STUDY OF THERMAL COMFORT CHARACTERISTICS OF WEFT-KNITTED LAYERED FABRICS FOR SPORTSWEAR

ABSTRACT

Submitted by

SUGANTHI T

in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

FACULTY OF TECHNOLOGY

ANNA UNIVERSITY

CHENNAI 600 025

APRIL 2017

ABSTRACT

In this competitive era, many technologies have been emerging out in the designing and development of sports apparel. Comfort is an important aspect in sports apparel because it affects the performance of the wearer due to discomfort. The properties of fibres, yarns, fabrics and garments are significantly related to comfort and must be taken into account in producing suitable sports apparel items. Fabric properties depend on fibre properties, yarn structure, fabric structure, mechanical and chemical finishing treatments given to the fabric. Engineered fabrics have been developed now-a-days to improve the wearer comfort of sportswear. Thermal comfort is one of the key requirements for sportswear because when a person is engaged in sport activity the transfer of air, heat and moisture is essential to facilitate the wearer comfortable. Clothing worn by the sportsperson should not impede the air, heat and moisture transfer from the human body through the clothing.

This research work focuses on the investigation of thermal comfort characteristics of weft-knitted layered fabric for sportswear. In bi-layer knitted fabric, inner layer is made up of micro-fibre polyester or polyester or acrylic yarn and outer layer is made up of modal yarn. Inner layer is formed by dial needles and the outer layer is formed by dial needles and the tuck stitch is incorporated for joining inner and outer layer.

Bi-layer knitted fabric derivatives were developed with different course repeat and varying tuck stitch position. In this research work, thermal comfort characteristics such as thermal conductivity, air permeability, water vapour permeability, wicking, moisture absorbency, drying rate and moisture management properties have been analysed for bi-layer knitted derivatives. Subjective evaluation by wear trial has also been conducted for bi-layer

knitted derivatives. The bi-layer knitted fabric with tuck stitch on 12th wale and 18th course showed good air, heat and moisture transfer when compared to other bi-layer knitted derivatives. The findings of objective and wear trial method indicates that among four bi-layer knitted fabric derivatives, the fabric with less tuck stitch is used for joining inner and outer layer exhibited good thermal comfort characteristics suitable for sportswear.

The bi-layer knitted fabric with tuck on 12th wale and 18th course which exhibited good thermal comfort characteristics have been taken for further study. Four bi-layer knitted fabrics were developed by changing the tuck stitch placement in four different points on wale such as tuck on 4th, 8th, 12th and 16th wale and the course repeat remains the same. Bi-layer knitted fabric with tuck on 12th wale have better air, heat and moisture transfer compared to bi-layer knitted fabrics with tuck on 4th, 8th, and 16th wale. The lower thickness and mass per unit area had better thermal conductivity, air permeability, water vapour permeability, wicking, moisture absorbency, drying rate and moisture management properties. The lesser number of tuck stitch had better thermal comfort characteristics both by objective and wear trial method.

Bi-layer knitted fabrics were developed by changing tuck position in course such as 6, 10, 14 and 18 course repeat and the tuck on 12th wale remains the same. The greater the distance between the successive tuck points had better air, heat and moisture transfer properties. Bi-layer knitted fabric with slack structure facilitates lower thickness and mass per unit area and had better thermal comfort characteristics. By wear trial method, bi-layer knitted fabric with tuck on 18th course and 12th wale had good rating compared to other bi-layer knitted fabrics.

An investigation of influence of yarn composition on thermal comfort characteristics were studied further. The thermal comfort characteristics of bi-layer knitted fabrics with varying yarn composition in the inner layer have been studied. Micro-fibre polyester or polyester or acrylic yarn was used as inner layer and modal yarn was used as outer layer. Based upon the objective evaluation of air, heat and moisture transfer and rating by wear trial method, it is inferred that the bi-layer knitted fabric with micro-fibre polyester in the inner layer and modal in the outer layer exhibit good thermal comfort characteristics when compared to polyester or acrylic yarn in the inner layer.

Further, an investigation on influence of modification of bi-layer structure on thermal comfort characteristics of layered knitted fabrics was studied. Three modified bi-layer knitted structures were developed in which inner layer is made up of micro-fibre polyester and outer layer is made up of modal yarn. The yarn used in the middle layer has been changed as either micro-fibre polyester or polyester or acrylic yarn. The thermal comfort characteristics such as thermal conductivity, air permeability, water vapour permeability, wicking, moisture absorbency, drying rate and moisture management properties have been analysed. Modified bi-layer knitted structure with micro-fibre polyester in the inner and middle layer and modal in the outer layer shows better thermal comfort characteristics compared to polyester or acrylic in the middle layer of modified bi-layer knitted fabrics.

The moisture management properties of bi-layer knitted fabrics such as wetting time, absorption rate, maximum wetted radius, spreading speed, cumulative one-way transport capacity and overall moisture management capacity have been studied for all developed bi-layer and modified bi-layer knitted fabrics. It was observed that longer top wetting time, higher bottom absorption rate, higher bottom maximum wetted radius and

higher bottom spreading speed exhibited good liquid transport properties or moisture management properties.

Correlation between various thermal comfort characteristics such as air, heat and moisture transfer and wear trial subjective judgment scales such as thermal perception, evaluation, thermal preference, personal acceptability statement and tolerance were studied.

Based on this research work, it is concluded that air, heat and moisture transfer properties of the weft knitted layered fabric are mainly dependent upon yarn type, fabric structure, tuck position in wale and course and geometric properties of structure. From the objective and subjective evaluation, it is concluded that the bi-layer knitted fabric with different course repeat and tuck stitch used to join the layers influences the thermal comfort characteristics of sportswear.