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EFFECT OF STITCH TYPE ON AIR PERMEABILITY 0F SUMMER OUTERWEAR KNITTED FABRICS

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ABSTRACT

The air permeability of a fabric is the volume of air measured in cubic centimeters passed per second through 1cm^2 of the fabric at a pressure of 1cm of water. The structure of a fabric plays vital role in determining its air permeability. In this study, weft knitted structures with different knit, tuck and miss (float) stitches combinations are produced. It is aimed at determining the effect of fabric structure with different stitch type on air permeability property, which is important factor in the people's perception of wear comfort. The air permeability measurements of produced knitted samples were made. From the obtained results, it is clear that stitch type has explicit impact on air permeability property of knitted fabrics. Loose knitted structure and porous structure with high percent of tuck stitches shows maximum air permeability compared with knit and miss stitches structures..

***Keywords**: Air Permeability, Circular Knitting Machine, Float stitch , Gauge, Tuck Stitch.*

I. INTRODUCTION

Knitting has long been recognized as a leading method of forming fabrics for various end uses. Knitted fabrics are widely used in outerwear due to their excellent stretch and recovery, porosity, air permeability and softness. The knitting parameters and the type of structure not only affect the comfort but also the performance properties of the knitted fabrics [1]. There are three basic knitted stitches; knit, tuck and miss (float or non-knit). Some fabrics have a combination of two or even three of the loop types. As might be expected fabric properties change as different loop types are knitted. All the various shapes and sizes of loops are made by controlling the height that a given needle is raised. Fabrics containing different types of loops will have one appearance on the technical face and another appearance on the technical back [2].

A knitted loop stitch is produced when a needle receives a new loop and knocks over the old loop that it held from the previous knitting cycle. The old loop then becomes a needle loop of normal configuration. The use of tucks and floats changes fabric characteristics. When the needle raised by a cam action to obtain yarn in the hook, but is not raised high enough to clear the previously formed loop below the latch, the needle will have two loop in the hooks tuck stitch is formed when it knits at next course. Tuck Stitches are used to create design effects with difference colored yarns, textured looks, or eyelet patterns. When using tuck stitches the fabric is wider, thicker and slightly less extensible. Tuck stitch structure is more open and porous than the knit stitched fabrics. When the needle is not raised upward to receive the new yarn that is presented to it, but it will retain the old loop in the hook. long float is not desirable which cause problem of snagging. It's used for designing when

an unwanted colored yarn is to be hidden completely from the surface. When using miss or float stitches, the fabric is narrower and much less extensible than either knitted or tucked stitched structure. Fabric is flimsy or less rigid compare to others [3].

Oinuma (1990) [4] examined that as the fabric with the lowest courses per centimeter and yarn number (tex) has the highest air permeability values. Therefore, raising loop length caused looser surface in fabric which increased the air permeability. Islam M.A (2014) [5] studied on the effect of increased tuck and miss loops on spirality of single jersey fabric. Ogulata and Mavruz (2010) [6] stated after their research that since, knitted fabrics have a loop structure, they have more pores than woven fabrics; therefore, in general, the air permeability of knitted fabrics is higher than that of the woven fabrics of the same weight. An experiment to determine the air permeability is very important as it defines the properties of keeping warm, protection against the wind, breathability etc., of knitted fabrics used as clothing.

Chen, Li, and Zhang (2008) [7] indicated that under comfortable conditions, fabrics with lower weight per square meter, higher thickness and air permeability will be more heat comfortable, while fabrics with higher air permeability, moisture regain and vertical wicking height will be more moisture comfortable. Miraftab (2012) [8] has concluded that given the similar raw material, fabric weight and chemical processing, the pique fabric gives the highest air permeability, followed by the single jersey and the interlock fabrics. Nazir, Hussain, Ahmad, and Faheem (2014) [9] found that the fabric mass per square meter increases by increasing the machine gauge and decreasing the stitch length, whereas the fabric thickness and porosity increase at these settings.

