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Wicking Behavior of Cotton Spandex Yarns Differing in Twists and Tension

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Abstract: *The Comfort properties of textiles are extremely important. It's sometimes more important than the aesthetic properties when the garment is next to the skin. Among all comfort properties, good absorption and easy drying are one of the most requirements. Wetting and wicking are two related processes. A liquid that does not wet fibers cannot wick into a cloth, and wicking can only occur when fibers assembled with capillary spaces between them are wetted by a liquid. Research is concerned with the wickability and other mechanical properties of cotton yarn with twist levels, and tension levels. wickability was determined by a wicking tester which was specially constructed for this research.The results showed that twist had a significant effect on the wickability of cotton yarns. Tension imposed also showed a significant effect on wickability in that higher the tension, lower the wickability. Use Washburn's equation and it is suggested that in studying wickability both the time exponents 'K' and intercept 'C' have to be considered to have a better understanding of wickability.*

Key words: *cotton spandex yarn,yarn twist, yarn tension, porosity, wicking height*

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I. Introduction

Clothing comfort is a vital facet for any garment used for activewear and leisurewear. Every human sweat throughout totally different varieties of activities. A vital feature of any fabric is; however, it transports this water out of the body surface and creates the user feel comfy.

Clothing manufactured from performance materials is claimed to be designed not just for fashion or simply a passive protects the skin however to critically influence the comfort and performance of the user. Mills and makers have designed these materials to manage wet, regulate temperature, and supply protection from the encircling setting. They're designed to act with and modify the heat-regulating operation of the skin because the close setting interacts with them [1]. Mainly, the fabric area unit designed to stay the body dry throughout vigorous athletic activities. Keeping the body dry, particularly throughout weather sports, ensures that the user doesn't lose heat unnecessarily by having wet skin. Interaction of fabric with wetness affects the two main classes of body comfort: sensory and thermo physiological [2]. Sensorial comfort pertains to the satisfaction of the user because the cloth or garment is perceived by the essential senses of the body [3]. This kind of comfort could also be littered with however a fabric feels against the skin, however, it seems to the attention, however it smells, or perhaps however it sounds. Within the case of performance fabrics worn in hot climates, however, a material feels to the user is one of the most important attributes. Performance materials facilitate to make sure that the contestant doesn't begin to feel dank as a result of, in general, "dry feel higher."

Thermo physiological comfort describes, however, the material controls the microclimate, that is that the air encompassing the body. This kind of comfort is crucial throughout activities performed in colder climates. as an example, polyester-based materials don't conduct heat, and thus, the air between the body and also the material will increase in temperature because of denial of body heat [4]. This is often one in each of the explanations of why polyester fabric as a base layer in atmospheric condition sports. If the bottom layer material absorbs and retains wetness, it loses this property and its ability to stay the body heat is lost. In general, this kind of comfort describes however hot or cold the material causes you to feel. Comfort is also outlined as a nice state of psychological, physiological and physical harmony between a personality's being and therefore the atmosphere. All three aspects area unit equally vital since folks feel uncomfortable if any one of them is absent [5]. Comfort isn't a property however a condition of mind. The human mind responds with varying degrees of satisfaction to the dynamic atmosphere. This perception includes the result of covering between body and atmosphere. The number of properties of fibers, yarns, fabrics, and clothes area units considerably associated with comfort and should be taken into consideration in manufacturing attire things [6].

Fabric properties rely on fiber properties, yarn structure, material structure and therefore the mechanical and chemical finishing treatments given to the material. Of the varied fiber properties, fiber type, fineness, cross-sectional form, crimp, length and surface properties square measure extraordinarily necessary. The yarn structure governs the yarn properties made from a fiber with a given set of fiber properties. Variety of yarn like filament yarn rough-textured yarn and small stuff made on completely different spinning systems, twist level, unevenness and visual aspect of yarns have a major influence on comfort and alternative properties of materials. The material structure includes yarn linear densities, sett, weave, crimp levels and might influence such important material properties like thickness, cover, bulk density, mechanical and surface behavior that have an instantaneous relation with material comfort opine Mehta and Narrasimham [7]. The term wetting is typically wont to describe the displacement of solid air interface with a solid-liquid interface. Wetting behavior is usually characterized by the worth of the contact angle inside the liquid. The absorption of water (or of the other liquid) by a textile is basically determined by 2 parameters. The primary is that the surface energy of the fiber materials, and also the second is that the capillary effects of the yarn recommend Mahltig and Textor [8]. A drop of wetting liquid impromptu wicks into the yarn thanks to the capillary forces related to the given structure and pure mathematics of the void areas between the filament's remarks bird genus et al., [9]. In keeping with Harnett and Mehta [10] 'wettability' is that the initial behavior of the material, yarn or fiber once brought into contact with a liquid. It conjointly describes the interaction between the liquid and also the substrate before the wicking method.

A spontaneous transport of a liquid driven into a porous system by capillary forces is termed wicking as a result of their caused by wetting; wicking is that the result of spontaneous wetting during a capillary system. Wetting and wicking are two connected processes. A liquid that doesn't wet fibers will not wick and wicking can solely occur once fibers assembled with capillary areas between them are wetted by a liquid. Fiber wettability is, therefore, a necessity for wicking states Kissa [11]. Capillarity will be outlined because of the microscopic motion or flow of a liquid underneath the influence of its own surface and surface forces within the slender tubes, cracks, and voids. The physical phenomenon relies on the united forces of cohesion and adhesion. once the forces of adhesion between the tube and also the tube walls are bigger than the forces of cohesion between the molecules of the liquid, then capillary motion happens quote Sharabaty et al., [12]. It's a development within which the surface of a liquid is determined to be elevated or depressed wherever it comes into contact with a material. The wetting and wicking of fiber mass represent a category of flows that have essential scientific and sensible significance on that technology like fiber lubricating and process fiber-reinforced composite producing and fiber net bonding and coloring is primarily based. Wetting and wicking behavior of the many client products like baby diapers, feminine hygiene products, and sport and alternative protecting clothes are essential in deciding their business success recommend screenwriter et al., [13]. It's conjointly been all over by Minor et al [15]. That yarn intersections act as new reservoirs and feeds all branches equally. This finding can become progressively vital once differing types of knit structures area units compared. It has been theorized by several researchers that the flow of a fluid in a very cloth is essentially ruled by the network structure of the material and undue to the fiber sort [14,15,16,17].Yarns of artificial fibers, on the opposite hand, square measure compact, well-aligned and sleek, leading to a coffee contact angle [18].

