Flammability and Its Influencing Factors

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Abstract:
The purpose of the study is to explore the effects of household fabric softeners on the thermal comfort and flammability of fabrics after repeated laundering cycles. Household fabric softeners are applied to textile products when people do home laundering with detergents and dryers by coating the laundry with lubricant and humectant chemicals (Consumer Reports, 1991; Robinson, et al., 1994). The study results could complement the gap in fully understanding of the effects of household fabric softeners on fabric properties. The influence of softener treatments on water vapor transmission, air permeability, and flammability of the fabrics may provide knowledge for consumers to make an informed choice of how to care for their textile products. Manufacturers may also use the results from the study to provide better care instruction for their textile products. The Statistical Package for the Social Sciences Personal Computer (SPSS/PC) program was used to analyze the data. This finding can help consumers to make a better decision when choosing softener treatment if they are concerned about the air permeability of their clothing. For example, if consumers prefer very high air permeability of their sportswear or summer clothes, avoiding using fabric softener is a better choice because both the rinse cycle softener and the dryer sheet softener will decrease the air permeability of their garments. In addition, prior studies indicated that dryer sheet softeners are the best in the improvement of static electricity. If consumers would like to have a softer hand or reduce the static problem in their sportswear, dryer sheet softeners may be a better choice instead of rinse cycle softeners.

Keywords: *Fabric softeners, Polyester fabrics, Thermal comfort*

1. Introduction

Flammability is related to the safety of clothing and textile products, which are closely related to our daily life because flammability of textiles can directly lead to serious bodily injury or fatality and loss of property. Collier and Epps (1998) defined the flammability of textile products by characterizing their burning behavior, especially ease of ignition and sustained burning after ignition.

2. Factors that Influence Flammability

Many factors, such as fiber content, fabric weight and structure, finishes, and garment design, affect flammability of clothing and textile products. Fiber content

2.1 Fiber content

Fiber content is probably the most important fabric property that affects flammability (Collier & Epps, 1998). Cellulosic fabrics, such as cotton and rayon, without a flame-resistant finish, can burn easily. A survey conducted by Gandhi and Spivak (1994) showed that an increased usage of cotton fibers in upholstered furniture fabrics led to increased ease of ignition. The researchers suggested that modification should be made in the textile finishing process to create safer upholstery fabrics. In contrast, wool fabrics, especially heavy weight, usually self extinguish because of their high ignition temperatures (570ºC~600ºC) and high moisture content. Blends of wool with inherently flame retardant fibers, such as Kevlar, Nomex, Ryton, and Index, could be utilized to provide flame retardant and thermally isolative protective clothing systems for firefighters. Thermoplastic fibers, such as nylon, polyester, and olefin, do not ignite easily because they shrink away when exposed to

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flame(Collier & Epps, 1998). However, if they are forced to ignite or are engulfed in flames, thermoplastic fabrics will melt and burn. Blends of fibers, or yarns of different fibers, are more likely to be flammable than fabrics made from a single fiber type (Taylor, 1991).

For example, although polyester is less flammable than cotton, because of a “scaffolding” effect, cotton/polyester blends burn rapidly; they generate more heat than all-cotton fabrics (Collier & Epps, 1998).

2.2 Burning process

In the burning process, charred cotton in the blend acts as a support or scaffold to support the burning polyester fiber, which prevents the melting polyester from dripping away as pure polyester products do, and allows the melting polyester to continue to contribute to the burning system. Similar concerns may apply to products made of fabrics and fillings, such as upholstered seating, mattresses, bed covers, duvets and pillows (Taylor, 1991). If the fabrics and fillings are highly flammable, their combinations can be even more dangerous.

2.3 Fabric weight and structure

Fabric weight and structure heavier fabrics ignite less easily and burn more slowly than lighter weight fabrics (Collier & Epps, 1998). A tightly woven and knitted fabric also ignites more difficultly and burns lower than sheer fabrics.

