STUDY ON THERMAL AND MOISTURE VAPOUR TRANSMISSION CHARACTERISTICS OF MULTILAYERED FABRIC ENSEMBLES

by

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CERTIFICATE

This is to certify that the thesis titled **“Study on Thermal and Moisture Vapour Transmission Characteristics of Multilayered Fabric Ensembles”**, being submitted by Mr. Shabaridharan K. to the Indian Institute of Technology Delhi, for the award of the degree of Doctor of Philosophy, is a record of bonafide research work carried out by him. He has worked under my guidance and supervision and fulfilled the requirements for the submission of the thesis, which has attained the standard required for a Ph.D. degree of this institute.

The results contained in this thesis have not been submitted, in part or in full, to any other university or institute for the award of any degree or diploma.

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ABSTRACT

The selection of appropriate material has always been issue of concern for design of lightweight clothing meant for cold weather conditions. The thermal comfort properties of such clothing depend on the complex interactions of fabric characteristics, human interaction with the environmental variables and physiological interactions with the textile materials. Modelling of thermal comfort properties facilitate to engineer the fabrics for specialized applications. The focus of this thesis is to address these issues by studying the effect of different parameters on thermal and evaporative resistance of multilayered fabric ensembles.

The effect of thickness of air layer on thermal transmission properties of multilayered fabrics were studied at different convective modes. It was observed that the thermal resistance increases with the increase in thickness of air layer. The mode of convection was found to have interactive effect with the type of fabric used in outer layer fabric. The effect of linear density of fibre, mass per unit area, punch density and depth of penetration on thermal and evaporative resistance of multilayered fabrics was studied. It was found that the thermal and evaporative resistance increases with increase in mass per unit area and decreases with increase in punch density and depth of penetration. The linear density of fibre was found to have no significant or very less effect on thermal and evaporative resistance of multilayered fabrics. Type of coated fabric, pore size and porosity of the fabric used in the outer layer was found to play a major role in determining the evaporative resistance of the multilayered fabric ensembles.

The thermal and evaporative resistance of multilayered fabric ensembles were predicted by ANN model. It was found that the ANN model predicts the thermal properties of fabrics with good prediction performance. Therefore, the ANN model can be used to engineer the fabric for cold weather applications. The use of Taguchi's method was explored to predict the thermal and evaporative resistances of multilayered fabrics. It was found that the Taguchi's method substantially reduces the number of experimental combinations required to study, with good prediction accuracy.

An instrument was developed to study the thermal transmission characteristics under different compressional load. Different types of multilayered fabrics were studied for thermal transmission properties under different compressional load. It was found that the thermal resistance significantly decreases with the slight increase in the compressional load.

Four different jackets were produced with different type of insulative materials. A wear trial study was performed to evaluate the thermal comfort of the produced jackets. It was found that the jacket consisting of hollow fibres were performed better even at sub-zero weather conditions. Thus the studies conducted in this research work will be helpful in understanding the thermal and evaporative resistance of multilayered fabrics that would help to produce the lightweight clothing for cold weather conditions. The developed statistical and ANN models would be helpful to the researchers for understanding the effects of fibre, fabric and process parameters on thermal comfort properties of multilayered fabrics.

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