In order to establish more detailed information about wicking behavior and the relationship between yarn twist and tension, in this study, demonstrated the wicking height on yarn twist and tension.

II. Materials and Methods

2.1 Wicking Apparatus of Yarns

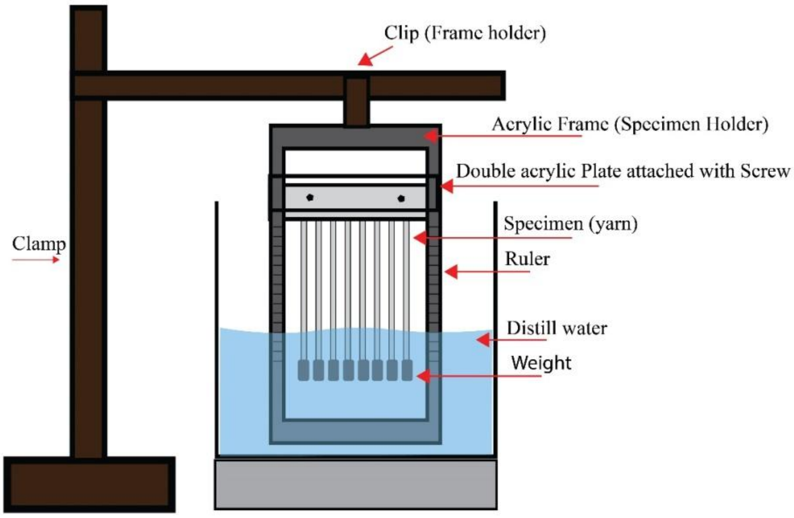


Figure 1 Wicking apparatus for yarns

2.2 Working Procedure

This instrument was made up of a metal stand where a plastic frame hangs and a ruler attached on both sides of the frame to record the height of water traveled along with the yarns. Distill water was set on the bottom. As it is difficult to measure single yarn wicking height and sometimes the yarn has some problem so to avoid the unusual results, use 10 yarns at a time and took the average result. The length of yarns was 30cm and both ends of the yarns were attached in the plastic frame to keep separated from each other. Figure 1shows the instrument developed for examining the wicking of yarns. The frame holder is fixed on the top of the metal fixed clamp holder in which the frame was hung vertically. Once the yarns were in contact with the distilled water, height was recorded by a digital camera to observe the capillary rise along the length of yarn. Thespecimens were suspended in a reservoir of distilled water with their bottom ends immersed vertically at a depth of 1 cm in the water. The wicking heights were measured and recorded every min for 10min. Every group of samples tested five times, and the average value calculated. In a similar manner, the cotton yarns with various twist levels and tensions with twist levels were subjected to wicking behavior. While testing the wickability of cotton yarns differing in a twist with tension, a weight was tied to ends of the yarns (fig. 1).

3 Results and Discussion

Table 3.1 shows the properties of cotton spandex yarns with various twist levels.

Table 3.1 Properties of cotton spandex yarns with various twist levels

Yarn Properties				
twist per cm	5.2	7	8.2	12.3
Yarn Diameter	0.3070	0.2783	0.1950	0.1730
Twist factor (K)	21	30	35	51
Elongation (%)	13.01	12.76	11.25	10.60
Single yarn strength (gms)	552.1	358.5	269.7	132.2

It is found the yarn diameter is found to be higher at lower twist levels and as the twist level increases, yarn diameter decreases. This is due to the reduction of pore sizes resulting in higher packing factors. Figures show the trend.

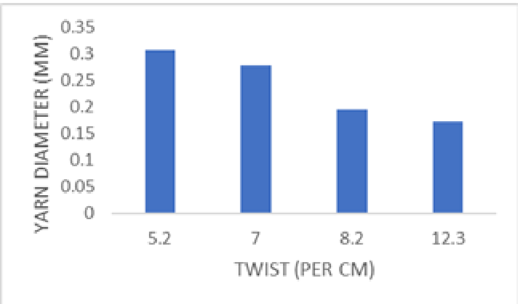


Figure 2 Yarn diameter

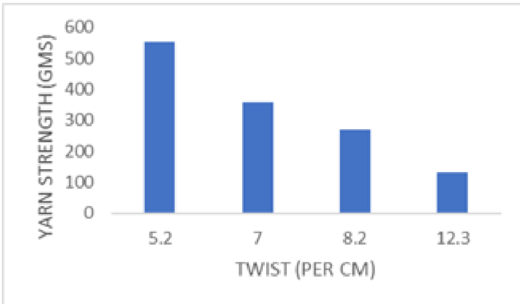


Figure 3 single yarn strength (gms)

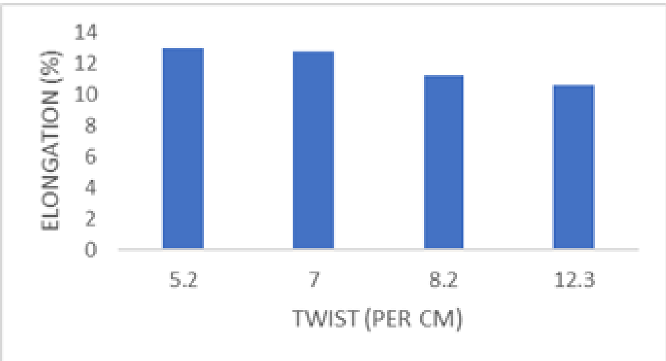


Figure 4 Yarn elongation (%)

Table 3.2 shows the packing factor values for cotton spandex yarns with various twist levels.

