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Effect of fibre, yarn and fabric variables on heat and moisture transport properties of plated knit

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In this study, the effect of fibre, yarn and fabric variables on heat and moisture transport properties of single jersey plated fabrics has been studied. Thermal properties, air permeability as well as moisture vapor and liquid transport properties of fabrics are found to be affected by fibre types, yarn linear density and fabric loop length. Slack fabrics knitted at longer loop length and with finer yarns in the inner layer show lower thermal insulation and are suitable choice as summer wear due to improved permeability of fabrics to air and moisture vapor. Cotton/viscose fabrics show better liquid transport properties along with the highest air and moisture vapor permeability, thereby resulting in rapid liquid dissipation and dry feel next to skin. The designed fabrics are thus suitable for use when an individual is involved in strenuous physical activity.

Keywords: Cotton, Heat transport, Moisture transport, Nylon, Permeability, Plated knit, Polyester, Single jersey fabric, Slack fabric, Thermal properties, Viscose fabric

1 Introduction

Heat and moisture transport properties of functional clothing, like active wear, sportswear and intimate wear are very crucial in providing dry skin micro climate and comfortable environment to the wearer by influencing the clothing's ability to manage heat, moisture vapor and liquid transfer. Wicking and wetting are the two main phenomena which govern the moisture transport properties of textiles. Wicking refers to displacement of a solid–air interface with a solid–liquid interface in a capillary system. Wettability is the initial behavior of a fabric, yarn, or fibre when brought into contact with a liquid and describes the interaction between the liquid and the solid surface prior to the wicking process[1].

Several fibre, yarn and fabric parameters are reported to influence the wetting and wicking behavior of textiles, as they influence the size and geometry of the capillary spaces between the fibres. The liquid transport properties of textiles are primarily influenced by the type of fibres, orientation of molecules, surface finish, cross-sectional shape, surface roughness, yarn structure, yarn tension, yarn twist, fibre shape, number of fibres in yarns, fibre configuration, finish and surfactants. Wicking rate and liquid transported in a fabric also depend on the pore sizes and their size distribution. The capillary principle dictates that smaller pores are completely filled first and then are responsible for the liquid front movement. As the smaller pores are completely filled, the liquid then moves to the larger pores[1].

Plated knit structure is a double layered construction characterized by distinct inner (next to skin) and outer (exposed to the environment) layers. The two layers can be designed and engineered with different combinations of fibres and yarns, thereby ensuring that structures can serve different roles in providing wearer comfort. A combination of natural and synthetic fibre yarns is an optimal solution for designing plated knits intended to provide dry feel next to skin.

Natural and synthetic fibres owing to the difference in moisture absorption and liquid moisture transfer properties have the potential to influence moisture vapor as well as liquid moisture transfer through fabrics. Selection of fibre and yarn combinations in the two layers can have a great bearing on the comfort properties, performance, aesthetic appeal and end use of the knit structures.

Cotton has good permeability to water vapor and air, so it is recommended for summer garments but is

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not a preferred choice as next to skin layer due to skin clinginess and slow drying property[2-6]. On the other hand, synthetic fibres such as polyester, polypropylene and nylon being hydrophobic have an additional advantage of liquid transport and release by capillary wicking without liquid retention[2, 7, 8].

Several researchers have studied the effect of fibre, yarn and fabric parameters on comfort properties of knitted fabrics. Majumdar *et al.*[9] studied the thermal properties of knitted fabrics made from natural and regenerated bamboo cellulosic fibres and observed that air and water vapor permeability increased but thermal conductivity decreased as the proportion of bamboo fibre increased. Bivainyte *et al.*[3] investigated the thermal properties of double layered fabrics knitted of cotton, bamboo and four types of synthetic threads. They found that fabrics knitted from yarns of cotton and synthetic fibres have higher thermal conductivity coefficient than those knitted from bamboo and synthetic yarns. Chidambaram *et al.*[10] studied the thermal comfort properties of bamboo knitted fabrics in relation to yarn linear density and observed that as the yarn gets finer, thermal resistance decreases and air and water vapor permeability increases. Similar observations were reported for double layered weft knitted fabrics by Bivainyte *et al*.[3] and Ozdil *et al.*[11] in their studies on rib fabrics. Chidambaram *et al.*[10] studied the effect of loop length on thermal comfort properties of bamboo knitted fabrics and observed an increase in air and water vapor permeability with the increase in loop length. Herath[12] observed that fabric tightness is correlated with air permeability, aerial density and fabric thickness. Fabrics knitted with lower loop length showed higher thickness & weight, and lower air permeability. Kumar and Das[13] suggested that tightness of knitted fabric structure affected the wicking nature of fabrics with tighter fabrics showing lesser amount of vertical wicking compared to loose fabrics.