Bhattacharya and Ajmeri (2013) [10] found that air permeability is a function of the thickness, tightness factor and porosity of the knitted fabrics and excel single jersey fabrics are considered preferred candidates for warmer climate sportswear, due to their higher air permeability. Mikucioniene, Milašiute, Baltušnikaite, and Milašius (2012) [11] investigations show that an increase in the loop length of the fabrics investigated increases their permeability to air, likewise an increase in the linear density of the yarn permeability to air of knits decreases. Tugrul Ogulata and Mavruz Mezarcioz (2011) [12] found that the fabric with the lowest course count per cm and yarn number in Tex has the highest air permeability values. Moreover, increasing the loop length produced a looser surface in the fabric and increased air permeability. Ciukas and Abramaviciute (2010) [13] investigated that variation in air permeability depending on the area density, linear density, loop length and tightness factor of plain and plated plain knits.

The air permeability of a fabric is the volume of air measured in cubic centimeters passed per second through $1cm^2$ of the fabric at a pressure of 1cm of water. The air permeability of a fabric is a measure of how well it allows the passage of air through it [14], [15]. In outdoor clothing it is important to have air permeability as low as possible for achieving better wind protection [6], [16]. Generally, the air permeability of a fabric can influence its comfort behaviors in several ways. In the first case, a material that is permeable to air is, in general, likely to be permeable to water in either the vapor or the liquid phase. Thus, the moisture-vapor permeability and the liquid-moisture transmission are normally related to air permeability. In the second case, the thermal resistance of a fabric is strongly dependent on the enclosed still air, and this factor is in turn influenced by the fabric structure.

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A detailed study is carried out here on various knitted fabrics structures with different stitch type (knit, tuck, miss) to understand the effect of fabric structure on air permeability.

II. MATERIAL AND METHODS

For the nine single weft knit structures, one of them was plain knit (single jersey) while the other eight of them were different combinations of knit, tuck and miss stitches. The notations of the nine single knitting structures which represent different types of loops were shown in Table (1). These fabrics were produced on a circular knitting machine (Gauge 24 and Diameter 30") with 100% combed ring spun (30/1 Ne) cotton.

Table1 The Specifications of Single Weft Knitted Structures

Sample No.	Notation diagram	Types of stitches	Fabric Weight (g/m^2)	Fabric Thickness (mm)	CPI (courses per inch)	WPI (Wales per inch)
`1	× × × × × × All Feeders	Only knit stitches	146	0.62	48	29
2	× × × × × . **F. 5-9** × × × × × × **F. 1-4**	91% Knit Stitches 9 % Tuck Stitches	151	0.64	50	27
3	. × × × × × **F.7-12** × × × . × × **F.1-6**	83 % Knit Stitches 17 % Tuck Stitches	158	0.68	53	24
4	. × . × . × **F. 4** × × × × × × **F. 3** × . × . × . **F. 2** × × × × × × **F. 1**	75 % Knit Stitches 25 % Tuck Stitches	166	0.72	56	22
5	. × . × . × **F. 2** × . × . × . **F. 1**	50 % Knit Stitches 50 % Tuck Stitches	175	0.77	59	19
6	× × × × × **F. 5-9** × × × × × × **F. 1-4**	91% Knit Stitches 9 % Miss Stitches	142	0.6	53	32
7	× × × × × **F.7-12** × × × × × **F.1-6**	83 % Knit Stitches 17 % Miss	138	0.58	57	34

								Stitches			
8		×		×		×	**F. 4**	75 % Knit Stitches	130	0.53	62	39
	×	×	×	×	×	×	**F. 3**					
	×		×		×		**F. 2**	25 % Miss Stitches				
	×	×	×	×	×	×	**F. 1**					
9								50 % Knit Stitches	122	0.47	68	45
		×		×		×	**F. 2**					
	×		×		×		**F. 1**	50 % Miss Stitches				

☒ = knit stitch

⊡ =Tuck stitch

☐ = Miss stitch

The testing of fabric samples was performed using ten replicates of each sample. Fabric thickness was determined according to ASTM D1777[17]. Fabric mass per square meter was determined according to ASTM D3776[18]. Air permeability was measured using air permeability tester following the standard test method ASTM D737[19].

The fundamental concept lies behind this study is to investigate the effect of stitch type on air permeability of single weft knitted fabrics.