Table 3.2 Packing factor for cotton spandex yarns with various twist levels

sample code	packing factor
5.2 TP cm	0.15
7 TP cm	0.245
8.2 TP cm	0.415
12.3 TP cm	0.531

From Table 3.2 it is clear that like the twist level increases, the packing factor increases, due to the reduction of pore sizes in higher twist levels.

3.1 Effect of Yarn Twist on Wickability

Figures 5,7, and 9 show the wickability of various yarns and the figures are presented below.

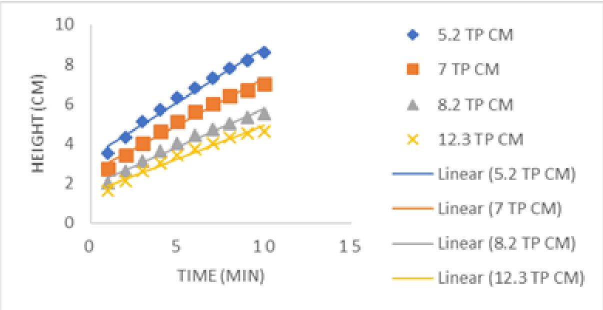


Figure 5 Wicking behavior of cotton spandex yarns with various twist levels-Height and Time

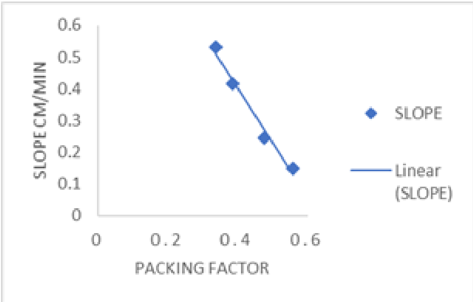


Figure 6 Slope values (Height and Time) versus packing factor

Table 3.3 Regression values and correlation coefficient for cotton spandex yarns with various twist levels (Height and Time)

Sample code	Slope(cm/min)	Intercept(cm)	Correlation Co-efficient	Regression Equation
5.2 TP cm	0.558	3.293	R^2= 0.986	Y = 0.558x + 3.293
7 TP cm	0.476	2.533	R^2= 0.983	Y = 0.476x + 2.533
8.2 TP cm	0.385	1.9	R^2= 0.979	Y = 0.385x + 1.9
12.3 TP cm	0.337	1.527	R^2= 0.972	Y = 0.337x + 1.527

Figure 6 shows the relationship between the packing factor and slopes. It is apparent that as the packing density decreases, slopes decreases.

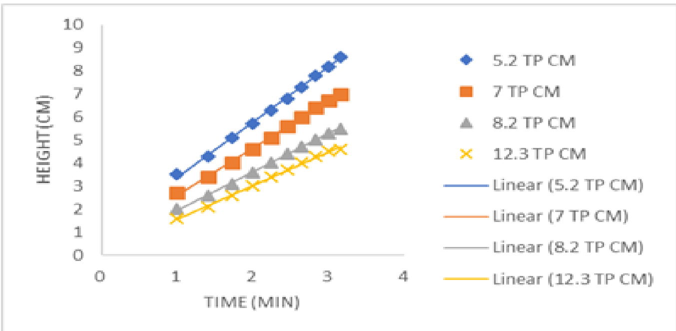


Figure 7 Wicking behavior of cotton spandex yarns with various twist levels- Square root of Time and Height

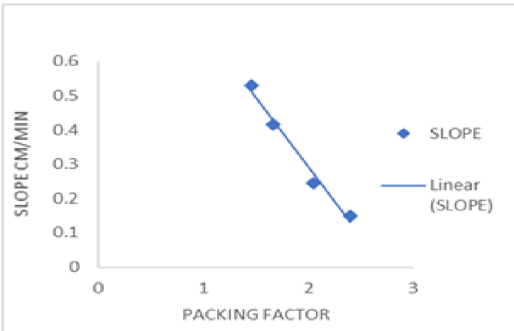


Figure 8 Slope values (Square Root of Time & Height) versus packing factor

Table 3.4 Regression equation of the form H=Kt^{½} + constant and correlation coefficient for various twist levels

Sample code	Slope(cm/min)	Intercept(cm)	Correlation Coefficient	Regression Equation
5.2 TP cm	2.398	0.973	R^2= 0.999	H= 2.398(t) + 0.973
7 TP cm	2.05	0.545	R^2= 0.998	H= 2.05(t) + 0.545
8.2 TP cm	1.664	0.282	R^2= 0.999	H= 1.664(t) + 0.282
12.3 TP cm	1.458	0.103	R^2= 0.997	H= 1.458(t) + 0.103

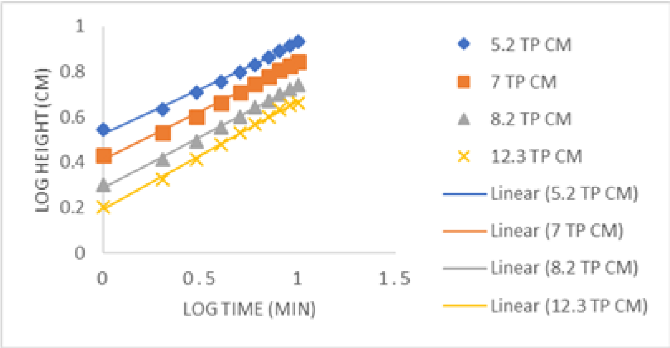


Figure 9 Wicking behavior of cotton spandex yarns with various twist levels- Log Height and Log Time

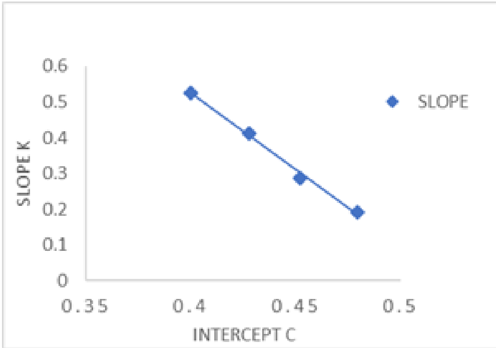


Figure 10 Slope versus intercept values (Log Height and Log Time)

Table 3.5 Regression values of the form log (h)=h log t + constant and correlation coefficient for cotton spandex yarns with various twist levels

