

STUDIES ON THERMO-PHYSIOLOGICAL PROPERTIES OF PLATED KNITS

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STUDIES ON THERMO-PHYSIOLOGICAL PROPERTIES OF PLATED KNITS

by

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***Dedicated to my parents,
husband
&
sister***

CERTIFICATE

This is to certify that the thesis entitled '**Studies on thermo-physiological properties of plated knits**' submitted by **Ms. Yamini Jhanji** to the **Indian Institute of Technology Delhi**, for the award of the degree of **Doctor of Philosophy**, has been prepared under our guidance with the rules and regulations relating to the degree.

The research report and results presented in the thesis have not been submitted for any degree or diploma in any other institute or university.

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ABSTRACT

The current research work deals with plated knit fabrics with different combination of fibre, yarn and fabric variables and studying their influence on thermo-physiological properties.

Results show that the type of fibre used has no effect on thermal insulation properties or moisture vapour transmission rate of plated knit fabrics. Polyester or polypropylene in the back layer coupled with cotton in the face layer (C/PET and C/PP respectively) shows good wicking and evaporation properties. Polypropylene in the back layer is more effective than polyester fibre in maintaining dry feel next to skin. Fabrics containing nylon and cotton in any combination have the property to absorb and hold water and are unable to transfer it away from the skin. However, nylon containing fabrics dissipate dry heat, as well as moisture vapour rapidly and feel cooler on the skin due to high thermal absorptivity.

Increasing linear density of cotton yarns, leads to increase in thermal insulation and water absorbing capacity of fabrics. Coarser cotton yarns (59.1 tex) have a tendency to trap heat as well as liquid sweat. Cotton yarns having linear density of 39.4 tex in the face layer with polypropylene in the back layer are better suited for heat and liquid dissipation. Finer (1.11 dtex) filament fabrics have better barrier properties than coarser filaments (2.31 dtex). The former offers better thermal insulation as well as better resistance to passage of air and moisture. At the same time they show higher wicking as well as absorbency.

Fabrics knitted with loop length of 5.4 mm are more breathable as compared to fabrics having loop length between 4.8 mm to 5 mm. Also slacker fabrics absorb less water and dry faster. Fabrics knitted with loop length of 5 mm and PET filament of 1.54 dtex (72 filaments) ensure good moisture vapour and liquid moisture transfer properties. With further increase in filament fineness, permeability of fabric to air and moisture decreases and the fabric takes longer to dry.

Use of triangular polyester fibre in the back layer gives all round better comfort than when circular fibres are used. In fabrics containing circular polyester fibres, the thermal resistance, air permeability and moisture vapour transmission increase with increasing fibre linear density. Trans planar wicking and absorbent capacity are also seen to follow the same trend. Carded cotton yarns in the face layer give better insulation, lower moisture vapour transmission rate and wicking as compared to their combed yarn counterparts. As compared to rotor spun yarns, ring yarn fabrics show lower thermal absorptivity coupled with better insulation and breathability.

Plated fabrics produced by combining triangular polyester fibre in the back and carded cotton yarn in the face layer, respectively show better insulation properties as well as feel warmer to touch as compared to other yarn combinations of combed/ rotor spun yarns. On the other hand, a combination of combed cotton yarn in face layer with triangular polyester fibre in the back layer results in fabrics having higher air permeability, moisture vapour transmission as well as trans planar wicking properties. Plated fabrics knitted with carded yarn in the face and polyester fibre of high linear density in the back layer show higher thermal resistance and lower thermal absorptivity. However, the air permeability and moisture vapour transmission rate increases while absorbent capacity decreases with combination of combed cotton yarn in face and higher linear density of polyester fibre in the back layer. Plated fabrics using a combination of ring spun cotton yarns in face and polyester fibre of high linear density in the back layer, show better air permeability as well as better thermal, moisture vapour and liquid transfer properties compared to when rotor yarns are used in the face layer.

Results obtained from the above tests were used to develop statistical and artificial neural network models for prediction of thermo-physiological properties of plated knits. The most sensitive parameters in prediction of thermo-physiological properties were found to be - total yarn linear density for thermal resistance, filament fineness for thermal absorptivity and loop length for air permeability and moisture vapour transmission rate. Comparison of ANN and response surface equations in terms of

their prediction performance showed that both the approaches could explain over 90% variability in the thermo-physiological properties (R^2 value over 0.9). ANN showed less prediction error in predicting the thermal resistance and air permeability of plated fabrics. However, response surface equations predicted the thermal absorptivity and moisture vapour transmission rate better.

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