III. RESULTS AND DISCUSSION

3.1. Fabric Thickness (mm)

The effect of knitting stitch type on the thickness of Single knitted fabric is shown in Figure (1). Figure (1) showed that, there is direct relationship between stitch type percent in the structure (from 0% to 50%) and fabric thickness. It is clear that, the thickness of the single knitted fabric increases with the increase of tuck stitches percent in the structure and decreases with the increase of miss stitches percent in the structure. Fabric with tuck stitches is thicker than knit stitches due to accumulation of yarn in stitches at tucking laces. Miss (float) stitch makes the fabric thinner than the tuck stitched one, as there is no yarn accumulation.

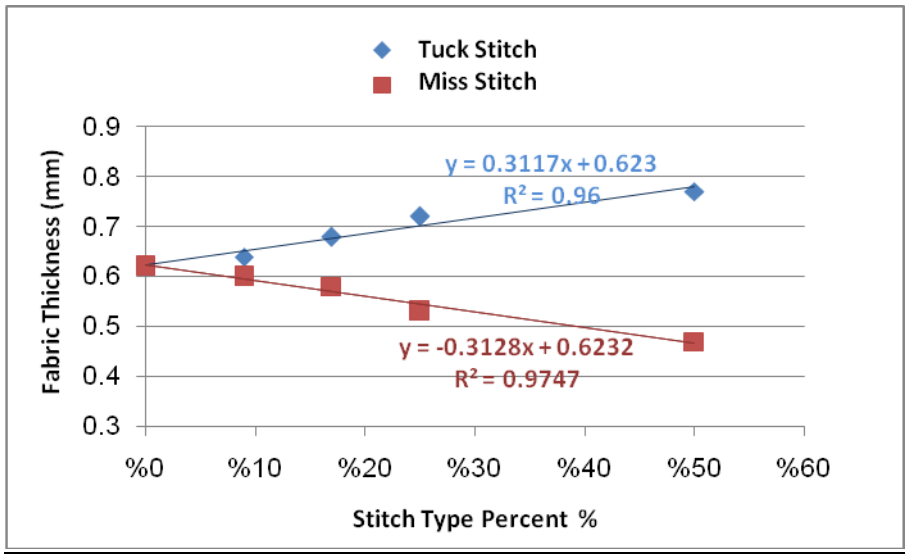

Figure 1 The Relationship between the Fabric Thickness (mm) and Stitch Type Percent % for Single Weft-Knitted Structures

3.2 Fabric Weight (g/m^2)

The effect of knitting stitch type on the weight of Single knitted fabric is shown in Figure (2). Figure (2) showed that, there is direct relationship between stitch type percent in the structure (from 0% to 50%) and fabric weight. It is clear that, the weight of the single knitted fabric increases with the increase of tuck stitches percent in the structure and decreases with the increase of miss stitches percent in the structure. Due to the thicker in nature, the tuck stitched fabric is heavier in weight per unit area than the knit stitches. Miss (float) stitches make a basic knit fabric narrower , thinner with less weight.