Sample code	Time exponent /Slope(K)	Intercept(cm)	Correlation Coefficient	Regression Equation
5.2 TP cm	0.4	0.525	R^2= 0.994	Log(h)= 0.4(t)+ 0.525
7 TP cm	0.428	0.413	R^2= 0.995	Log(h)= 0.428(t)+ 0.413
8.2 TP cm	0.452	0.288	R^2= 0.997	Log(h)= 0.452(t)+ 0.288
12.3 TP cm	0.479	0.192	R^2= 0.997	Log(h)= 0.479(t)+ 0.192

The wicking time was plotted against the wicking height in the first method and the regression equation and correlation coefficient were computed and shown in Table 3.3. Cotton yarns with lower twist levels show higher values of slope and intercept followed by higher twist levels. Higher the slope and intercept, better the wickability and vice versa. The correlation between height and time was found to be good. Wickability in higher twists is minimum due to the decrease in pore sizes, tortuosity of the fibers and permeability affecting irregular fiber path due to twist. It was observed that using the yarn linear density, the wicking rate decreases with an increase in the amount of yarn twist. This may be due to the presence of discontinuous capillaries and tortuous paths the liquid has to take.

In the second method, the wicking height was plotted against the square root of time and the correlation coefficient and regression equations were computed. Table 3.5 shows the slopes and intercept values (Model assumed Kt ½ + constant, where K is the slope. It is apparent that in both cases, the trend followed is the same. The correlation between wicking height and the square root of time, wicking height and wicking time was found to be good for all the yarns. Slopes values obtained from the different methods of analysis of wicking were plotted against the packing factor to illustrate the trend.

It is interesting to note that the slopes obtained from the raw data depict wickability in the sense that the higher the slope, the greater the wickability and vice versa. The time exponent h which was computed from log h-log t curves, on the other hand, show contradictory results as they have been calculated from the model of Laughlin and Davies (1961). In this case, cotton yarns with lower twist levels which showed higher slopes from raw data showed opposite results. Intercepts also provide useful information on wickability. Slope and intercept values obtained from log h and log t have been plotted to illustrate the trend. A lower value of K indicates good wickability and the correlation between K and C is found to be negative.

3.2 Effect of Tensions on Wickabilityof Various Yarns

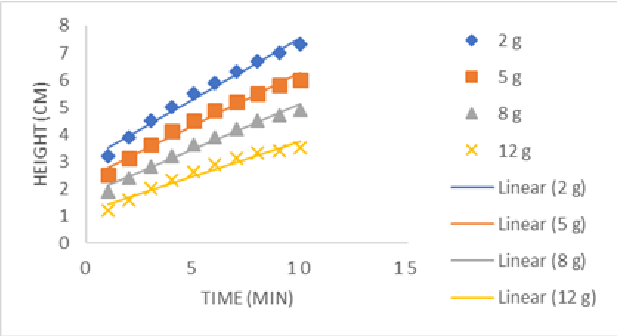


Figure 11 Wicking behavior of cotton spandex yarns with 5.2TPcm at different tension levels - Height and Time

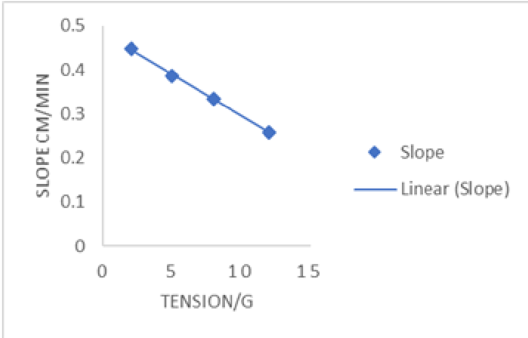


Figure 12 Slope values (Time & Height) versus tensions

Table 3.6 Regression values and correlation coefficient for cotton spandex yarns with 5.2TPcm at different tension levels (Height and Time)

Sample code/g	Slope(cm/min)	Intercept(cm)	Correlation Co-efficient	Regression Equation
2	0.448	3.067	R^2= 0.984	Y= 0.448x + 3.067
5	0.385	2.4	R^2= 0.979	Y= 0.385x + 2.4
8	0.333	1.78	R^2= 0.983	Y= 0.333x + 1.78
12	0.258	1.173	R^2= 0.962	Y= 0.258x + 1.173

The relationship between wickability depicted by slope and tension is shown in Figure 14. It is apparent that as the tension increases, wickability decreases.

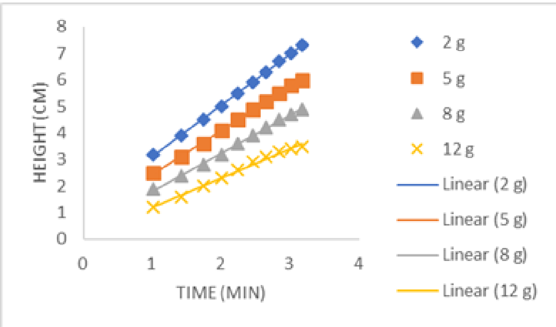


Figure 13 Wicking behavior of cotton spandex yarns with 5.2TPcm at different tension levels – Height and Square root of Time

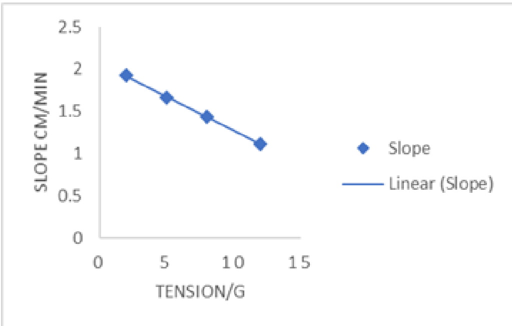


Figure 14 Slope values (Square Root of Time & Height) versus tensions

Table 3.7 Regression equation of the form $H=kt^{1/2}$ + constant and correlation coefficient for 5.2TPcm at different tension levels