Studies are mainly focused on the effect of fibre, yarn and fabric constructional variables on comfort properties of single and double jersey structures, however there is lack of detailed and systematic studies on plated knits although the structures are fast becoming preferred choice as inner wear and intimate wear. Limited studies are devoted on the effect of inner layer fibre, yarn and fabric parameters on heat and moisture transport properties of plated fabrics even though the type of fibre and yarn used in the inner (next to skin) layer can greatly influence heat, moisture vapor and liquid transport to the outer fabric layer. In the view of foregoing, it becomes inevitable to examine the influence of different combinations of fibre, yarn and fabric variables in the two layers of plated knits which has not been reported explicitly so far. The present study is therefore, undertaken to draw some concrete conclusions regarding the effect of fibre, yarn and fabric variables in the distinct layers of plated knits on heat and moisture transport properties.

2 Materials and Methods

2.1 Materials

Cotton spun yarn (Ne 20), and filament yarns of polyester (250D/100, 100D/100 and 200D/200), nylon (70D/20) and viscose (40D/100 and 80D/200) were used for the preparation of twelve single jersey plated knit samples (Table 1). Cotton yarn was used in the outer layer while filament yarns of three varying fibre types were used in the inner (next to skin) layer in all the test samples. Of the total twelve test samples, nine samples (CP1- CP3, CN1- CN3 and CV1-CV3) were knitted at three levels of loop length to obtain tight, medium and slack structures (Table 2).

The test samples were prepared on hand-operated flatbed knitting machine (Elex, China) with machine gauge of 12, needle bed of 42 inch and 504 needles on each bed. The machine had two needle beds – front and rear. The front bed was utilized for sample preparation.

2.2 Methods

The test samples were washed with 1% (w/v) nonionic detergent (Lisapol N) at 40°C for 30 min followed by tumble drying for 30 min.

Table 1 — Experimental Plan for sample preparation

Sample code	Fibre content in IL/OL	Yarn D in IL den	Number of filaments in IL	Yarn D in OL Ne	Resultant yarn D tex
CP_1	PET/C	250	100	2/40	57.3
CP_2	PET/C	250	100	2/40	57.3
CP_3	PET/C	250	100	2/40	57.3
CP_4	PET/C	100	100	2/40	40.6
CP_5	PET/C	200	200	2/40	51.7
CN_1	N/C	70	20	2/40	37.3
CN_2	N/C	70	20	2/40	37.3
CN_3	N/C	70	20	2/40	37.3
CV_1	V/C	40	100	2/40	34.0
CV_2	V/C	40	100	2/40	34.0
CV_3	V/C	40	100	2/40	34.0
CV_4	V/C	80	200	2/40	38.4

IL – Inner layer, OL – Outer layer, D – linear density, PET – polyester, C – Cotton, N – nylon, V – Viscose.

Table 2 — Physical properties of single jersey plated fabrics

Sample code	Aerial density g/m^2	Thickness mm	Courses/ cm	Wales/ cm	Loop length mm	Tightness factor
CP_1	259	1.34	7.87	7.08	4.8	15.7
CP_2	239	1.33	8.66	6.29	5.0	15.1
CP_3	233	1.33	8.66	6.29	5.2	14.5
CP_4	132	0.80	7.87	5.51	4.8	13.3
CP_5	213	0.94	7.87	5.51	4.8	15.0
CN_1	242	1.31	8.66	7.87	4.8	12.7
CN_2	239	1.30	8.66	7.87	5.0	12.2
CN_3	231	1.27	9.44	7.87	5.2	11.7
CV_1	182	0.93	7.87	6.29	4.8	12.1
CV_2	152	0.88	7.87	5.51	5.0	11.6
CV_3	133	0.85	8.26	5.51	5.2	11.2
CV_4	143	1.04	8.66	5.51	5.2	11.9

2.2.1 Physical Characterization of Test Samples

Aerial density, determined according to ASTM D-1059, was obtained by dividing the weight of test sample with the area of the sample. The thickness of fabrics was determined on Essdiel thickness gauge at a pressure of 20gf/cm^2 according to ASTM D 1777-96, 2007. Course and wale density was determined by counting the number of courses and wales per centimeter as per ASTM D3775-03 using pick glass. Tightness factor of the test fabrics was determined using the following equation:

$$\text{Tightness factor} = \frac{\sqrt{\text{Tex}}}{\text{Loop length}} \qquad \dots (1)$$

where l is the loop length in cm.

2.2.2 Comfort Characteristics

Thermal Properties – Fabric samples were evaluated for their thermal properties, such as thermal resistance (TR), thermal conductivity (TC) and thermal absorptivity (TA) on Alambeta (Sensora, Czech Republic).

Air Permeability – Air permeability (AP) of the fabrics was measured on FX 3300 air permeability tester (TEXTEST AG, Switzerland) at a pressure of 98 Pa according to ASTM D737.

Relative Water Vapor Permeability – Relative water vapor permeability (RWVP) of test samples was measured using the Permetest instrument (Sensora, Czech Republic) according to ISO 11092 standard.

Vertical Wicking – A sample of 200 mm × 25mm size was cut along course and wale directions to perform vertical wicking test. The test samples were suspended vertically with the bottom end clamped by a weight for ensuring proper immersion in a reservoir of distilled water[10].

