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Influence of yarn manufacturing techniques on comfort properties of knitted fabrics

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Abstract: *Knitted fabrics are well known for their comfort characteristics and different yarn technologies have different effect on comfort characteristics. The present work is related to the measurement of comfort characteristics of fabrics knitted from Ring, Rotor and Compact yarns. Samples from different yarn have been prepared by keeping same gauge of the machine and using the same yarn count. Comfort characteristics such as Air permeability, Thermal insulation, Kawabata Evaluation, Moisture Vapour Transmission Rate. knitted fabric. From thermal comfort point of view Rotor yarn is found to be good. It shows good wicking character. From permeability point of view, Compact knitted fabric is found to be best. From tactile comfort point of view Rotor knitted fabric is found to be good.*

Key words: *Comfort, knitted fabric, Kawabata, MVTR, ring, rotor and compact yarn.*

I. Introduction

Comfort can be defined in many ways. The “absence of discomfort” is one of the so many interpretations [1]. According to Oxford dictionary comfort is “the state of being physically relaxed and free from pain”. As per the definition of Slater [2] comfort is a “pleasant state of physiological and physical harmony between a human being and environment”. The first aspect of comfort is physiological comfort, which is associated with the capacity of the human body to live life, on the other hand psychological comfort, is related to the mind’s ability to keep it functioning perfectly with an external help, and physical comfort is an external environmental effect on the human body. Clothing comfort is classified into three categories i.e. Psychological, Tactile, and Thermal comfort [3] [4]. Fashion and style deals with Psychological comfort. Tactile comfort is a function of stress distribution in fabric and skin, which is strongly, depends on the surface and mechanical properties of fabrics and is associated with fabric handle. Fabric handle always differ from person to person due to different culture, background, climate, individual likings, etc. The fabric transmission properties directly effects the thermal comfort, which mean fabric should have ability to perspire and maintain constant temperature of skin.

The body is rarely maintain a thermal steady state, but it is continuously exposed to transients in physical activity and environmental conditions [5]. In the discussion of clothing comfort, the transfer of water vapour and heat are the prime factors. Another property, which plays a critical role to decide comfort, is the body temperature. Few researchers investigated that, how a fabric can assist during heat inflow and outflow from the body through heat loss or gain, because of the difference in temperature between environment and skin. Air permeability, thermal resistance, liquid water permeability and water vapour permeability are the four properties, which directly influence the thermal comfort. Thermo-physiological comfort is not related with psychological factors but with body temperature.

Another researcher Saville [6] classified the clothing comfort in to two types: thermo-physiological wear comfort and skin sensational wear comfort. First, one deals with heat and moisture transfer through clothing to maintain body temperature. Second one deals with the mechanical contact of fabric with human body its softness, lack of irritation, pricking, or cling on damping. There is another type of comfort, called body movement comfort i.e. the body movement during fabric wear.

The change in yarn structure is able to make some effective changes in fabric quality from the view of comfort. The different yarn manufacturing techniques of yarn are able to create different structural characteristics in yarns. Therefore, this research work aims to investigate the effect of influence of yarn structure on fabric comfort by changing different yarn manufacturing technologies like ring, rotor, and compact.

II. Materials

In this study, four yarns of 24s Ne count, prepared from cotton fibre were used. The specifications of the fibres used in this work are summarized in Table 1.

Table-1: Yarn details

Yarn type	**Ring 24s**	**Ring 2/48s**	**Rotor 24s**	**Compact 24s**
Material	100% cotton	100% cotton	100% cotton	100% cotton
Twist per inch	16.36	15.96 doubles-S 17.92 sinlge- Z 18.00 Single-Z	13.24	15.52
Count	24/1 Ne	2/48 Ne	24/1 Ne	24/1 Ne
Diameter, mm	0.24	0.23	0.26	0.22
Yarn to metal friction	0.24	0.24	0.25	0.23
Hairiness	3364	1470	389	1070

III. Methods

A. Sample preparation

Type of fabric – Plain knitted fabric (single jersey)
Machine used – circular bed
Machine Gauge- 18
No. of samples-5
Length of each sample-2.5 meter

B. Sample characterization

Determination of Air permeability

TEXTEST Air permeability tester (FX330) was used to measure the air permeability of fabrics according to the ASTM D727.The air permeability of a fabric is the volume of air measured in cubic centimeters passed per second through 1 cm^2 of the fabric at a pressure of 1 cm of water.

