IN•TOUCH

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Tests Of Foam Performance, Part 1: Laboratory Methods

This issue of IN•TOUCH® provides an overview of the laboratory testing methods used to quantify physical properties (i.e., density, IFD, etc.) and to gauge the performance of flexible polyurethane foam (FPF). Laboratory testing of flexible foam performance properties provides important information for flexible polyurethane foam producers and end-users.

Physical tests on statistically selected production samples help foam producers maintain quality control in the production process. Physical test results are also used to grade foam to customer specifications.

Laboratory testing has evolved with industry participation and contributions to standard test methods.

Accurate testing requires both good testing equipment and accurately sized and prepared flexible polyurethane foam samples.

Common Foam Testing Methods

In the last 20 years, there has been significant work done to standardized foam testing methods and to provide the FPF value chain with consistent ways to evaluate foam.

A variety of performance test methods exist for FPF. The most commonly used of these is ASTM International's *D3574, Standard Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams*. Originally published in the 1970s, ASTM D3574 has been reviewed and updated multiple times over the years, and is considered the framework around which foam testing and evaluation is built.

In addition, there are a number of other ASTM standards for specific foam properties that supplement ASTM D3574, and there are also test methods required by specific industries (automotive, for example).

And work continues within the FPF industry and with standardized testing organizations to refine testing and evaluation the many performance properties of flexible polyurethane foam. PFA and its members routinely participate in discussions with testing organizations to provide information to standards bodies and to review any proposed changes.

ASTM D3574

ASTM D3574 has procedures for evaluating a number of foam properties. These include:

Density. Density is a measurement of the mass per unit volume. Measured and expressed in pounds per cubic foot (pcf) or kilograms per cubic meter (kg/m3), density is one of the most important of all foam properties. Density affects foam durability and support. Typically, the higher the polymer density, the better the foam will perform. Density can be measured by hand measurement and weighing or laser assisted. Precise weight and dimensions are imperative in determining density, usually with an accepted variance of 0.05± pcf.

IFD (Indentation force deflection). This is a measurement of firmness. It is calculated by measuring the force needed to indent a platen 50 square inches in size to a specified deflection into the foam block. The force is measured after one minute of dwell. IFD measurements are typically reported at 25% and 65%,

CFD (Compression force deflection). CFD is a measurement of the stress needed to fully compress the foam block to a specified deflection. It is similar to IFD, but IFD is thickness dependent, while CFD is independent of thickness. CFD is typically used on thin profile foam samples, such as carpet cushion.

Compression Set. To evaluate foam durability, samples are compressed between metal plates to 50%, 75% or 90% of their thickness at specified conditions for 22 hours. This can be done under ambient, wet, humid, and/or heat aged conditions, depending on the intended application. After removal, samples are allowed to recover for 30 minutes, and measured to see how much of their original height is recovered. Sample size is typically 2" x 2" by 1".

Tensile Strength And Elongation. Tensile is the stress required to pull the foam apart. Elongation is a measure of how much the foam stretches. These measurements help determine foam durability, especially in applications where the foam is stretched or pulled.

Tear Strength. This is the force required to propagate a tear, divided by the sample thickness. This factor can be used to evaluate durability in certain applications.

Air Flow measures the openness or the porosity of the foam. This property has a significant impact on performance properties such as compression sets, fatigue and flammability.

Resilience. This is measured by dropping a steel ball and visually measuring the rebound height. Automated testing equipment takes highly accurate measurements rather than relying on human testers who visually observe rebound. Higher resilience means better comfort and durability.

Fatigue Tests (Static And Dynamic: Pounding, Roller Shear, Caster) These tests evaluate durability. In static testing, large samples are compressed 75% and held for 22 hours. After a 30 minutes of recovery, thickness and IFD loss are measured.

For dynamic testing such as pounding, a foam sample is loaded with a 10" indenter weighing 168 pounds at 70 cycles/minute for a total of 80,000 times. After one hour, loss of thickness and IFD are measured.

In roller shear, an 18" offset roller with a 30-pound load rolls 20,000 times over the foam sample at 60 cycles/minute. After one hour, loss of thickness and IFD are measured.

Caster testing is typically done for carpet cushion. A 6" diameter, 6" wide rubber roller with a 60 pound load is run 40,000 cycles over the foam at 60 cycles/min. After the test, the sample is measured to determine loss of thickness and how much of its original CFD is retained.

Steam Autoclave and Heat Aging (Dry and Wet) Environmental conditions can affect foam performance. Testing samples in dry and wet heat conditions can determine how well they hold up in mattress or carpet cushion applications. Typical properties evaluated are CFD and Compression Set.

Recovery Test measures the recovery time of viscoelastic foams. Using the standard IFD setup, the sample is rapidly indented 75% and held for one minute. Rapidly releasing the loading, the foam is timed for recovery.