Sample code/g	Slope(cm/min) $^{1/2}$	Intercept(cm)	Correlation Co-efficient (R2	Regression Equation
2	1.929	1.196	R^2= 0.999	H= 1.929(t) + 1.196
5	1.664	0.782	R^2= 0.999	H= 1.664(t) + 0.782
8	1.433	0.391	R^2= 0.998	H= 1.433(t) + 0.391
12	1.119	0.076	R^2= 0.994	H= 1.119(t) + 0.076

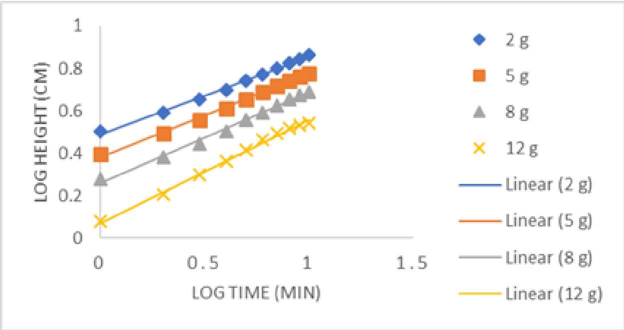


Figure 15 Wicking behavior of cotton spandex yarns with 5.2 TP cm at different tension levels –Log Height and Log Time

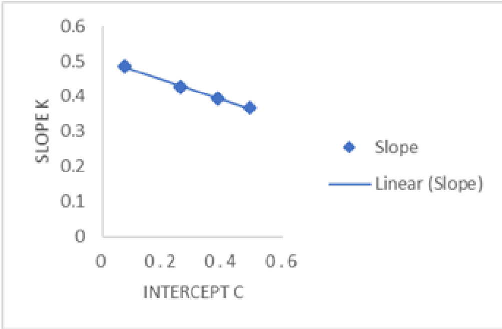


Figure 16 Slope versus intercept values (Log Height and Log Time)

The relationship between wickability depicted by slope and tension is shown in Figure 16. It is apparent that as the tension increases, wickability decreases.

Table 3.8 Regression values of the form log (h)=S log t + constant and correlation coefficient for cotton spandex yarns with 5.2 TP cm at different tension levels

Sample code/g	Time exponent /Slope(K)	Intercept(cm)	Correlation Co-efficient	Regression Equation
2	0.367	0.488	R^2=0.994	Log(h)= 0.367(t)+ 0.488
5	0.393	0.382	R^2=0.996	Log(h)= 0.393(t)+ 0.382
8	0.426	0.26	R^2=0.995	Log(h)= 0.426(t)+ 0.26
12	0.486	0.072	R^2=0.996	Log(h)= 0.486(t)+ 0.072

The relationship between wickability depicted by slope and intercept is shown in Figure 7.23. It is apparent that as the slope decreases, intercept increases.

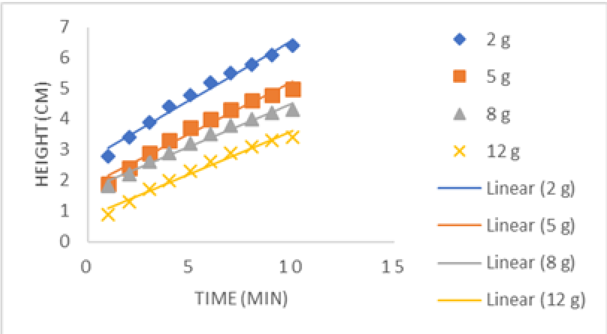


Figure 17 Wicking behavior of cotton spandex yarns with 7 TPcm at different tension levels –Height and Time

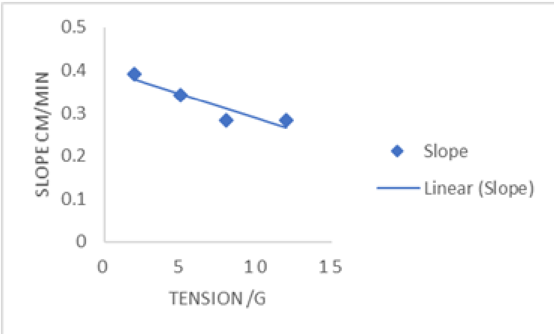


Figure 18 Slope values (Height & Time) versus tensions

Table 3.9 Regression values and correlation coefficient for cotton spandex yarns with 7 TP cm at different tension levels (Height and Time)

Sample code/g	Slope(cm/min)	Intercept(cm)	Correlation Co-efficient	Regression Equation
2	0.391	2.68	R^2= 0.983	Y= 0.391x + 2.68
5	0.342	1.807	R^2= 0.978	Y= 0.342x + 1.807
8	0.282	1.7	R^2= 0.98	Y= 0.282x + 1.7
12	0.282	0.8	R^2=0.98	Y= 0.282x + 0.8

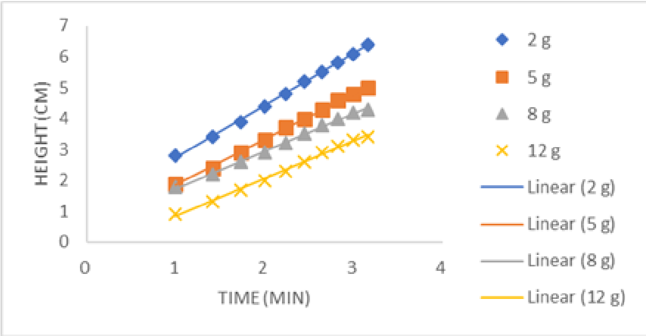


Figure19 Wicking behavior of cotton spandex yarns with 7 TPcm at different tension levels – Square root of Time and Height

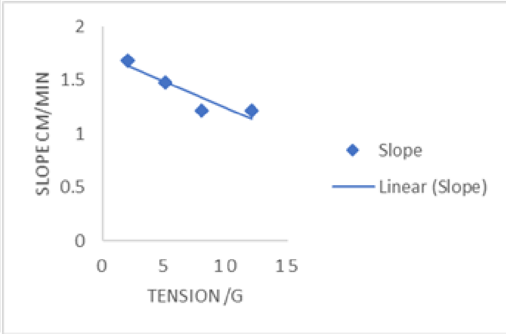


Figure20 Slope values (Square Root of Time and Height) versus tensions

The relationship between wickability depicted by slope and tension is shown in Figure 20. It is apparent that as the tension increases, wickability decreases.

