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THERMAL INSULATION PROPERTIES OF NONWOVEN SEMI-DISPOSABLE BLANKETS FROM RECYCLED POLYESTER/COTTON FIBERS

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Introduction

One of the major objectives of US textile industry is to process waste and low-grade materials into economically viable consumer products. The utilization of the large quantities of waste polyester fibers annually generated by clothing and home furnishing industries could be very beneficial economically and more importantly, environmentally. It is well known that under ambient conditions it takes a long time for synthetic fibers such as polyester to degrade, thus creating significant environmental problems. The development of new consumer products such as low-cost, semi-disposable, nonwoven thermal blankets that could be made from various blends of waste polyester fibers and greige cotton would benefit both the environment and the economy. Many of the nonwoven blankets currently available on the market do not have soft, comfortable hand and most of them are intended for dry-cleaning only. The goal of this research was to study the basic thermal insulation properties of nonwoven blanket materials made from reprocessed PET/cotton.

Experimental

Recycled polyester and greige cotton fibers that require no chemical processing were used to produce low-cost, semi-durable, nonwoven thermal blanket materials. These fibers were opened separately and blended on an opener (SpinLab) before carding. Nonwoven batts were prepared from recycled polyester and cotton fibers in a weight percent ratio of 70/30 using a card (Whitin) equipped with plates (Cardmaster). The bats were reinforced with a spun-bounded nylon scrim (0.5 oz/yd^2) for greater integrity. They were then needlepunched four times on a needle loom (Morrison Berkshire) equipped with a single 31.8-cm board containing 575 needles. The list of samples with their descriptions and selected samples properties are presented in Table 1.

Thermal blankets were also finished with carboxylic acid to improve structural stability during use and laundering. The antibacterial treatment was performed by reacting hydrogen peroxide with magnesium acetate tetrahydrate to form a solid compound described as magnesium hydroperoxyacetate or MHPA [1,2]. Laundering was carried out using 50g of commercial detergent and a machine wash setting of warm/cold water temperature and the with cotton/sturdy operating cycle.

A Steady-State Heat Flow meter FOX 200, designed and manufactured by LaserComp Corporation, was used for measurement of thermal conductivity* and heat transmittance** of samples of nonwoven blankets. Before conducting measurements, all samples were conditioned at standard textile conditions (20 $^{\circ}$C ± 2°C, 65 % ± 2 % RH) for 24 hours. The thickness of the nonwoven samples, which should be known to insure correct spacing between the base plates of FOX 200, was measured in accordance with standard procedure ASTM D 5736-95. The average of three measurements for each sample was used to calculate the mean values of the specific thermal conductivity and heat transmittance for each specimen. The overall accuracy of the measurements of thermal conductivity and heat transmittance of nonwoven samples was found to be better then 1 %, repeatability – 0.2 % and reproducibility – 0.5% [3].

Results and Discussion

Since the studied blanket materials were only ~ 0.5 cm. thick, thermal insulation properties are extremely important. Thermal conductivity and heat transmittance measurements are a direct indication of the amount of warmth provided by these blankets. Thermal insulation properties were measured on blanket materials before finishing, after carboxylic acid treatment, and after carboxylic acid plus MHPA treatment. Measurements were also made on these samples after completion of 5 laundry cycles. Figure 1. shows the combined results of the measurements of thermal conductivity and heat transmittance of the samples.

thermal conductivity – time rate of heat transfer per unit area, through *unit of distance*, per unit difference of temperature.

thermal transmittance – time rate of heat transfer per unit area, per unit difference of temperature.

The higher the values of thermal conductivity and/or thermal transmittance, the greater is the amount of heat lost through the material. The initial value of the thermal conductivity of the cotton/polyester blanket material was 0.0385, and this value decreased to 0.036 after the material was finished and washed. Therefore, finishing and laundering increased thermal insulation properties of the blanket. Because of changes in thickness of samples during these treatments an overall thermal insulation properties, characterized by value of heat transmittance, did not change significantly. The comparison of thermal insulation properties of the studied blanket material with data for commercially available blankets show that cotton/polyester blankets provide on average 20 –30 % better protection against the heat loss [4].

Conclusion

The measurement of thermal insulation properties of nonwoven blanket material made from recycled polyester/cotton indicated that these blankets provide on average better protection against heat loss then commercially available blankets.

Overall these "environmentally improved" nonwoven blanket fabrics had a good hand, excellent thermal and comfort qualities. Thus they can be an economically viable product.

Disclaimer

Specific company, product, and equipment names are given to provide exact description of experimental details. Their mention does not imply recommendation or endorsement by the U.S. Department of Agriculture.

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Table 1. List of samples of nonwoven composites, their descriptions and basic properties

Sample	Sample Description	Components weight ratio, %	d, thickness, cm
C	cotton/polyester, no finish	70/30	0.51
C5	cotton/polyester, no finish, laundered five cycles	70/30	0.59
CX	cotton/polyester, carboxylic acid finish	70/30	0.46
CX5	cotton/polyester, carboxylic acid finish, laundered five cycles	70/30	0.50
CXA	cotton/polyester, carboxylic acid and antibacterial finish	70/30	0.44
CXA5	cotton/polyester, carboxylic acid and antibacterial finish, laundered five cycles	70/30	0.47

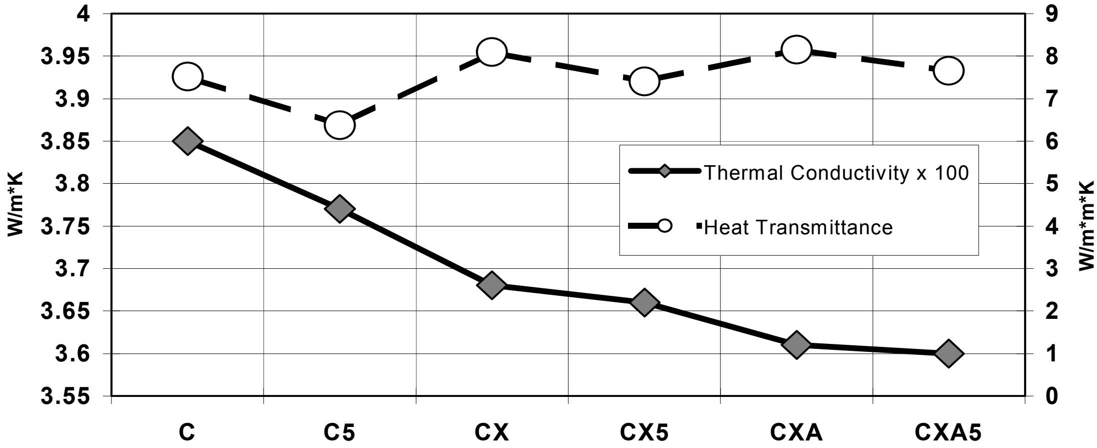

Figure 1. Thermal Conductivity and Heat Transmittance.