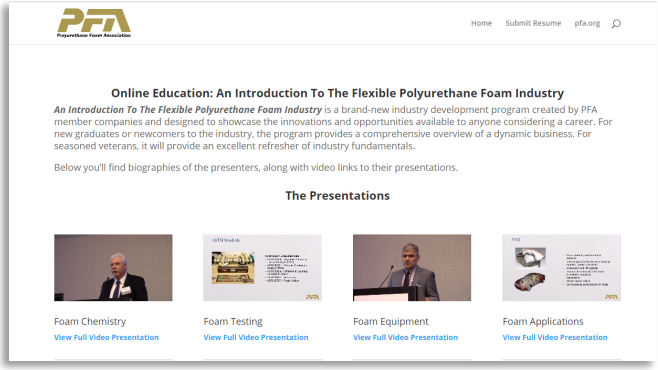
Creep Test measures the change in thickness as a function of time at a constant loading weight. This is particularly important for packaging and viscoelastic foams.

Other ASTM Test Methods

There are 18 other ASTM test procedures to evaluate FPF performance, covering topics including abrasion, vibration, sound dampening, and other factors that can be important in specific applications. Some examples:

- ASTM D624 Graves Tear Test (force required to initiate a tear divided by the sample thickness
- ASTM D737 Frazier Air Flow (measures air flow in low permeability foams)
- ASTM D257 Surface and Volume Resistivity (measures anti-static or conductive properties of foam)
- ASTM E1050 Sound Absorption Measurement

Additional ASTM tests are outlined in PFA's video series, *An Introduction To Flexible Polyurethane Foam,* that cover



testing methods in greater detail, along with foam chemistry, foam production equipment, and foam applications. Videos are free and are available online at www.pfa.org/training.

Flammability Testing

In addition, there are a number of flammability tests that must be passed for products containing foam, such as furniture, mattresses, motor vehicles and aircraft. These include:

- Consumer Products Safety Commission 16 CFR Part 1640 Safer Occupancy Furniture Flammability Act (SOFFA), the National Standard For Upholstered Furniture Flammability (based on the California Technical Bulletin 117-2013 Test Method, which references ASTM).
- California Technical Bulletin 117-2013 (See our INTOUCH Bulletin Volume 15, No. 1)
- Consumer Products Safety Commission FF 1-70, Part 16-30 (Standard for Carpet Cushion)
- Consumer Product Safety Commission FF 4-72 16 CFR Part 16-32 and Part 16-30 (Residential Mattresses). Note: this is not a test of foam, but mattresses are required to meet it. See INTOUCH Vol. 13, No. 1.
- Federal Motor Vehicle Safety Standard 302 (Passenger Compartments Of Motor Vehicles)
- Federal Aviation Regulations FAR 25:85:3a, 25:85:3(a-1) (Seat Cushions And Compartment Interiors of Aircraft)

Voluntary Certification Programs

In addition to individual company testing, there are two independent organizations that test foam samples and certify the manufacturers as meeting certain key criteria. These are important because they improve consumer confidence in end products.

CertiPUR-US® is a program for polyurethane foam in furniture and bedding. For CertiPUR-US certification, foam must meet requirements set out by the program:

- Made without ozone depleters
- Made without PBDEs, TDCPP or TCEP ("Tris") flame retardants
- Made without mercury, lead, and other heavy metals
- Made without formaldehyde
- Made without phthalates regulated by the CPSC
- Low VOC (Volatile Organic Compound) emissions for indoor air quality (less than 0.5 parts per million)

To learn more visit www.certipur.us.

The Upholstered Furniture Action Council (UFAC) is implementing a testing program for furniture manufacturers to verify SOFFA Act compliance. Learn more at www.ufac.org. UFAC's voluntary furniture flammability test created in 1978 (which influenced California TB 117-2013) is also still referenced for furniture welt cord.

For carpet cushion the Green Label Plus program ensures that customers are purchasing the lowest emitting carpet, adhesive and cushion products on the market. The program meets and exceeds California's indoor air quality standards for low-emitting products used in commercial settings. (https://carpet-rug.org/testing/green-label-plus/)

Summary

1. There are a number of laboratory foam testing procedures developed by different industry, government, and independent organizations. For flexible polyurethane foam, ASTM D3574 is a comprehensive foundation to be used as a starting point. It includes tests for density, firmness, strength, and durability.
2. There are 18 other ASTM test methods for FPF, plus flammability testing and specific industry tests. A video overview of these is provided on the PFA website at www.pfa.org/video.
3. There are also a variety of flammability tests affecting products made with flexible polyurethane foam including SOFFA (the national furniture flammability standard), FMVSS 302 (automobiles), CFR 16:32 and 16:30 (residential mattresses), and Federal Aviation Regulations FAR 25:85:3a, 25:85:3(a-1) (Seat Cushions And Compartment Interiors of Aircraft).
4. Voluntary independent certification programs such as CertiPUR-US®, UFAC, and Green Label Plus offer additional testing that can boost consumer confidence in end products.

Visit the training section at **www.pfa.org** for a complete, downloadable library of IN•TOUCH Bulletins. For video training and to learn about entry-level jobs in the FPF industry, visit **www.flexfoamjobs.com**.

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