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Effect of Accelerated Hydrothermal Aging on the Strength and Water Vapour Transmission Rate of Moisture Barriers used in Firefighters' Protective Clothing

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ABSTRACT

The moisture barrier is an essential layer in firefighters' protective clothing because it prevents water entry while allowing the body perspiration to exit. Over time the performance of the moisture barrier degrades as the protective clothing is used. One aging condition that negatively impacts the protective performance of the protective clothing is moisture. This study aims at examining the effect of hydrothermal aging on the tear strength and water vapor transmission rate (WVTR) of moisture barriers. Three moisture barriers used in firefighters' protective clothing were selected for the study. The specimens were immersed in containers filled with reverse osmosis water and aged at 20, 60, 80, 90, and 95°C for times between 6 and 1080 h. The aging temperatures were selected considering the conditions faced by firefighters. The residual tear strength of the fabrics was measured by trapezoidal procedure following the ASTM D5587-15 standard test method; however, due to limitations in fabric availability a slightly smaller specimen size (55 x 110 mm) was used. The WVTR of the moisture barrier specimens before and after aging was measured according to ASTM E96 (2021), procedure B (upright cup with water). One-way analyses of variance were carried out to analyze the influence of the aging time and temperature on the mean tear strength. Scanning electron microscopy was used to evidence any potential changes in the membrane surface due to hydrothermal aging. For two of the moisture barriers tested, a decrease in tear strength was observed for the highest hydrothermal aging temperatures while the same conditions did not affect the other moisture barrier. However, the decrease in tear strength observed remained lower than 10% after 600 h of hydrothermal aging. In one case, the decrease in tear strength was possibly attributed to a degradation in the membrane top polyurethane layer. In terms of the WVTR measurements, higher hydrothermal aging temperatures and longer exposure times led to an in increase in the WVTR values. These preliminary results demonstrate the importance of better characterizing and understanding the hydrothermal behavior of moisture barriers used in fire protective clothing.

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