Water Absorbency – Water absorbency of test samples was determined by gravimetric Absorbency Tester (GATS).

2.2.3 Statistical Analysis

Statistical analysis was performed by carrying out one way Anova analysis using SPSS 16 window statistical software. F and p values were obtained which enabled to conclude whether the effect of selected fibre, yarn and fabric variables has significant influence on the test properties.

3 Results and Discussion

3.1 Fabric Characterization

Table 2 shows the physical properties of test samples. Aerial density of cotton/polyester fabrics lies in the range of 132 – 259 g/m^2, while that for cotton/nylon and cotton/viscose fabrics varies in the range of 231 – 242 g/m^2 and 133 – 182 g/m^2 respectively. The thickness lies between 0.80 mm and 1.34 mm for cotton/polyester, 1.27 mm and 1.31 mm for cotton/nylon and 0.85 mm and 1.04 mm for cotton/viscose fabrics. Tightness factor varies from 13.3 to 15.7 for cotton/polyester, 11.7 to 12.7 for cotton/nylon and 11.2 to 12.1 for cotton/viscose fabrics.

3.2 Comfort Characteristics

3.2.1 Thermal Properties

Thermal resistance and thermal conductivity of plated fabrics knitted with polyester yarn of varying linear density in inner layer decreases as the polyester yarn becomes finer. Similar trends are observed for fabrics with viscose yarn of varying linear density in the inner layer plus cotton yarn of fixed count in the outer layer. Statistical analysis of test results show that the effect of yarn linear density has significant affect on thermal resistance (F value of 13.8 & p value of 0.06). The findings are in accordance with Chidambaram *et al.*[10] on thermal properties of bamboo knitted fabrics. Decrease in thermal resistance may be attributed to the reduction in fabric thickness and aerial density with decrease in yarn linear density (Tables 2 and 3). An inverse relationship is registered between thermal resistance and thermal conductivity as given by the following equation:

$$R = \frac{h}{\lambda} \qquad \dots (2)$$

where R is the thermal resistance (km^2/W); h, the fabric thickness (mm); and λ, the thermal conductivity (W/mK).

However, the test results indicate that as the thermal resistance decreases, the thermal conductivity decreases as well. This contradiction might be explained by fabric thickness. Yarn diameter and therefore fabric thickness decrease as the yarn becomes finer. If the amount of decrease in thickness is more than the amount of decrease in thermal conductivity, the thermal resistance also decreases. The average reduction in thickness with decrease in yarn linear density for cotton/polyester fabrics is found to be 22.4% as against 6.5 % decrease in thermal conductivity. Hence, the observed trend can be explained in this light.

As the fabric loop length increases, thermal resistance and thermal conductivity decrease, irrespective of the inner layer fibre type (polyester, viscose or nylon) (Table 3). The decrease in thermal resistance can be attributed to corresponding decrease in fabric thickness with the increase in loop length. Thickness by far is the greatest determinant of thermal insulation properties of textiles and hence decreases in thermal resistance with an increase in loop length (Table 3).

Cotton/polyester fabrics show the highest value while cotton/viscose fabrics show the lowest value of thermal resistance. The observed trend may be attributed to the highest fabric thickness along with low conductivity of polyester fibre compared to viscose and nylon fibres since thermal resistance depends both on fabric thickness and thermal conductivity (Eq. 2). Likewise, the highest thermal conductivity of cotton/nylon fabric may be attributed to the highest conductivity of nylon fibre compared to other two fibres used in the study (Table 3).

Table 3 — Thermal properties, relative water vapor permeability and air permeability

Sample code	TR×10^{-3} km^2/W	TA W s$^{1/2}$ m^{-2} K^{-1}	TC×10^{-3} W/mK	RWVP %	AP cm^3/cm^2/s
CP$_1$	34.18	84.5	43.15	49.4	47.3
CP$_2$	33.34	83.2	42.22	50.0	55.5
CP$_3$	32.10	82.5	42.00	52.1	57.0
CP$_4$	26.53	70.4	37.60	60.4	62.0
CP$_5$	31.06	71.0	37.80	59.2	58.0
CN$_1$	30.20	103.5	53.35	53.3	72.5
CN$_2$	29.70	101.1	49.22	55.2	74.0
CN$_3$	28.00	91.1	48.00	56.0	79.0
CV$_1$	25.86	80.0	38.02	55.0	154.0
CV$_2$	25.80	78.8	37.56	57.0	158.0
CV$_3$	25.20	74.2	36.00	58.1	229.0
CV$_4$	28.22	84.0	41.00	53.2	212.0

TR – Thermal resistance, TA – thermal absorptivity, TC – thermal conductivity, RWVP – relative water vapor permeability, AP – air permeability.