The reason is that why lighter weight and sheer fabrics ignite and burn more easily is because there is more air space and more oxygen among fibers in the sheer fabrics to fuel the flames as the fabrics burn. Kotresh (1996) tested 25 commonly used fabrics as to the potential hazard they present in flame temperature during burning and burning rate. The researcher found that the rate of burning decreased as the fabric weight increased. The lightweight fabrics burned faster than the heavier ones no matter what the fabric type was. As the fabric weight increased, flame temperature increased, indicating that heavy fabrics provided more amount of fuel sustaining burning.

Fabrics burned at a slower rate than light fabrics, the high flame temperature during burning made heavier fabrics as dangerous as the light ones. Fabrics with projecting surface fibers are ignited easily by an unexpected flame or flash on the surface of the fabric (Taylor, 1991). For example, pile fabrics can ignite easily and cause flames to spread rapidly over the fabric surface

2.4 Finishes

Flame-retardant (FR) finishes were developed for flammable fabrics to provide flame resistant properties and to change the burning behavior of the fabric (Collier & Epps, 1998). FR finishes can be used on cotton, rayon, nylon and polyester fabrics (Kadolph & Langford, 1998).By chemically modifying the surface of the fibers, FR finishes make the fabric less flammable by reducing the volume of flammable gases that generate heat further decomposing the fiber(Taylor, 1991).

Phosphorus containing substances, which react chemically with the fibers, are the most common FR finishes for cellulosic materials (Collier & Epps, 1998). However, FR cottons are unsatisfactory to consumers because the FR finishes for cotton increase the stiffness of the fabric, reduce the tearing strength, yellow easily, and add to the cost of production (Collier &Epps, 1998; Shekar, Yadav, Kasturiya, & Raj, 1999; Taylor, 1991). FR finishes were also developed for fabrics made of thermoplastic fibers, such as polyester and nylon, to quench the flame by inhibiting the creation of flammable gases.

Sometimes fabrics lose their FR properties after washing or dry cleaning and it becomes more dangerous than a fabric without FR finishes because the users are not aware of the change.

2.5 Flame-retardant and water-repellent treatments

Shekar, et al. (1999) studied the combined effect of flame-retardant and water-repellent treatments on a bleached cotton drill fabric and found that for a flame-retardant fabric, satisfactory performance in terms of appearance, functional properties such as water repellency and oil repellency, and physical properties such as breaking strength, stiffness and tear strength, could also be achieved by an effective combination of the finishing agents.

Garment design Garment design also affects flammability, especially ignition. For example, loose-fitting and flowing garments, such as nightdresses, dressing gowns, and full skirted dresses, are more liable to catch fire than tight-fitting garments or apparel with close fitting cuffs and necks because loose clothing provides greater air supply (Taylor, 1991).

2.6 Flammability Regulations

It was not until the 1940s that the public’s attention in the U.S. started to focus on the flammability of fabrics (LeBlanc, 2001). In the late 1940s, a number of people were seriously injured due to burning apparel; the most dangerously flammable fabrics were brushed rayon (Collier & Epps, 1998). In reaction to highly flammable garments resulting in many cases of injury or death, the Flammable Fabrics Act (FFA), a federal law, was passed by Congress in1953.

Under this regulation, the use and sale of highly flammable textile materials including brushed rayon was prohibited. Local and state laws and other regulations imposed more restrictions on the use of flammable textile materials in public buildings. In 1967, the FFA was amended to include additional items such as carpets, draperies, bedding, and upholstery. Flammability standards for various products were also established.

3. Measurement of Flammability

There are two common tests for the flammability of clothing textiles. They are the 45-Degree Test and the Vertical Flammability Test.

3.1 45-Degree Test and the Vertical Flammability Test

The 45-Degree Test is used in 16 CFR 1610, Standard for the Flammability of Clothing Textiles, which is a mandatory testing procedure for all apparel materials except for children’s sleepwear, and some accessories such as hats, gloves, shoes, and interlinings (Collier & Epps, 1998; Kadolph, 1998; Kadolph & Langford, 1998). In this test, a specimen of 6" (warp/wale) x 2" (filling/course) is used. Before testing, the specimens should be dried in an oven and be kept in desiccators until just prior to testing because the moisture level in the fabrics would significantly influence the flammability test result. The specimen is mounted in a holder at a 45° angle and exposed to flame for one second. After the ignition, the flame is removed. The time for the specimen to burn up to its entire length (i.e., 6inches) is recorded. The test is repeated 10 times. The standard for the flame to spread up the specimen length should be less than 3.5 seconds for smooth fabrics or 4.0 seconds for napped fabrics.

