STUDY OF COMFORT PROPERTIES OF SWISS DOUBLE PIQUE FABRIC

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ABSTRACT

The term comfort is defined as "the absence of unpleasantness or discomfort" or "a neutral state compared to the more active state of pleasure". There is general agreement that the movement of heat and water vapour through a garment is probably the most important factor in clothing comfort.

Keyword: - Thermal conductivity, Airpermeability, Watervapour permeability

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INTRODUCTION:

Clothing comfort is a subjective matter as it depends on the wearers' perception. It is usually measured with the interaction between human body with its surrounding microclimate and also the clothing.Knitted fabrics are widely used due to their easy-care properties and possessed high degree of clothing comfort.Comfort is being reinforced as key parameter in clothing. Comfort is a pleasant state of psychological, physiological and physical harmony between the human being and the environment. The processes involved in human comfort are physical, thermo - physiological, neuro -physiological and psychological.

Effect of Blend Ratio, Loop Length on Thermal Comfort Properties of Single Jersey Knitted Fabrics:

The effect of the linear density, loop length, and blend proportion on thermal comfort properties (air permeability, thermal conductivity, thermal resistance, and water-vapor permeability) have been studied.

The thermal conductivity of the fabrics was generally found to decrease with an increase in the proportion of bamboo fiber. The water-vapor permeability and air permeability of the fabrics were observed to increase with an increase in bamboo fiber content. An increasing presence of bamboo fiber in the fabric causes a reduction in the fabric thickness and mass per unit area for all linear densities of yarn. As the constituent yarn gets finer, both the fabric air and water-vapor permeability increase while the thermal conductivity decreases.

As the loop length increases, the thermal conductivity also increases independent of the fabric packing density. As far as the water-vapor permeability is concerned, the increase in loop length decreases the flow rate of water vapor because of the hindrance of air layers.
As the linear density of the yarn increases, the thermal conductivity decreases as more air is caught by fibers, and vice versa. In the case of a higher water-vapor permeability, the linear density of yarn and the thickness of the fabric increase and the flow rate will be less.

The dimensional properties of double-knit fabrics:

Double-knit structures are made from a combination of loops such as plain, rib, tuck, and Heat. having unequal lengths and knitted on different feeds, such as a cylinder-only or dial-only feed or a dial-and-cylinder feed. This results in individual feeders giving rise to unequal numbers of courses appearing at any one side of the fabric and to differing numbers of wales per unit length.
Determination of Dimensions The dimensions of double-knit structures are governed by many parameters, such as the type of loop, method of loop combination, run-in ratio, average loop length, and course length associated with individual feeds. To determine the manner in which each of the above factors affects the fabric dimensions and appearance, it was found necessary to determine the practical limits within which, for a given yarn and machine, knitting could take place. this was done by determining the maximum and minimum lengths for the main types of loop used in knitting double-knit structures, such as interlock, rib, plain half-gauge, and plain full-gauge fabrics.

Geometric and dimensional properties of double pique knitted fabrics using cotton sheath elastomeric Core Spun Yarn:

The influence of various loop length variables and subsequent tightness factors on geometric and dimensional properties of knitted fabrics produced from cotton sheath elastomeric core spun yarn. Cotton sheath elastomeric core spun yarn was knitted into one of the single jersey derivative structures called double pique or thick pique with three different loop length variables to obtain equal number of variables in tightness factor. The results show that the changes in loop length and corresponding tightness factor have significant impact on knit fabric geometric properties except wale density measured in terms of wales per inch at all the relaxation states. The changes in the wale density values among the samples with different tightness factors at same or different relaxation states may be the effect of widthwise shrinkage and growth of the samples. The results have clearly depicted that the changes in loop length do not play any role in the wale density of the samples knitted. All the double pique fabric samples have attained their dimensionally stable state perfectly after the fourth washing and drying cycle and the same trend is noticed after the fifth wash also. The sample knitted with the smallest loop length and highest tightness factor has reached its width wise dimensionally equilibrium state in the first wash itself. In all the samples, the contraction in length and growth in width was noticed uniformly after every washing and drying cycle.

Dimensional Characteristics of Knitted Fabrics Made from 100% Cotton and Cotton/Elastane Yarns:

Knitted fabrics are produced by interloping of yarns and showed increasing demand for their shape fitting, smoothness, flexibility, elasticity, and good elastic recovery. But all knitted fabrics may not have these properties equally. These properties are determined by raw material types and characteristics, knitting machine parameters, and type of knit structures. These knitted fabrics are textile structures made of elastic interconnected stitches and characterized by two perpendicular directions, the direction of stitches courses on the direction of stitches courses in vertical direction.

