This testing took more than a year to conduct and involved multiple third-party test labs.

Six FIBCA members volunteered to submit fabric samples for testing. All fabric samples were sent to the Executive Director of FIBCA, who cut and labeled the samples and sent them to Q-Labs Test Services for both the indoor accelerated laboratory testing and actual outdoor weathering exposure.

Parameters for fabric samples were:

- 200 GSM
- Uncoated
- White

At the completion of each test duration, samples were returned to the Executive Director, who cut, labeled, and forwarded them to Ten-E for tensile strength testing. Three weft (cross direction) and two warp (machine direction) tests were conducted on each specimen.

Part 2: Indoor Accelerated Laboratory Testing

Indoor accelerated laboratory testing was conducted at Q-Labs Test Services. Fabric samples from each participant were tested using the following parameters:

- Tested in QUV Accelerated Weathering Testers
    - Cycle - 8 hours of UV light using UVB 313 lamps at 0.71 W/m^2 irradiance at 60°C, followed by 4 hours of dark condensation at 50°C.
- Fabric specimens were exposed for 1100 hours, pulling samples at 100, 200, 300, 400, 500, 700, 900, and 1100 hours for tensile strength testing at Ten-E.

Results of this testing exhibited that indoor accelerated laboratory test can be conducted using the parameters above for a 300-hour test that includes 200 hours of UV exposure and 100 hours of condensation.

Part 3: Outdoor Weathering Testing

Q-Labs Test Services also conducted outdoor weathering testing in both Arizona and Florida, where climate conditions are very different. While Arizona has a wider range in seasonal temperatures from day to night and less precipitation, Florida has a more consistent range in temperatures with much more precipitation.

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Fabric samples from each participant were placed on plywood, angled at 45° South, and exposed directly to the environmental elements. Test specimens were pulled at the end of 3, 6, 9, and 12 months for tensile strength testing at Ten-E.

Results of this testing exhibited that most of the fabric specimens performed for six to nine months in actual outdoor weathering exposure.

Part 4: Correlation Results

At the conclusion of both tests, a good correlation was seen between 300 hours of indoor accelerated laboratory testing and six to nine months of actual outdoor weathering exposure.

Part 5: Calcium Carbonate Testing

Samples from each participant were sent to Element Materials Technology for an Ash Content Analysis. The purpose of the Ash Content Analysis is to determine the percentage of inorganic materials, such as calcium carbonate, that are used in a product. The test was conducted at 550°C following the procedure from ASTM D5630. The temperature of the ash is reduced to allow fillers such as calcium carbonate to remain stable.

The percentage of calcium carbonate does appear to affect the tensile strength of fabric, as the specimens with the lowest percentages of calcium carbonate performed the best in both indoor accelerated laboratory testing and actual outdoor weathering exposure.

For additional information see the Calcium Carbonate Additive White Paper in the Resource Center on the FIBCA website.

Conclusion

FIBC fabrics utilize UV additives for protection. The type and quantity of these additives will vary from one fabric manufacturer to another. Therefore, fabrics may perform differently during indoor accelerated laboratory testing and actual outdoor weathering exposure. Additionally, because locations and regions around the world experience a variety of environmental conditions, results from actual outdoor exposure will vary. **Therefore, FIBCA recommends that users do not store FIBCs outside or in areas where they experience prolonged exposure to UV radiation or elements of the environment.**

When performing indoor accelerated weathering testing, the FIBC Association recommends using the following test parameters.

Total Test Duration:	300 hours (200 hours UV exposure with 100 hours dark Condensation exposure)
Cycle:	8 hours at 60°C with UV exposure, alternating with 4 hours at 50°C with condensation.
Lamp:	UV-B 313
Irradiance Level:	0.71 W/m^2