3.2 Vertical Flammability Test

The Vertical Flammability Test is applied to children’s sleepwear, which is required to meet minimal flammability performance standards of 16 CFR 1615 (size 0-6X) and 16 CFR1616 (size 7-14) after 50 washings and dryings (Kadolph & Langford, 1998). Similar to the 45-Degree Test, before testing, the specimens should be dried in an oven and be kept in desiccators until testing. In the vertical flammability test, a specimen of 10" (warp/wale) x 3.5"(filling/course) is suspended vertically in a holder and subjected to an igniting gas flame along the bottom edge for three seconds. The char length, which is the amount of fabric burned or damaged by the flame, is recorded. The test is repeated 10 times. The minimum performance standard of 16 CFR 1615 (size 0-6X) and 16 CFR 1616 (size 7-14) requires that specimens cannot have an average char length of more than seven inches and no individual specimen has a char length of 10 inches.

4. Summary of Flammability

Flammability is an important issue in the clothing and textiles area as it can lead to bodily injuries and property loss. Flammability of textile products is defined by characterizing their burning behavior, especially eases of ignition and sustained burning after ignition. Many factors, such as fiber content, fabric weight and structure, finishes, and garment design, may affect the flammability of clothing and textile products. The Flammable Fabrics Act (FFA) and later the Consumer Product Safety Commission (CPSC) developed flammability standards and tests to separate dangerously flammable fabrics from normally combustible fabrics. Two common tests for the flammability of clothing textiles are the 45-Degree Test and the Vertical Flammability Test.

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Reference

1. American Society for Testing and Materials (2000).Annual Book of ASTM Standards, 2000.ASTM D 3775 - 96 Standard Test Method for Fabric Count of Woven Fabric. Vol.7.02. Philadelphia, PA: ASTM.
2. Baumert, K. J., & Crews, P. C. (1996). Influence of household fabric softeners on properties of selected woven fabrics. Textile Chemist and Colorist, 28(4), 36-43.
3. Collier, B. J., & Epps, H. H. (1999).Textile Testing and Analysis. Upper Saddle River, NJ: Prentice-Hall, Inc.
4. Consumer Reports (2002, December).Ratings laundry detergents. http://www.ConsumerReports.org
5. Egan, R. R. (1978). Cationic surface active agents as fabric softeners. Journal of the American Oil Chemists' Society, 55(1), 118- 121.
6. Gandhi, S., & Spivak S. M. (1994).A survey of upholstered furniture fabrics and implications for furniture flammability. Journal of Fire Sciences, 12(3), 284-312.
7. Kadolph, S. J. (1998). Quality Assurance for Textiles and Apparel. New York: Fairchild Publications.
8. Kotresh T. M. (1996). Hazard potential of apparel textiles. Indian Journal of Fiber& Textile Research, 21(2), 157-160.
9. Pierard, G. E., Arrese, J. E., Dowlati, A., Daskaleros, P. A., & Rodriguez, C. (1994). Effects of softened and unsofted fabrics on infant skin. International Journal of Dermatology, 33(2), 138-141.
10. Shekar R. I., Yadav, A., Kasturiya, N., & Raj, H. (1999). Studies on combined flame retardant and water-repellent treatment on cotton drill fabric. Indian Journal of Fibre & Textile Research, 24(3), 197-207.
11. Simpson, B. G. (1958). The effect of silicone softeners on resin treated cottons. Textile Research Journal, 28(2), 170-179.
12. Taylor, M. A. (1991). Technology of Textile Properties (3rd ed). London: Forbes Publications.
13. Vigo, T. L. (1994). Textile Processing and Properties: Preparation, Dyeing, Finishing and Performance. Amsterdam: Elsevier.
14. Vital Statistics of the United States (1973). Volume II: Mortality, Part A.