The dimensional characteristics of five knitted structures made from 100% cotton and 95% cotton/5% elastane blended yarns were studied. As investigated in the results and discussion, the loop lengths of the primary knitted fabrics such as single jersey, 1x1rib, and 1x1interlock knitted fabrics made from cotton/elastane yarn have been increased for the needles were able to frequently receive new loop and release an old loop during knitting. The other fabric properties such as wales per centimetre (wpc), courses per centimeter (cpc), stitch density (s), tightness factor (K), take-up rate (T), and loop shape factor (R) are significantly influenced by the presence of elastane yarns in the knitted fabrics.

Effect of Stitch Length and Fabric Constructions on Dimensional and Mechanical Properties of Knitted Fabrics:

The dimensional and mechanical properties of single jersey, single lacoste and double pique fabrics were studied under five level of stitch length. An attempt has been made to investigate the impact of stitch length and knit constructions on the dimensional and mechanical properties of knitted fabrics. The three fabrics were manufactured from 28 Ne cotton yarn by varying the stitch length. It is found that the effect of stitch length and knit structure on the properties of knitted fabric is significant. Bursting strength of single lacoste fabric is higher than other fabrics whereas double pique fabrics shows lowest bursting strength.

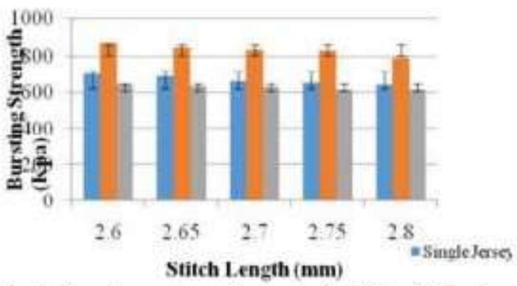

Fig. 1: Bursting strength test of knitted fabrics with different stitch length

Bursting Strength: Figure 1 shows the bursting strength test result of different knitted fabrics. It is noticed there is a significant relationship between bursting strength and stitch length. Stitch length greatly influences the bursting properties of the knitted fabrics.

An unconventional way to incorporate comfort in knitted fabric:

The comfort and absorbing power of the cotton knitted fabric have been improved significantly by using bicomponent yarn, made up of 90% cotton fibres and 10% water-soluble compound, in place of 100% cotton yam. After knitting, the fabric is subjected to washing treatment where water-soluble compound is di5solved, making the yam in the fabric lighter, bulkier and softer. This results in the improvement of air permeability, absorbing power and feel of the fabric over that of 100% cotton knitted fabric.

It has already been reported 7 that after the washing treatment, the fabric made out of the bicomponent yam has better softness and feel than that made out of 100% cotton yam.

The Influence of Double Layer Knit Fabric Structures on Air and Water Vapor Permeability:

The face and back surfaces of the fabrics are connected by a) Loop and b) Tuck. The developed fabrics are taken to measure the water vapor permeability and air permeability properties. The test results were discussed statistically with single factor ANOVA. The results in the analysis of variance were based on conclusions from Tukey’s Least Significant Difference test. They showed that the differences among the double layer structures were highly significant in the WVP and air permeability properties of the knit fabrics. The stitch densities in the fabric were found to influence more on the permeability property of the fabrics.

There are many factors influences the air permeability through textile structure such as Fiber – Orientation, morphological structure, volume of fiber fraction. Yarn – twist, linear density, type of material, yarn flattening, yarn structure. Fabric – Surface Porosity, fabric thickness, specific energy of the fabric, loop length, tightness factor, type of structure, types of stitch the barrier ability of the plain double-layered cotton/polyester knitted fabric to the air is based on surface porosity, fabric thickness & type of stitch. The air permeability of the fabrics made from natural yarns is higher than textured polyamide, highest than elastane knitted socks. There is no correlation between water vapor permeability and the air permeability of the double-layered knitted fabrics. The structure of the fabric is important factor that influence the permeability properties of the textile fabrics.

The influence of moisture content on the thermal conductivity of a knitted structure:

A theoretical model has been created to predict the thermal conductivity of knitted structures in terms of porosity, thickness and moisture content. The validity of the model was examined by the results of experiments conducted using different knitted fabrics, in which the porosity, thickness, fibre and water content are different. The thermal conductivity of a dry plain knitted fabric decreases with the increase of porosity; however, with increased water content, the increase of porosity contributes to an increase in thermal conductivity.

The thermal conductivity increases when the thermal conductivity of the fibres increases and also increases as the porosity decreases.