Thermal Absorptivity

Figure 1 (a) shows the effect of inner layer yarn linear density on thermal absorptivity of test samples. Thermal absorptivity decreases as polyester and viscose yarns in the inner layer become finer. Results are found to be statistically significant for both cotton/polyester ($F = 7.93$ & $p = 0.02$) and cotton/viscose fabrics ($F = 8.3$ & $p = 0.04$). It can thus be inferred that these fabrics would be perceived warmer on initial brief skin contact. Plated fabrics knitted with finer yarns give slacker constructions as indicated by lower value of tightness factor (Table 2), which, in turn, leads to reduced thermal absorptivity. Similar trends were also observed by Ozdil *et al.*[11] in their studies on thermal comfort of knitted fabrics.

Thermal absorptivity of cotton/polyester, cotton/nylon and cotton/viscose fabrics decreases as the fabrics are knitted with longer loop lengths, as shown in Fig. 1 (b). The decrease in thermal absorptivity can be attributed to corresponding decrease in thermal conductivity and bulk density as the fabric loop length increases, owing to direct dependence of thermal absorptivity on thermal conductivity and bulk density as per following equation:

$$b = \sqrt{\lambda \rho c} \qquad \dots (3)$$

where b is the thermal absorptivity; λ, the thermal conductivity; ρ, the fabric density; and c, the specific heat capacity of fabric.

Cotton/nylon fabrics show the highest value of thermal absorptivity as shown in Fig. 1(c), thereby suggesting that these fabrics would be perceived coolest on first contact with skin. The observed trend may be attributed to higher thermal conductivity of cotton/nylon fabric. However, cotton/viscose fabric with the lowest value of thermal absorptivity would give warm feeling on first contact with the skin.

3.2.2 Relative Water Vapor Permeability

Figure 2 (a) shows the effect of inner layer yarn linear density on relative water vapor permeability (RWVP). An increase in RWVP is observed for both cotton/polyester and cotton/ viscose fabrics as the

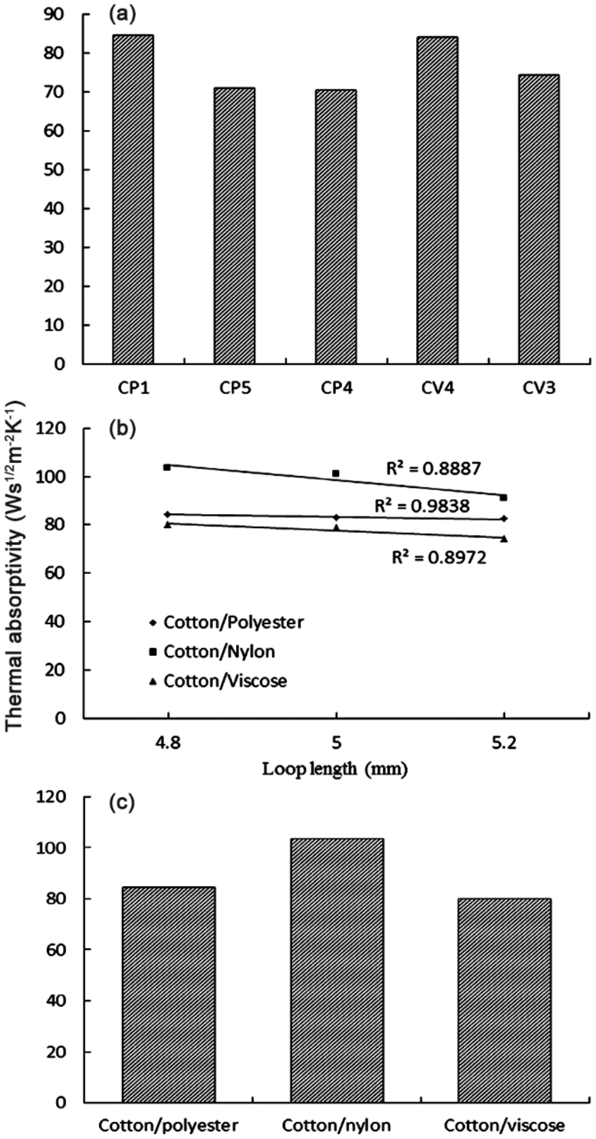

Fig. 1 — Effect of (a) inner layer yarn linear density, (b) loop length, and (c) inner layer fibre type on thermal absorptivity

polyester and viscose yarns in the inner layer become finer (Table 3). Results are found to be statistically significant at 95%. Fabrics knitted with finer yarns result in more open and porous structures, thereby allowing easier passage of water vapor through the structure. Moreover, the lower thickness and mass per square metre of finer yarn fabrics also contribute towards increased water vapor permeability as compared to their coarser yarn counterparts.

RWVP of test samples increases with the increase in loop length, irrespective of the fibre type in the inner layer, as shown in Fig. 2 (b). The reason being, the increase in loop length results in fabrics of slacker and open construction, thereby enabling easier passage of water vapor through these fabrics.

