The issue of selecting the appropriate fire retardant foam to meet flammability requirements is a complex process for FPF producers. It is important for FPF purchasers to alert their foam suppliers to the intended end-use for the final product and applicable design and construction characteristics that may affect combustion performance.

Room conditions, ventilation and the presence of secondary ignition sources and the ability of inhabitants to escape also are important considerations in terms of end-product fire performance.

Summary

The proper combustion modified product is not determined just by the use of a particular additive, but also upon consideration of various construction and application variables and chemical and mechanical processing considerations.

Adding significant amounts of combustion modifying agents may reduce cushion comfort and durability.

There is no such thing as a "flame proof" or "fire proof" FPF. Even combustion modified FPF cushioning materials can burn vigorously in the right conditions.

Fire prevention is everyone's responsibility. Consumers should be educated about fire prevention and urged to take appropriate precautions.

This information is provided as a service from the Polyurethane Foam Association to improve the understanding of key issues that affect flexible polyurethane foam cushioning. To learn more about how combustion-modifying additives function within flexible polyurethane foam cushioning, contact a member of the Polyurethane Foam Association.

A complete library of PFA IN•TOUCH® issues can be found on the Internet at http://www.pfa.org.

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IN•TOUCH®

INFORMATION ON FLEXIBLE POLYURETHANE FOAM

IN•TOUCH® is a regular publication of the Polyurethane Foam Association (PFA). It covers topics of interest to users of flexible polyurethane foam and is designed as a quick reference for background information on key issues. To get more detailed information about a particular topic, consult a PFA member.

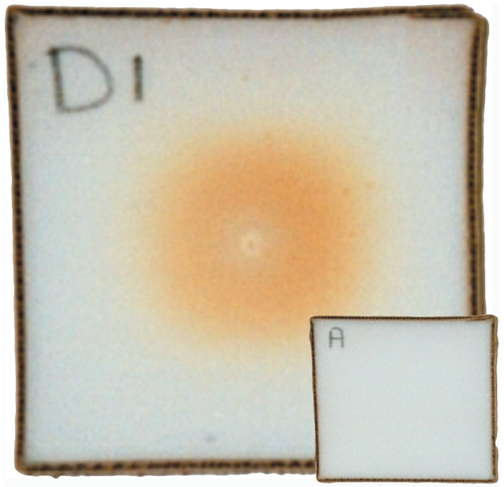
The Combustion Modification of Flexible Polyurethane Foam

Combustion modifier (CM) agents assist in producing a flexible polyurethane foam (FPF) product that can be more resistant to ignition and may burn more slowly once ignited. The objective in manufacturing FPF that incorporates CM agents is to produce a less efficient fire, generating less heat and therefore inhibiting and possibly stopping fire growth. This issue of IN•TOUCH will discuss the combustion modification process.

Achieving a Flame Retardant FPF Product

Although the term "flame retardants" is often used, the polyurethane foam industry prefers the term "combustion modifiers" to avoid giving the impression that FPFs containing CM will not burn. All FPF, including combustion-modified FPF, like any organic product material, will burn when subjected to sufficient heat and an adequate ignition source.

As background, FPF combustion modification is usually achieved by the addition of various agents to the foam formulation. The type and amounts of additives will vary depending on the level of ignition or combustion resistance required in the end use situation. The type and density of foam being produced is also a factor.



Early CM additives were helpful in reducing discoloration, called scorch (as seen in Sample D1 above), due to excessive exotherm during the foam manufacturing process. Sample A shows unscorched FPF.

It is the responsibility of the foam buyer to select the proper FPF product to meet specific end-use requirements. The end user is responsible for complying with any applicable building code, occupancy requirements and flammability standards and for taking reasonable precautions to protect FPF products from ignition in the home and workplace.

Choosing appropriate combustion modifiers is complex and may affect various FPF performance properties, and should be done by personnel with experience in and an understanding of the manufacture of FPF. In turn, the CM additive supplier is responsible for insuring that the products they offer perform well and in a consistent manner and that the additive products comply with all environmental, health and product safety requirements.

Early CM additives were effective in terms of slowing flame spread and inhibiting cigarette smoldering ignition. They were compatible with most foam processing methods, but these early modifiers often produced undesirable softening effects and promoted discoloration, called scorch, due to excessive exotherm during the foam manufacturing process.