The effect of fiber cross-sectional shape and texturing temperature on knitted fabric air permeability:

Texturized yarns are often preferred especially in home textiles and sportswear. To improve polyester filament properties, mechanical, thermal, chemical and combinations of texturing processes are applied. With these processes, filament yarns take on a curved and voluminous structure and gain a permanent form. Properties of the texturized yarn can be varied as raw materials properties, machine type and process factors. This study covers the investigation of the effect of cross-sectional shape of fiber (round and trilobal) and texturing process temperature (150, 175 and 200 0C) on air permeability of false twist textured polyester single jersey knitted fabrics. Results showed that the highest air permeability value was obtained from knitted fabric with round fiber cross-sectional shape polyester filament textured at 150 0C. According to the statistical analysis, both the fiber cross-sectional shape and process temperature were found to have a significant effect on air permeability property.

Thermal properties of knitted fabrics made from cotton and regenerated bamboo cellulosic fibres:

The thermal properties of different knitted fabric structures made from cotton, regenerated bamboo and cotton-bamboo blended yarns. Three blends of fibres (100% cotton, 50:50 cotton: bamboo and 100% bamboo) were used to produce three yarn counts (30 tex, 24 tex and 20 tex).It was found that the thermal conductivity of knitted fabrics generally reduces as the proportion of bamboo fibre increases. For the same fibre blend proportion, the thermal conductivity was lower for fabrics made from finer yarns. The thermal conductivity and thermal resistance values of interlock fabric was the maximum followed by the rib and plain fabrics. The water vapour permeability and air permeability of knitted fabrics increase as the proportion of bamboo fibre increases. The air permeability and water vapour permeability values were higher for plain fabric as compared to those values of rib and interlock fabrics.

The effect of some fabric parameters on the thermal comfort properties of flat knitted acrylic fabrics for winter wear:

The thermal comfort properties of flat knitted acrylic fabrics differing in terms of knit structure, tightness, thickness and porosity were investigated within the perspective of its usage in winter wear products. Measured and calculated using the data from Permetest and Alambeta devices, the thermal comfort properties were handled in three aspects, namely thermoregulation characteristics, breathability and thermo-physiological characteristics, and their relationship with fabric structural parameters were investigated statistically. The results indicated that rib 2 2 structures provide the optimum condition in terms of thermoregulation, breathability and thermo-physiological comfort, whose thickness and porosity values should be adjusted accordingly, since the thickness improves thermal insulation and porosity improves breathability.

The parameters of thermal comfort are significantly affected bythe knit structure. Furthermore, it was found that tightness of the knitted structures has an influence on thermal conductivity, thermal absorptivity and air permeability, while it had no significant impact on water vapor resistance and the water vapor permeability index. Thickness was also found to have a statistically significant influence on providing thermoregulation properties and water vapor resistance, whereas air permeability as an indicator of porosity is influential on thermal conductivity and thermal absorptivity, in terms of thermoregulation characteristics, and influential on the water vapor permeability index, in terms of thermo-physiological characteristics.

The Influence of Knitted Fabrics' Structure on the Thermal and Moisture Management Properties:

The influence of fabric's structure on the thermal and moisture management properties of knitted fabrics made of two types of yarns with thermo-regulating effect: Coolmax® and Outlast®. The main purpose of this study was the selection of the most adequate fabric, to be used in summer and winter sportswear. The results demonstrated that some properties, such as, thermal properties, diffusion ability, air and water vapor permeability are influenced by both raw material type and knitted structure parameters. Wicking ability is influenced to a greater extent by the knitted structure, while the drying ability is primarily determined by raw material and to a lesser extent by the knitted structure parameters. Outlast® fabrics are preferred candidates for warmer climate sportswear, particularly due to their lower thermal resistance, higher thermal conductivity and absorptivity, air and water vapor permeability. When considering sportswear for colder weather, Coolmax®

based structures seem to be the best choice. These findings are an important tool in the design of a sportswear product tailored to the different body areas thermal and moisture management requirements.

Thermal resistance of knitted fabrics:

The investigation is to draw out conclusions about significant fabric parameters affecting the heat transfer through a porous structure. A series of samples of single jersey fabrics was knitted and treated according to the same recipe. Essential primary and secondary parameters were determined to characterize the manufactured fabrics. Comparing the measured results for the thermal resistance of the knitted fabric, one can observe a strong correlation between the thermal resistance of the knitted fabric and thickness, mass per unit area, cover factor and porosity.The results of the statistic test showed that the correlation of fibre conductivity and the resistance of the knitted fabric to heat transfer is small ($R = 0.32$). It is to conclude that the air entrapped in the knitted fabric structure plays a prevalent role for thermal resistance of this kind of products. Performed investigations, presented results and findings have expanded previous findings on the basis of which parameters of similar knitted products in moderate environmental conditions can be predicted. Therefore, the value and performance characteristics of the product for the specific purpose can be evaluated to a certain extent.