Determination of Thermal Insulation

ALAMBETA thermal insulation tester was used to measure the thermal insulation of the fabrics. ASTM F1868 standard was followed.

Determination of Compression and Surface characteristics

Two modules of Kawabata have been used.

1. KES-FB3-Compression
2. KES-FB4-Surface friction and variation

Determination of MVTR (Moisture vapor transmission rate)

PERME W3/060 instrument was used to measure water vapor transmission rate. ASTM E96 was followed to measure the water vapor transmission rate

IV. Result and discussion

A. Air permeability measurement

Samples were tested at a pressure of 125 Pascal. Thirty readings was taken for each sample. From the Fig. 1, it was observed that the fabrics made from compact yarn results in more permeable because of its lowest diameter. And it is obvious that when diameter will be lesser, the inter yarn space will be higher in the fabric, as a results the fabrics will allow more air to be pass through. The two-ply yarn may tend to align in the plane of fabric axis and turn flattened.

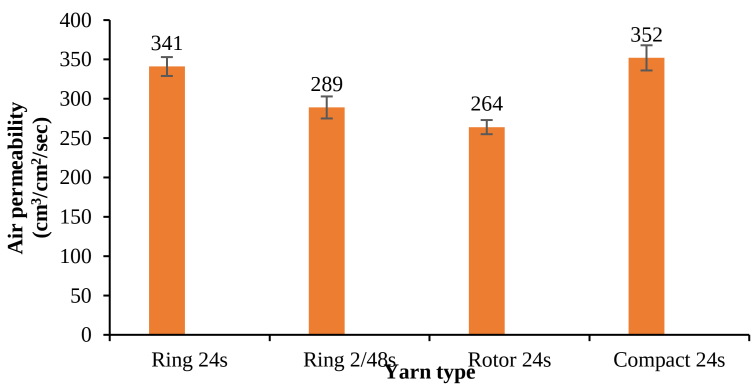

Figure-1: Air permeability of fabrics

That is why at the time of compression the air permeability of same count ply yarn showed less air permeability due to the flattening effects. When yarns get flattened the overall fabric cover increases. Therefore, the increased fabric cover pull down the air permeability when yarn is in flat condition.

B. Thermal Insulation

The thermal insulation of fabrics tested on ALAMBETA thermal insulation tester are given in the Figure 2.

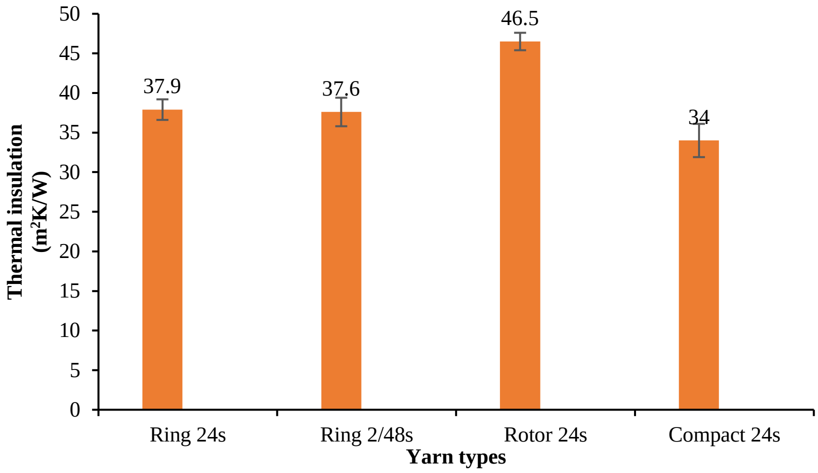

Figure-2: Thermal insulation of fabrics

From the Fig. 2, it was found that fabric knitted produced by rotor yarn, provides better thermal insulation. The possible reasons may be its more bulk and lesser packing density, can entrap more air than other yarns. Accordingly, the fabrics manufactured by ring yarn results comparatively better insulation than the fabric of compact yarn, because the hairiness of ring yarn is greater than compact yarn, which can entrap air on surface and results in better thermal insulation properties. There is very small difference noticed in thermal insulation between the fabrics of ring single and ply yarn.