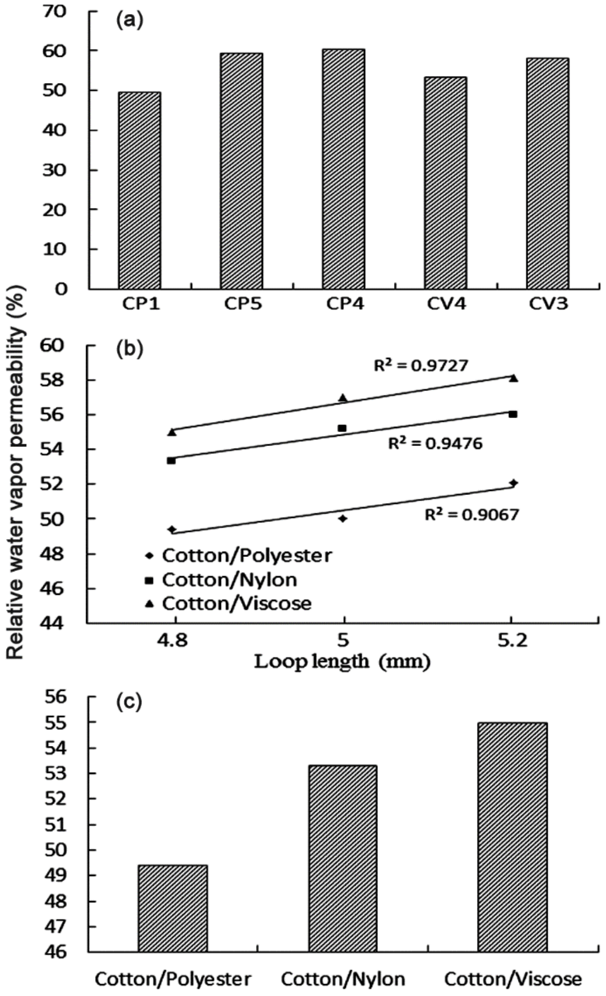

Fig. 2 — Effect of (a) inner layer yarn linear density, (b) loop length, and (c) inner layer fibre type on relative water vapor permeability

Cotton/viscose fabric shows the highest value of relative water vapor permeability while cotton/polyester fabrics are found to be the least permeable to passage of moisture vapor as shown in Fig. 2 (c). The observed trend can be explained by higher moisture regain of viscose fibre compared to polyester and nylon fibres. Moisture vapor diffusion through textiles depends on both moisture diffusivity of fibres and bulk properties of fabrics. Higher moisture regain of viscose fibre leads to higher diffusion of moisture vapor through cotton/viscose fabric. However, highest thickness and aerial density of cotton/polyester fabric inhibits easy passage of moisture vapor through fabric and hence lowest RWVP for cotton/polyester fabric.

3.2.3 Air Permeability

Figure 3 (a) shows the effect of inner layer yarn linear density on air permeability (AP) of cotton/polyester and cotton/viscose fabrics. Air permeability shows an upward trend as the polyester and viscose yarns in the inner layer become finer. Results are found to be statistically significant for both cotton/polyester (F = 11.72 & p = 0.008) and cotton/viscose (F = 36.4 & p = 0) fabrics. This may be attributed to reduction in thickness and aerial density of fabrics knitted with finer yarns.

Increase in fabric loop length results in corresponding increase in air permeability, irrespective of the inner layer fibre type, as shown in Fig. 3 (b) and Table 3. One way Anova analysis suggests that the effect of loop length on air permeability is found to be statistically significant. The observed trend may be attributed to increase in slackness and openness of fabric structure along with reduction in tightness factor with the increase in loop length which facilitates easy passage of air through fabrics.

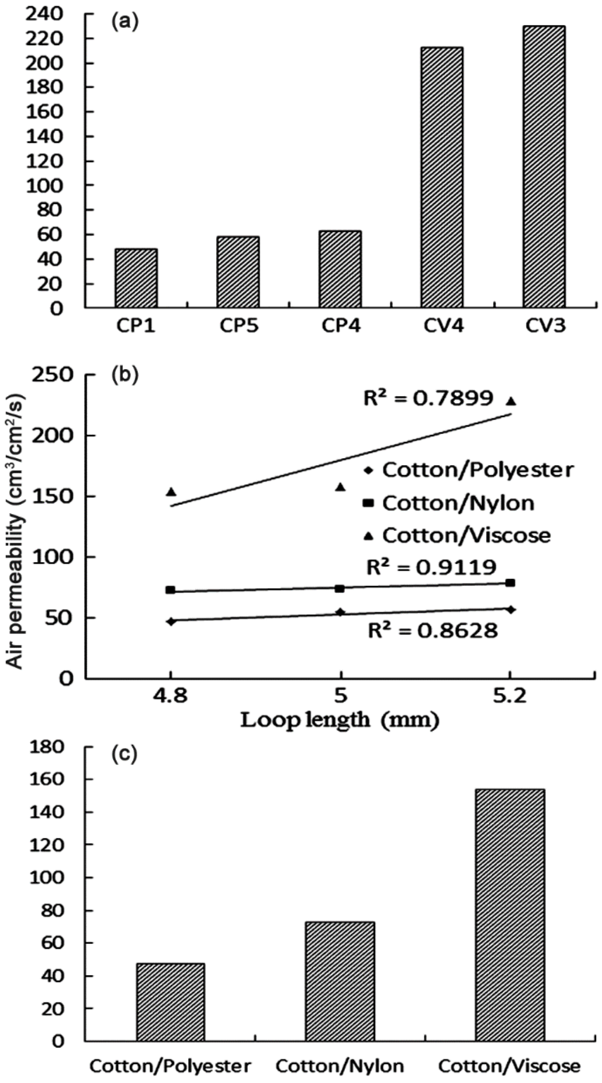

Fig. 3 — Effect of (a) inner layer yarn linear density, (b) loop length, and (c) inner layer fibre type on air permeability