Table 3.10 Regression equation of the form H=St 1/2 + constant and correlation coefficient for 7 TPcm at different tension levels

Sample code/g	Slope(cm/min)$^{1/2}$	Intercept(cm)	Correlation Co-efficient	Regression Equation
2	1.684	1.046	R^2= 0.999	H= 1.684(t) + 1.046
5	1.479	0.521	R^2= 0.999	H= 1.479(t) + 0.521
8	1.215	0.368	R^2= 0.997	H= 1.215(t) + 0.368
12	1.215	-0.379	R^2= 0.997	H= 1.215(t) – 0.379

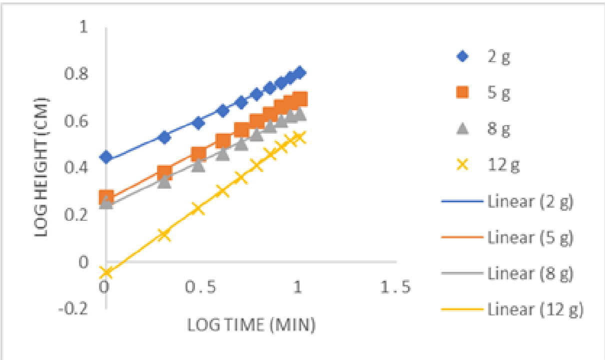


Figure 21 Wicking behavior of cotton spandex yarns with 7 TP cm at different tension levels –Log Height and Log Time

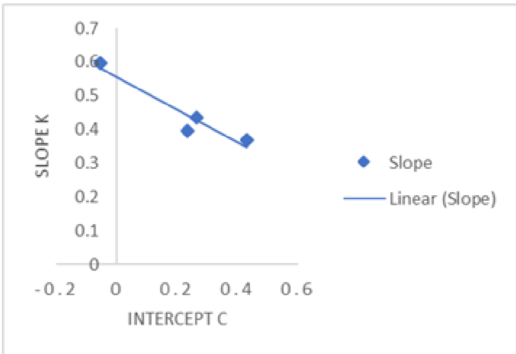
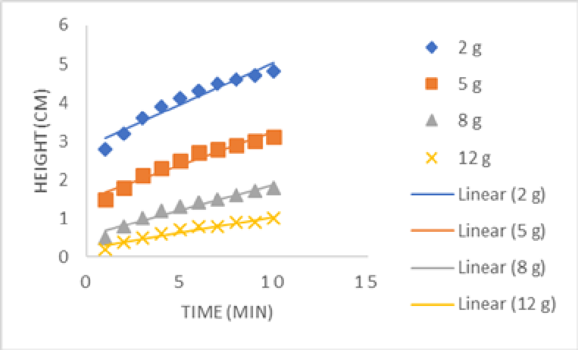


Figure 22 Slope versus intercept values (Log Height and Log Time)

Table 3.11 Regression values of the form log (h)=S log t + constant and correlation coefficient for cotton spandex yarns with 7 TP cm at different tension levels

Sample code/g	Slope(cm/min)	Intercept(cm)	Correlation Co-efficient	Regression Equation
2	0.367	0.43	R^2= 0.994	Log(h)= 0.367(t)+ 0.43
5	0.435	0.263	R^2=0.996	Log(h)= 0.435(t)+ 0.263
8	0.397	0.235	R^2= 0.993	Log(h)= 0.397(t)+ 0.235
12	0.597	-0.054	R^2= 0.998	Log(h)= 0.597(t)+ 0.-054



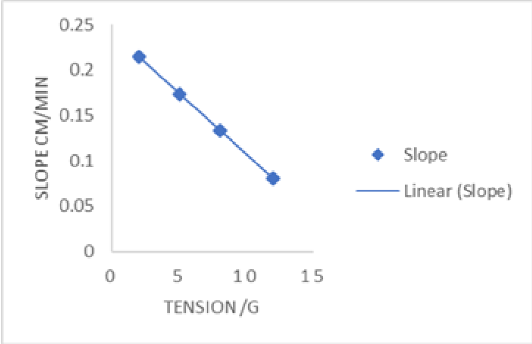


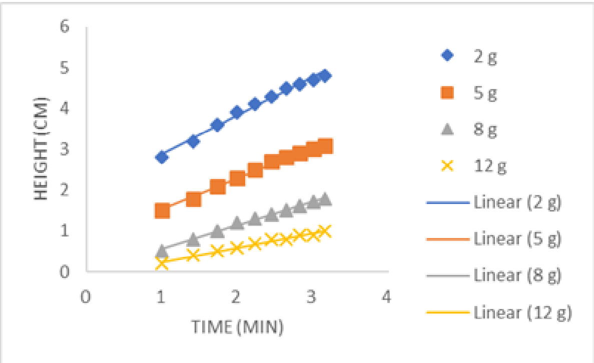
Figure 23 Wicking behavior of cotton spandex yarns with 8.2TPcm at different tension levels – Height and Time

Figure 24 Slope values (Height and Time) versus tensions

Table 3.12 Regression values and correlation coefficient for cotton spandex yarns with 8.2 TP cm at different tension levels (Height and Time)

Sample code/g	Slope(cm/min)	Intercept(cm)	Correlation Co-efficient	Regression Equation
2	0.215	2.867	R^2= 0.939	Y = 0.215x + 2.867
5	0.173	1.52	R^2= 0.954	Y = 0.173x + 1.52
8	0.133	0.547	R^2= 0.955	Y = 0.133x + 0.547
12	0.081	0.233	R^2= 0.945	Y = 0.081x + 0.233

The relationship between wickability depicted by slope and tension is shown in Figure 24. It is apparent that as the tension increases, wickability decreases.