C. Kawabata evaluation

From the Table 2, it is observed that Linearity of compression found highest for the fabric made of compact yarn because of its higher packing density allows lesser space between the fibres in the yarn. Therefore, the fabric needs higher compressive force to compress and its exhibits height resilience. On the other hand the rotor yarn needs least energy to compress, because of its lowest packing density, which reflects in low compressional resilience. There is very less difference detected between the compression resilience of the fabrics of rotor yarn and ring yarn, sometimes the rotor absorbed more energy to be compressed.

Table-2: KAWABATA evaluation results

Fabric	Ring 24s	Ring 2/48s	Rotor 24s	Compact 24s
Linearity of compression LC (lb/inch^2)	0.341	0.377	0.359	0.413
Compressional energy WC (gf.cm/cm^2)	0.643	0.702	0.437	0.821
Compressional Resilience RC (%)	38.44	37.65	42.91	48.94
Coefficient of friction MIU	0.214	0.234	0.284	0.204
Mean deviation of MIU MMD	0.0076	0.0104	0.0154	0.0086
Geometrical roughness SMD	2.714	4.636	6.496	4.335

The possible reason may be the wrapper fibres, which are tight and tucked on the yarn surface, undergo elastic extension during compression. Upon, removal of load the wrapper fibres as annulus would recover better compared to ring yarns.

D. MVTR (Moisture vapor transmission rate)

Moisture vapour transmission rate is found higher for the fabric of compact and ring yarns in comparison with rotor yarn as shown in fig. 3. Due to higher diameter, the fabric prepared by rotor yarn results in less permeable because of its higher bulk also. The inter yarn spaces in the fabric is low for rotor yarn, which effects the moisture vapour transmission. Moisture vapour transport has direct correlation with air permeability.

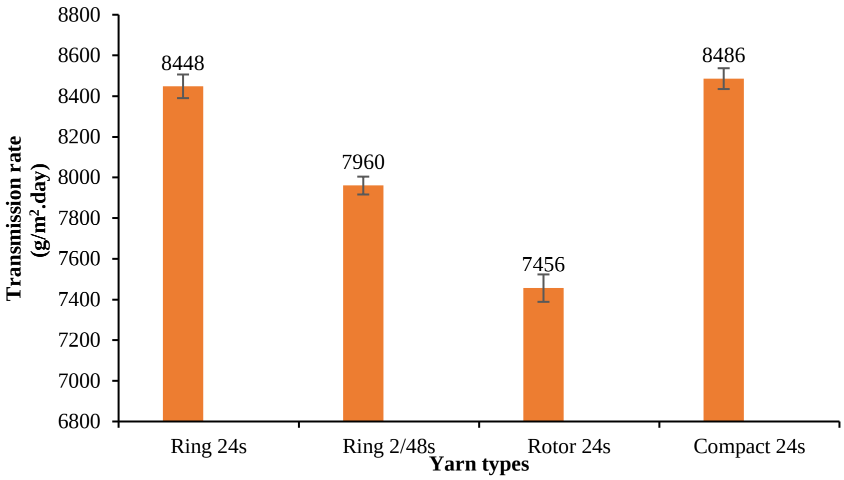

Figure-3: Moisture vapour transmission rate of fabrics

V. Conclusions

Air permeability of the fabrics produced by rotor yarn is lowest, followed by ring, and compact yarn. Thermal insulation of knitted fabric of compact yarn is found lowest, followed by Ring yarn and rotor yarn. Linearity of compression of rotor yarn knitted fabric is lowest, followed by ring yarn knitted fabric, and compact yarn knitted fabric. Compressional energy of rotor yarn knitted fabric is lowest, followed by ring yarn knitted fabric, and compact yarn knitted fabric. Compressional Resilience of ring yarn knitted fabric is found lowest, followed by rotor and compact yarn. Coefficient of friction of the fabric of compact yarn is found lowest, followed by the fabric of and rotor yarn.

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