The optimal thermophysiological comfort of a knitted structure can be achieved if all parameters of the manufacturing and finishing methods are selected studiously and optimized in conformity with the requirements set by the purpose of the product.

Water vapour permeability as a factor of the thermophysiological comfort of knitted fabrics:

The ease with which the knitted fabric transports moisture from the body depends on the characteristics of the fiber, that is, the raw material composition, but even more so from the geometric characteristics of the knitted fabric. The paper examined the permeability of water vapor in cotton knitted fabric for underwear made from cotton yarn of the same fineness, embedded in three different interlacing, single jersey, double jersey 1: 1 (rib) and interlock jersey. According to the results, the two-sided interlacing double jersey 1: 1 (rib) and interlock jersey have shown better water vapor transport, which means that t-shirts made from these knitted fabrics will absorb the sweat faster from the body, giving them a feeling of greater comfort. The choice of appropriate clothing for a particular purpose should be made on the basis of user requirements, the thermal characteristics of the material and the interaction between the material and the user in different environments.

Thermal Comfort Properties of a Bi-layer Knitted Fabric Structure:

The thermal comfort properties of different knitted fabric structures made from modal, polypropylene and micro denier polyester were studied for volleyball sportswear. Eleven knitted fabrics were produced, in which three samples were single jersey, two plated and six bi-layer knitted structures. The air permeability, water vapour permeability, thermal conductivity, wicking and drying ability of bi-layer knitted fabric made up of polypropylene as the inner layer and modal as the outer layer with one tuck point of repeat were found to be higher as compared to other bi-layer, plated and single jersey structures. Both the objective and subjective results show that bi-layer knitted fabric with polypropylene as the inner layer and modal as the outer layer with one tuck point of repeat is mostly suitable for sportswear. The results are discussed together with multivariate ANOVA test results at a 95% significance level.

Thermal comfort properties of Viloft/cotton and Viloft/polyester blended knitted fabrics:

Viloft is a special regenerated cellulosic fiber with a flat cross-section and crenulated surface that maintains air gaps in the yarns that help to improve the thermal properties of the fabrics. This fiber is mainly used for underwear, socks and sportswear fabrics and blends of Viloft with polyester or cotton are commonly preferred in the market. In this study, thermal-related characteristics, such as the thermal conductivity, thermal diffusivity, thermal absorptivity, thermal resistance, moisture and air permeability, of Viloft/cotton and Viloft/polyester blended knitted fabrics were investigated.

Viloft-rich blends, in general, improved the thermal properties of the fabrics. However, the relative water vapor permeability of Viloft/polyester blended fabrics was found not to be significant and only small significances were present for cotton blended ones, statistically

Thermophysiological comfort properties of fabrics in relation to constituent fibre fineness and cross-sectional shapes:

The effect of linear densities and profiles of polyester fibres on the physiological properties of their fabrics. Four different polyester fibre finenesses along with microdenier and four cross-sectional shapes (circular, scalloped oval, tetrakelion and trilobal) were selected to produce two sets of 2/1 twill fabrics; one composed of 100% polyester and the other 67:33 P/V blends. In studying the thermophysiological component of the clothing comfort, heat, air and moisture transmission characteristics of the fabrics were assessed. The principal thermal properties, such as thermal absorptivity, thermal resistance and thermal conductivity, were experimentally evaluated, using the Alambeta instrument. The study of the obtained results established the fabrics of non-circular cross-sections as against circular ones, and increase in the linear density results in higher thermal resistance, lower thermal conductivity and lower thermal absorptivity.

A fall in fibre linear density raises the spreading speed of a water droplet through the fabric. On the other hand, fibres with non-circular profiles behave similarly owing to their large specific surface.

CONCLUSION:

1. It is observed that the parameters of air permeability thermal resistance, water vapour permeability and thermal conductivity are significantly affected by the fibre blend ratios.
2. It is estimated that an increase in the loop length of the fabrics investigated increases their permeability to air, whereas an increase in the linear density of yarns decreases the permeability to air of the knits
3. When the loop length of knit and the linear density of yarn are considered as one parameter - the tightness factor, this can be used for fabric air permeability forecasting. The high correlation between the permeability to air and tightness factor confirms that.
4. The width wise dimensional stability of double Pique fabric is better than length wise direction. Spirality of all experimental fabric is directly proportional to stitch length. Single jersey fabric has poor spirality than other fabric on the other hand double pique fabric has very good spirality properties.
5. The water vapour permeability and air permeability shows concomitant increase as the proportion of bamboo fibre increases. If the blend proportion is the same, then the thermal conductivity reduces, but the air and water vapour permeability increase as the yarn becomes the finer one

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