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Flammability on textile of business uniforms: use of natural fibers

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Abstract

The flammability issue of textile materials employed in business uniforms becomes an important part in the management of worker safety, as in the case of electricians or kitchen chefs. Among the categories that wear business uniforms, the aeronauts are trained among other activities to fight fire on board. It is part of the crew functions, notably the flight attendants in-flight fire event. This study compares the Limiting Oxygen Index (LOI) values to the key fibers (including that ones from natural origin) used on professional clothing material. The range of LOI index presented of the materials used in the preparation of professional uniforms was from 17.4 to 30%. The variation represents the difference in materials origins and their chemicals structures, relative to flame resistance.

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1. Uniforms

The choice of a textile material suitable for the creation a business uniform passes through the symbolic representation of corporate values, but it must also provide to the user the adequate comfort for the performed functions, the ease and cleaning care and, for some categories, protection when exposed to flames [1].

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The wearing of uniforms by employees of a company is a common fact, aiming work organization, presentation of the company to the public, corporate image and business objectives. Also, as long as it is stated in the contract of employment, the uniform wearing may be compulsory [2].

Uniform can be defined as a garment with similar appearance, denoting group distinction or uniformity, and indicating other information. The function of uniform through its delineation of hierarchy, status, authority and values also carries the representation of what is not allowed to perform when the individual is dressed in it. The uniform becomes an indicator of the codification of appropriate conduct rules and their internalization [3].

By the same reason, the business uniform is adopted by workers in service activities such as receptionists, guards of security companies, workers related to kitchen and food companies, hospitals, beauty clinics, parking lots, language schools, airlines (aeronauts), operators and service providers in multiple areas [4].

Among the categories that wear business uniform, the aeronauts are trained among other activities to fight fire on board [5] and kitchen workers and chefs perform their activities in an aggressive environment, in proximity to hot surfaces, boiling water, hot oil and flames, increasing the risk of burns [6].

There are professions whose work clothes are regulated in order to meet safety conditions, especially individual protection equipments, specific and appropriate to the involved activities. The uniforms of electricians are examples of regulated clothing. According to ASTM F 1506-15:2015 standard, they should be appropriate to activities, including conductivity, flammability and electromagnetic protection [7].

1.1. Materials Used in Uniforms

Polyester and its blends with cotton are extensively employed in the apparel textile industry and particularly for professional clothing [8]. However these fibers and blends present low thermal stability and high flammability [9]. On the other hand, other ones, as wool, presents difficult ignition, slowing the propagation of the flames [10].

Tests carried out on chef vests identified the use of cotton twill as the main constituent material. However, cotton/polyester blends are also used in order to increase washability, stain and wrinkle resistance [6].

Cotton fiber is one of the most important for this purpose and cotton fabrics present excellent biodegradable properties, biocompatible, mechanical properties, air permeability, hydrophilicity, softness and comfort. In addition, it is extensively applied in the areas of clothing, furniture, firemen's equipment and military clothing. However the ease of ignition and high flammability are limiting for the applications of cotton fabrics [11,12], as well as low UV protection and low electrical conductivity [13].

In these cases, cotton fiber fabrics can be employed if previously treated with flame retardants [14], as in the case of electricians work uniforms. This fabric treatment is also indicated for exposure to situations of sudden fire and electric arc. Among the materials available to producers to meet the regulatory requirements of ASTM F1506 standard, cotton treated with organo-modified phosphorus is indicated, since it does not allow the release of oxidizing gases during burning, avoiding fire propagation power [15].

Furthermore, wool is another natural fiber (from animal origin) employed in the manufacture of uniforms, which presents resistance to the fire action. This property can be credited to the great amount of nitrogen of its structure. Wool presents difficulty for ignition, with a slow spread of the flame and, once extinguished the source of fire, it stops to burn. In some cases, in which the weight is greater than 800 g/m², wool is considered a non-combustible material [10].

The thermal behaviour of wool contributes to make it a safe fiber. When it is heated in ambient conditions, the loss of water begins at 105°C. The fiber becomes weak and loses its softness if heated to the boiling water temperature for long time periods [16]. In case of temperature range from 200°C to 400°C, the mass loss related to endothermic process occurs, then protein chains decompose into lighter products and volatile compounds such as CO, NH₃ and H₂S. In the second phase of combustion, in the range of temperature from 450°C to 600°C, the exothermic process takes place and some pyrolysis products react with oxygen, through various reactions in the gas phase, leading to oxidation products. The wool needs more oxygen concentration to burn than available in the air. It also does not melt, drip or glue on the body if burned [17].

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