Figure 3 (c) shows the effect of inner layer fibre type on air permeability of test samples. Cotton/viscose fabric shows the highest value of air permeability while cotton/polyester fabric is found to be least permeable to passage of air. Highest air permeability of cotton/viscose fabric may be attributed to highest specific gravity of viscose fibre compared to the other two fibres used in the study. The higher the specific gravity of fibre, the lesser is the volume of fibre for given weight, thus providing less fabric cover and better permeability to air through fabrics.

3.2.4 Vertical Wicking

Table 4 shows the course-wise and wale-wise vertical wicking of test samples. Cotton/polyester and cotton/viscose fabrics knitted with finer polyester and viscose yarns respectively in the inner layer show higher wicking height in both course-wise and wale-wise directions as compared to their coarser yarn counterparts (Fig. 4). The change in polyester linear density from 40.6 tex to 57.3 tex results in significant difference in wicking with respect to time. The increase in wicking height for fabrics knitted with finer yarns can be attributed to increase in the number of fine capillaries; the fibres come closer to each other introducing a greater number of capillaries with smaller diameters likely to promote enhanced liquid flow. As the radius of capillary decreases, pressure generated in the capillary increases, thereby causing faster flow through capillary and hence increased wicking height. All the test samples irrespective of fibre type in inner layer shows no particular trend with the loop length.

Vertical wicking of cotton/viscose fabrics is the highest in both course-wise and wale-wise direction, while cotton/nylon fabrics show the least wicking height after passage of 5 and 10 min both in course-wise and wale-wise directions (Fig. 5). It is expected that viscose fibre being hydrophilic would absorb moisture (as indicated by higher water absorbency of cotton/viscose fabric) and hence inhibit the liquid transfer by vertical wicking, while polyester would result in better wicking owing to its hydrophobic nature. Deviation from the trend can be explained by

Table 4 — Course-wise and wale-wise wicking height in cm

Sample code	1		2		3		4		5		6		7		8		9		10	
	C	W	C	W	C	W	C	W	C	W	C	W	C	W	C	W	C	W	C	W
CP$_1$	0.3	0.7	0.7	1.7	1.2	2.3	1.7	3.3	2.4	3.6	2.7	4.0	3.1	4.5	3.5	5.1	3.7	5.5	3.9	5.9
CP$_2$	1.1	0.9	2.3	2.0	4.1	3.5	5.0	4.4	5.8	5.7	6.4	6.5	7.0	7.0	7.5	7.7	8.3	8.2	8.7	8.6
CP$_3$	0.9	0.5	1.8	1.7	3.0	2.5	3.8	3.5	4.5	4.2	5.8	4.7	6.3	5.4	6.7	5.8	7.2	6.3	7.5	6.6
CP$_4$	2.0	2.3	3.1	3.2	3.8	3.8	4.5	4.6	5	5.5	5.3	6.2	5.7	6.8	6.0	7.2	6.2	7.6	6.4	7.9
CP$_5$	1.1	1.2	2.2	2.3	3.0	3.4	3.8	4.0	4.6	4.8	5.0	5.4	5.5	6.2	5.8	6.5	6.0	6.7	6.2	7
CN$_1$	0.1	0.3	0.2	1.2	0.5	1.8	0.7	2.5	1	3.1	1.2	3.7	1.6	4.2	1.9	4.5	2.3	5	2.5	5.4
CN$_2$	0.1	0.2	0.7	0.7	1.0	1.5	1.5	2.1	2.0	2.4	2.4	3.0	2.9	3.4	3.3	3.7	3.6	3.9	4.0	4.5
CN$_3$	0.3	0	1.1	0.2	1.7	0.4	2.2	0.8	2.8	1.2	3.2	1.7	3.5	2	4.0	2.3	4.2	2.6	4.6	2.8
CV$_1$	2.5	3.3	3.9	5.2	4.6	6.0	4.9	6.7	5.3	7.4	5.7	7.9	6.1	8.2	6.5	8.5	6.7	8.7	7.0	9.0
CV$_2$	2.6	3.5	3.4	5.4	3.8	5.8	4.3	6.7	4.7	7.3	5.2	8.0	5.7	8.4	5.9	8.8	6.2	9.0	6.6	9.2
CV$_3$	2.8	3.3	4.0	5.2	4.9	6.1	5.5	6.9	6.1	7.5	6.7	8.0	6.9	8.4	7.2	8.6	7.4	9.0	7.5	9.4
CV$_4$	3.0	2.2	3.9	3.7	4.6	4.8	5.1	5.5	5.5	5.9	5.8	6.6	6.1	7.1	6.5	7.6	6.7	8	6.9	8.4

1-10 are time in min, C– course-wise, W– wicking-wise.