The California upholstered furniture flammability standard (California TB117), adopted in 1978, required FPF to be resistant to both smoldering and small, open flame ignition. TB117 substantially increased combustion modifier consumption within the FPF industry. To meet the performance requirements of California TB117, one or several CM compounds were added to the foam formulations. When they became available in the mid 1980s, pentabromodiphenylether (pentaBDE) CM products provided the best combined processing and combustion performance solution for certain types of FPF. FPF products modified with pentaBDE maintained their physical properties and performance better, at the time, than foams made with other CMs. End products produced using pentaBDE were more resistant to scorch discoloration during processing, and pentaBDE additives provided the needed level of combustion inhibition.

Recent publicized studies raise possible environmental and health issues related to pentaBDE combustion modifying additives. In response, PFA manufacturing members and their CM additives suppliers began aggressive work to find satisfactory alternative technologies to reduce the need for pentaBDE additives. Today, PFA manufacturing members have essentially completed conversion from the use of pentaBDE additives to other types of combustion modification technologies that will allow continued production of similar cushioning products that meet current flammability requirements without sacrificing appearance, comfort, support or durability.

CM Agents and Processability

The number of CM materials suitable for use in flexible polyurethane foams has been relatively limited due to the requirements for combustion modified performance combined with foam processing compatibility. The modifier's effect on the physical and durability properties of the foam must be minimal. It is also critical that CM additives remain stable during the FPF manufacturing process; a process that can generate significant heat as raw materials react to expand the foam product.

The additives also must be compatible with other raw materials and work within the processing parameters of the foam pouring equipment. Additionally, CM agents must not escape or volatilize from the foam during production or during the product's expected lifecycle. And they must be durable and remain in the foam even after the foam is cleaned or saturated with water or other liquids.

Furthermore, it is important to understand that adding combustion modifying agents may diminish the cushioning properties of the foam and can adversely affect cushion durability.

Considerations in the Selection of Combustion Modification Additives

There are some basic considerations FPF manufacturers have to address that are key to the selection of CM additives, regardless of the end use of the particular FPF product.

These additives must:

- Provide the desired level of combustion resistance.
- Meet environmental, health and safety objectives.
- Not impair physical comfort, support and durability.
- Protect the FPF from excessive discoloration during production.
- Not limit the types of CM foams that can be produced, such as those products that are very soft and/or have low density for non-weight bearing applications.
- Meet economic constraints imposed by customers and consumers.

Other Factors Influencing Fire Performance

FPF is one of several components in household and home furnishings products. FPF is almost always covered by some material, and FPF is not typically the first of these components to ignite. Only in very rare situations is flexible polyurethane foam the only fuel source in a household fire. The performance of individual components is not indicative of how the composite product will perform in a real fire situation.

Some of the component variables in upholstered furniture and bedding include combinations of filling materials such as FPF used in conjunction with different types and grades of synthetic fiber, natural materials and possibly cotton batting. The addition of slickening agents, used to lubricate fiberfill material to help reduce the tendency for fibers to entangle and matte down with use, can also have a dramatic effect on filling material fire performance.

Fabrics can affect composite fire performance. Fabric variables include four (4) key aspects of a fabric:

1. Composition
2. Weight
3. Weave
4. Denier

The composition of the fabric is significant. Fiber content can vary greatly, from cellulose products such as cotton, rayon and linen to protein-based fibers like wool and leather. There are synthetics in the thermoplastics family like polyester, nylon, polypropylene and PVC, and other synthetics such as acrylics and modacrylics and countless blends and mixtures.

Barrier materials or interliners are ignition-resistant substrates found between the upholstering fabric and filling material. They may be manufactured from spun glass, synthetic glass, carbon fibers, and various co-polymer fibers. The use of a barrier material may reduce or eliminate the need for combustion modifying additives in the FPF or upholstery fabric. While most barrier materials inhibit flame penetration, they do not effectively halt heat transfer. Depending on test requirements, significant filling material decomposition due to heat may produce a failure.

Furniture design and construction, including overall size, thickness of the seat and back, positioning of the seat to the back, and the presence of full sides, flanges, skirts and other trim that might become ignition points or add to combustion, also play a role in fire propagation. Certain designs may require more combustion modification of components than others.

The prediction of the most likely ignition source is also critical to combustion modification strategy. Despite recent attention given to small, open flame ignition, from sources such as a disposable lighter, match or candle, the majority of household fires involving furniture begin with smoldering ignition from smoking materials. Therefore, selection of a combustion-modifying additive must anticipate both small, open flame and cigarette ignition as possible threats.

California is presently revising Technical Bulletin 117 to address small, open flame ignition. The U.S. Consumer Product Safety Commission (CPSC) has committed to regulating upholstered furniture flammability, from both smoldering and small, open flames sources, on a national level, possibly beginning as soon as 2006.

Fabric composition is key to composite fire performance.