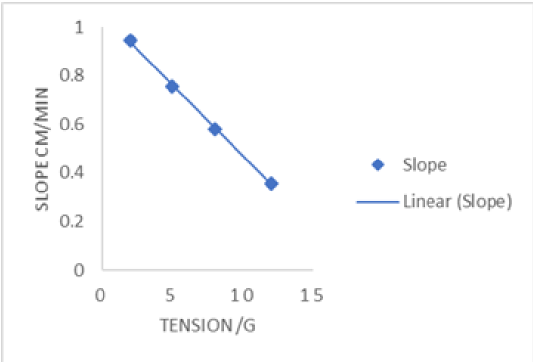


Figure 25 Wicking behavior of cotton spandex yarns with 8.2 TP cm at different tension levels – Square root of Time and Height

Figure 26 Slope values (Square Root of Time and Height) versus tensions

Table 3.13 Regression equation of the form H=St 1/2 + constant and correlation coefficient for 8.2 TP cm at different tension levels

Sample code /g	$Slope(cm/min)^{1/2}$	Intercept(cm)	Correlation Co-efficient	Regression Equation
2	0.943	1.931	R^2= 0.988	H= 0.943(t) + 1.931
5	0.754	0.777	R^2= 0.994	H= 0.754(t) + 0.777
8	0.581	-0.026	R^2= 0.994	H= 0.581(t) – 0.026
12	0.355	-0.117	R^2= 0.987	H= 0.355(t) – 0.117

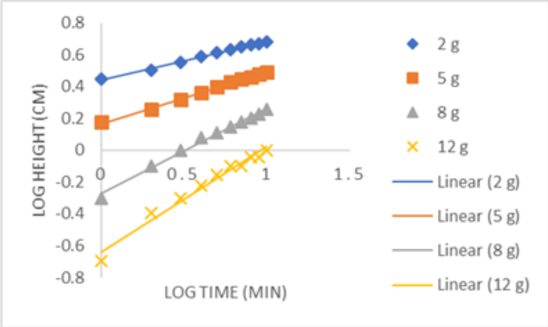


Figure 27 Wicking behavior of cotton spandex yarns with 8.2 TP cm at different tension levels –Log Height and Log Time

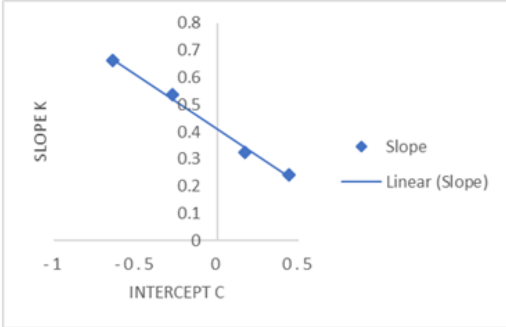


Figure 28 Slope versus intercept values (Log Height and Log Time)

Table 3.14 Regression values of the form log (h)=S log t + constant and correlation coefficient for cotton spandex yarns with 8.2 TPcm at different tension levels

Sample code /g	Slope(cm/min)	Intercept(cm)	Correlation Co-efficient	Regression Equation
2	0.243	0.442	R^2= 0.996	Log(h)= 0.243(t)+ 0.442
5	0.325	0.169	R^2= 0.997	Log(h)= 0.325(t)+ 0.169
8	0.537	-0.272	R^2= 0.991	Log(h)= 0.537(t) - 0.272
12	0.662	-0.639	R^2= 0.976	Log(h)= 0.367(t) - 0.639

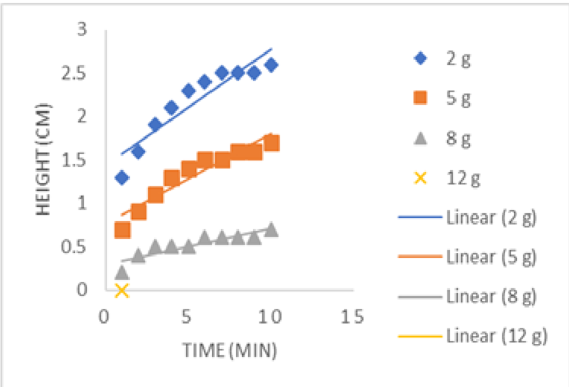


Figure 29 Wicking behavior of cotton spandex yarns with 12.3TPcm at different tension levels –Height and Time

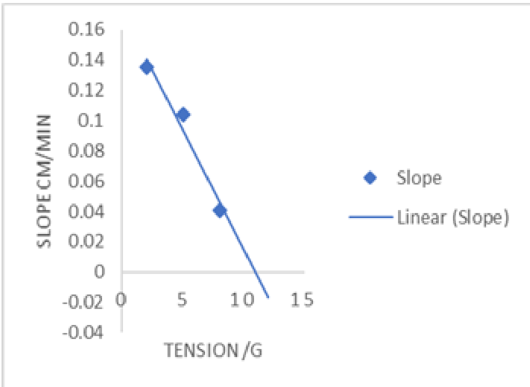


Figure 30 Slope values (Height and Time) versus tensions

Table 3.15 Regression values and correlation coefficient for cotton spandex yarns with 12.3 TP cm at different tension levels (Height and Time)

Sample code/g	Slope(cm/min)	Intercept(cm)	Correlation Co-efficient	Regression Equation
2	0.135	1.427	R^2= 0.866	Y = 0.135x + 1.427
5	0.104	0.76	R^2= 0.903	Y = 0.104x + 0.76
8	0.041	0.293	R^2= 0.796	Y = 0.041x + 0.293
12			No Wicking	

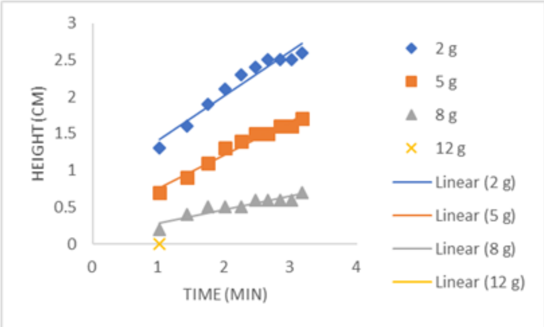


Figure 31 Wicking behavior of cotton spandex yarns with 12.3 TPcm at different tension levels – Square root of Time and Height