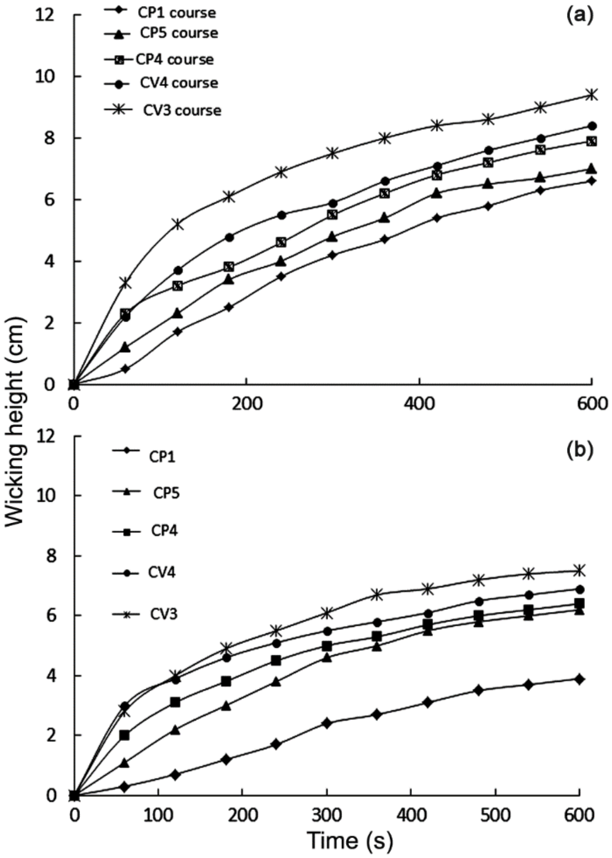

Fig.4 — Effect of inner layer yarn linear density on wicking height (a) course-wise, and (b) wale-wise

the factors that affect the vertical wicking in knitted fabrics. Wicking not only depends on the nature of fibre (hydrophobicity, hydrophillicity) but it also depends on the filament fineness. In the present study, the use of micro denier viscose filament has enabled to achieve higher wicking height in spite of its hydrophilic nature. Thus, it can be inferred that higher wicking can be achieved even with hydrophilic fibre in the inner layer by selection of micro denier filament.

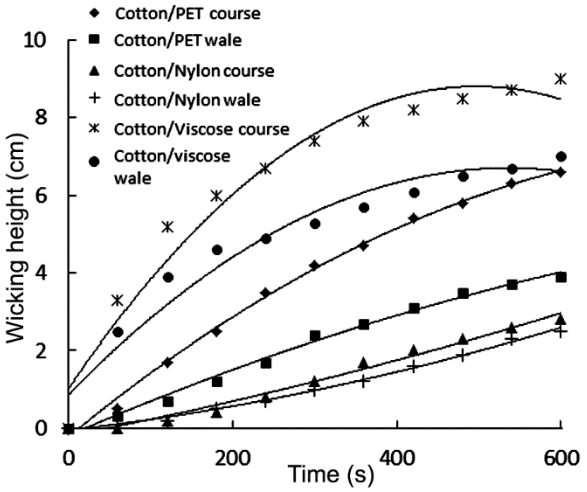

Fig.5 — Effect of inner layer fibre type on vertical wicking

3.2.5 Water Absorbency

Figure 6 (a) shows that water absorbency increases with the increase in inner layer yarn linear density. Amount of water absorbed by fabric depends on its bulk properties i.e. thickness and aerial density. The greater the fabric weight and thickness, the more is the amount of water absorbed by fabric. The increase in inner layer yarn linear density results in the corresponding increase in fabric weight and thickness (Table 2) and therefore, an increase in water absorbency of fabrics knitted with coarser yarns.