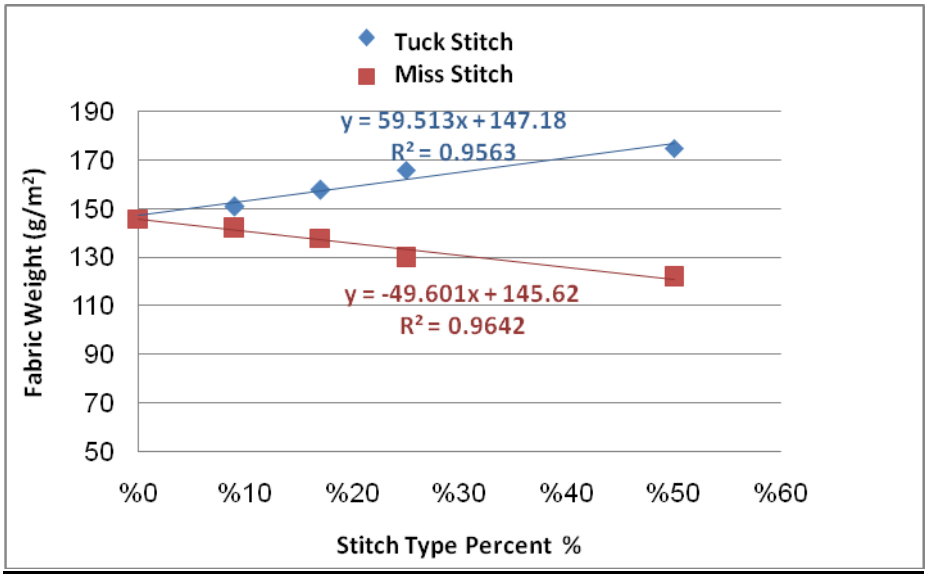

Figure 2 The Relationship between the Fabric Weight (g/m^2) and Stitch Type Percent % for Single Weft-Knitted Structures

3.3 Air Permeability (l/m^2/s)

The effect of knitting stitch type on the air permeability of Single knitted fabric is shown in Figure (3). Figure (3) showed that, there is direct relationship between stitch type percent in the structure (from 0% to 50%) and air permeability. It is clear that, the air permeability of the single knitted fabric increases with the increase of tuck stitches percent in the structure. Loose knitted structures with tuck stitches are more permeable to air owing to their higher porosity compared with knit or miss stitches. Tuck stitched structure is more open and porous than knit stitched fabric.

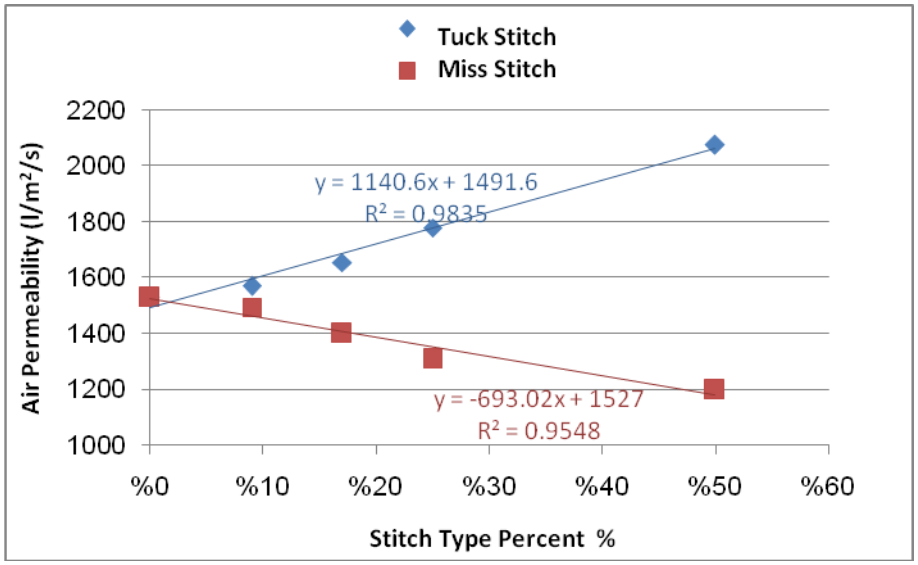

Figure 2 The Relationship between the Fabric Weight (g/m^2) and Stitch Type Percent % for Single Weft-Knitted Structures

IV. CONCLUSION

Regarding the comfort of a knitted fabric air permeability is an important factor used for evaluating and comparing the 'breathability'. In this study, fabrics with different knit, tuck and miss (float) stitches are produced from 100% combed ring spun (30/1 Ne) cotton yarn. It is aimed at determining the effect of fabric structure with different stitch type on air permeability property. The results obtained in the present work indicated that, fabric properties change as different stitch types are knitted, when using tuck stitches the fabric is wider, thicker and heavier while using float stitches, the fabric is narrower, thinner and lighter. It was obvious that, the stitch type has a significant effect on the fabric thickness, weight and air permeability for all weft knitted samples. It was concluded from this study that, the increase in fabric porosity by increasing the tuck stitches percent consequently results in increase in fabric air permeability. The higher air permeability rate the quickest heat-loss obtained from a textile material. For summer wear, structures with tuck stitches could be used as it is characterized by higher air permeability, creating a cool feeling to the wearer by allowing more cold air to penetrate through to bring the heat away from the body and accelerate the sweat evaporation at the skin and fabric surface.

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