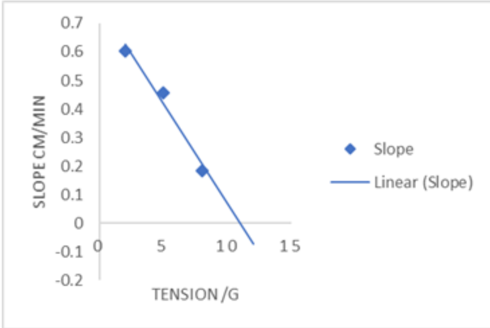


Figure 32 Slope values (Square Root of Time and Height) versus tensions

Table 3.16 Regression equation of the form H=Kt 1/2 + constant and correlation coefficient for 12.3TPcm at different tension levels

Sample code/g	Slope(cm/min) 1/2	Intercept(cm)	Correlation Co-efficient	Regression Equation
2	0.604	0.814	R^2= 0.945	H= 0.604(t) + 0.814
5	0.458	0.3	R^2= 0.967	H= 0.458(t) + 0.3
8	0.185	0.105	R^2= 0.875	H= 0.185(t) + 0.105
12			No Wicking	

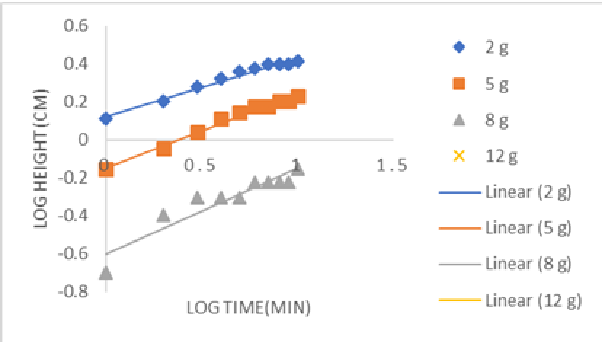


Figure 33 Wicking behavior of cotton spandex yarns with 12.3 TPcm at different tension levels –Log Height and Log Time

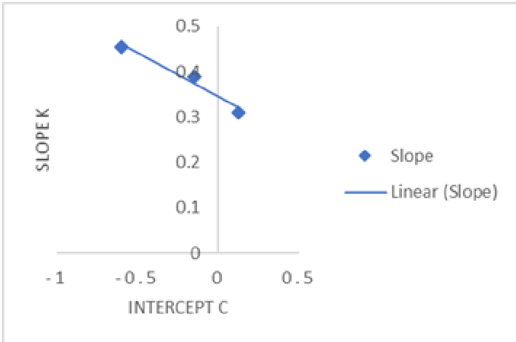


Figure 34 Slope versus intercept values (Log Height and Log Time)

Table 3.17 Regression values of the form log (h)=S log t + constant and correlation coefficient for cotton spandex yarns with 12.3 TPcm at different tension levels

Sample code/g	Slope(cm/min)	Intercept(cm)	Correlation Co-efficient	Regression Equation
2	0.31	0.123	R^2= 0.976	Log(h)= 0.31(t)+ 0.123
5	0.39	-0.146	R^2= 0.983	Log(h)= 0.39(t) – 0.146
8	0.454	-0.601	R^2= 0.877	Log(h)= 0.454(t) – 0.601
12			No Wicking	

Figures 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31 and 33 show the wickability of various yarns with different twist levels and tensions.

In the first method of analyzing wicking, the wicking time was plotted against the wicking height and the regression equation and correlation coefficient were computed and shown in Tables 3.6, 3.9, 3.12 and 3.15. Cotton yarns subjected to minimum load showed higher values of slope and intercept followed by maximum loads. When the tension is increased, there is a gradual decrease in wicking and this may be attributed to the commencement of the locking of the yarn structure that resulted in the change of the yarn "tortuosity" which hindered continuous liquid pumping. Also, the yarn diameter diminishes due to higher tensions which leads to

Poisson's effect. This agreement with the findings of Nyoni and Brook. Higher the slope and intercept, better the wickability and vice versa. The correlation between height and time was found to be good.

In the third method of analyzing wicking, the wicking height was plotted against the square root of time and the linear regression analysis was computed (Model assumed Kt ½ + constant, where K is the slope). It is apparent that cotton yarns subjected to minimum load showed higher values of slope and intercept compared to maximum loads. The wicking trend followed here is the same. The correlation between wicking height and the square root of time was found to be good for all the yarns.

It is interesting to note that the slopes obtained from the raw data depict wickability in the sense that the higher the slope, the greater the wickability and vice versa. The time exponent K which was computed from log K-log t curves, on the other hand, shows contradictory results as they have been calculated from the model of Laughlin and Davies (1961). In this case, cotton yarns subjected to minimum loads showed higher slopes from raw data reported opposite results as evidenced from Figures 16, 22, 28 and 34. Intercepts also provide useful information on wickability. A lower value of K and the higher value of C indicates good wickability. A negative correlation between K and C has been noticed and thus both are to be considered for interpreting wickability. In all the cases, the time exponent K was less than Washburn's predicted time exponent of 0.5, which was attributed to the non-uniformity of the capillaries and the simultaneous occurrence of wetting, wicking liquid dispersion, and evaporation.

Figures 12, 14, 18, 20, 24, 26, 30 and 32 show the relationship between wickability depicted by slopes and tensions. Slopes values obtained between height and time, and wicking height and the square root of time have been plotted against tensions to illustrate the trend Kamath et al., (1994). It is apparent that as tension increases, wickability decreases.

III. Conclusion

Wickability is affected by the packing factor due to the decrease in pore sizes, tortuosity of the fibers and permeability affecting irregular fiber path due to twist. By increasing the yarn twist, the radius of capillary channels decreases. It is noticed that when the tension is increased the wickability reduces due to the higher packing factor. The yarn wicking behavior was dependent on the structure of the constituent fibers, their orientation in yarn, the yarn structure, the pretension, and the load applied. Hence, it is found that the higher the twist and load, the lower the wickability. Twist and tension are the important parameters that affect wickability which in turn affect the comfort characteristics. When the tension is increased, packing factor increases which contributes to the reduction in wicking.

Acknowledgements

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