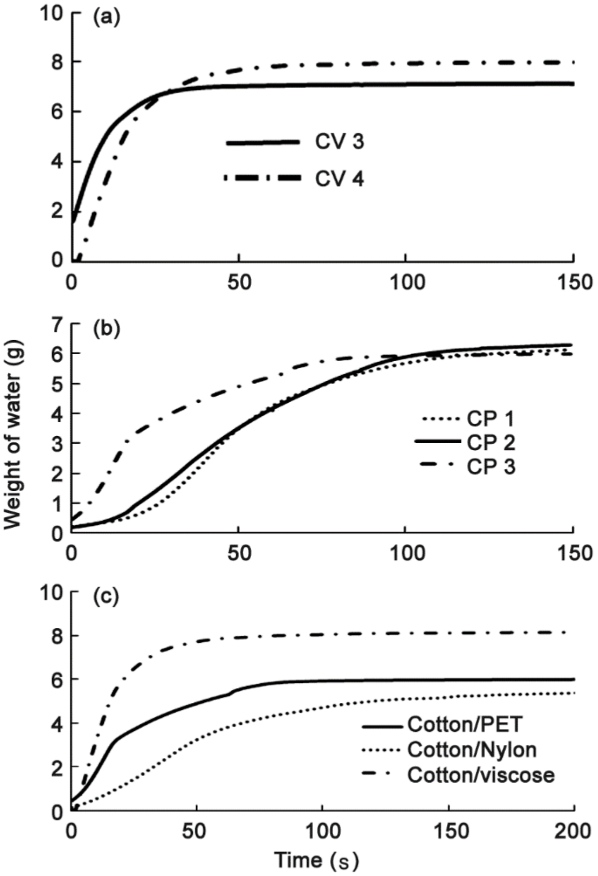

Fig. 6 — Effect of (a) inner layer yarn linear density, (b) loop length, and (c) inner layer fibre type on water absorbency

Water absorbency of fabrics knitted at longer loop length is higher compared to their shorter loop length counterparts, as shown in Fig. 6 (b). Increase in loop length results in fabrics of slack construction and high pore volume. The more the pore volume, the greater is the water entrapped by the pores and hence higher water absorbency of fabrics knitted with longer loop length.

Comparison of fabrics with varying fibre types in the inner layer shows that cotton/viscose fabric has the highest water absorbency and cotton/nylon fabric the lowest value of water absorbency as shown in Fig. 6 (c). Water absorbency of fabric depends on the moisture absorbency or regain properties of the fibres as well as with bulk properties. Higher moisture regain of viscose fibre as compared to polyester and nylon might have led to higher water absorbency for cotton/viscose fabrics. Lowest water absorbency of cotton/nylon fabric may be attributed to the lower thickness and an aerial density of cotton/nylon fabric compared to cotton/polyester fabric.

4 Conclusion

Bi-layered plated knits designed with distinct fibre, yarn and fabric combinations in the two layers can be effectively used in changing ambient conditions and at varying activity levels of individuals due to ability of fabrics to reflect varying thermal, moisture vapor and liquid transfer properties. Thermal resistance, thermal absorptivity, thermal conductivity and water absorbency decrease, while an increase in relative water vapor permeability, air permeability and wicking is observed for cotton/polyester and cotton/viscose fabrics as the yarns in the inner layer become finer. Thus, it can be concluded that plated knits designed with finer yarn in the inner/next to skin layer are suitable for use when ambience is hot and activity level of an individual is high, resulting in generation of sensible perspiration. Such fabric would be quick drying as characterized by low water absorbency and would result in rapid liquid transfer by wicking. Moreover high air and water vapor permeability further ensures wearer comfort. Decrease in thermal resistance, thermal conductivity and thermal absorptivity while an increase in relative water vapor permeability, air permeability and water absorbency are observed with the increase in loop length, irrespective of fibre type in the inner layer.

Cotton/nylon fabric would be perceived cooler on initial skin contact owing to the highest value of thermal absorptivity and thermal conductivity and can be preferred as summer wears. However, cotton/viscose fabrics owing to their better liquid transport properties as characterized by higher wicking, absorbency along with the highest permeability to moisture vapor and air seem suitable choice where rapid liquid dissipation and dry feel next to skin is the prime requirement, such as in intimate wear, sportswear, etc.

References

1 Patnaik A, Rangasamy R S, Kothari V K & Ghosh A, *Text Prog*, 38 (2006) 22. DOI:10.1533/jotp.2006.38.1.1

2 Bivainyte A & Mikucioniene D, *Fibres Text East Eur*, 19 (2011) 64.

3 Bivainyte A, Mikucioniene D & Kerpauskas P, *Materials Sci*, 18 (2012) 167.

4 Chaudhari S S, Chitnis R S & Ramakrishnan R, Water proof breathable active sports wear fabrics (2008). http://www.sasmira.org/sportswear.pdf.

5 Oglakcioglu N, Celik P, Ute B, Marmarali A & Kadoglu H, *Text Res J*, 79 (2009) 888.

6 Yoo S & Barker R, *Text Res J*, 75 (2005) 523.

7 Terliksiz S, Kalaoglu F & Eryuruk S H, *J Text Eng*, 19 (2012) 15.

8 Das B, Kothari V K, Fanguiero R & Araujo D, *Fiber Polym*, 9 (2008) 225.

9 Majumdar A, Mukhopadhyay & Yadav R, *Int J Therm Sci*, 30 (2010) 1.

10 Chidambaram P, Govindan R & Venkatraman K, *Autex Res J*, 11 (2011) 102.

11 Ozdil N, Marmarali A and Kretzschmar S, *Int J Therm Sci*, 46 (2007) 1318.

12 Herath C, *Fiber Polym*, 14 (2013) 1339.

13 Kumar B & Das A, *Fiber Polym*, 55 (2014) 625.