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Mechanical Properties and Yarn Pull-Out Behaviour of High-Performance Fabrics after Various Surface Treatments

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Structured Abstract

Background: High-performance fabrics, including Twaron, Kevlar, and ballistic Nylon, are well-known for their superior strength, toughness and durability, which makes them essential in a range of technical textile fields. These materials are extensively used in applications such as automotive, protective clothing, and aerospace. This study investigates the mechanical properties and yarn pull-out behaviour of an aramid fabric after washing with detergent and softener. The main purpose is to assess whether any alterations impact the frictional properties, and thus the tensile strength and modulus of the fabric yarn.

Methods: Plain-woven high-strength Kevlar fabric was used in the study. The fabric samples were subjected to three (3) distinct washing treatments: washing with detergent only, washing with softener only, and washing with a combination of detergent and softener. Each washing cycle was set to include washing and rinsing cycles, taking a total of 50 minutes to complete. The washed fabric samples were then hanged to dry and subsequently were tested and examined for tensile strength, puncture resistance, and pull-out tests, according to standard test methods.

Results: The findings show that untreated samples maintained the original characteristics due to their rigid polymer chains, which demonstrated a moderate level of mechanical performance. Meanwhile, treatments that involve the detergent gave better results and showed noticeable improvements. It was found that both detergent only and detergent+softener treatments yielded superior mechanical performance, demonstrating higher force resistance and elongation, reflecting enhanced flexibility and durability. This implies that the fabric's flexibility, resilience, and ability to withstand mechanical stresses are all enhanced by the combination of the detergent and softener. However, the amount of the detergent and softener may significantly influence the result.

Conclusion: Overall, treatment with the softener significantly showed reduced mechanical resistance and lower results in all the tests conducted. As observed, the inter-yarn grip is typically weakened by the lubricating effect of softeners, which lowers the fabric's resistance to forces like tensile and puncture loads. Softeners can also increase the soft finish and reduce inter-fiber friction. Due to the coating, the fabric's surface will be more likely to slide. In addition, the softeners may also be harmful to the fabric.

Keywords: high-performance fabrics, aramid, yarn pull-out, technical textiles, detergent

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