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Review Article

Performance of terry towel

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In this paper, a critical review of the evolved theories and mechanisms of water absorption in terry fabric has been reported along with the key factors to improve the water absorption. Critical analysis of all the information helps to understand and choose the most realistic theory and mechanism of water absorption of terry fabric which will be helpful in designing the most absorbent terry fabric. Both dynamic and static water absorbency along with the initial time lag immerse to be the equally important attributes of the water absorbency performance of terry fabrics. High loop shape factor is the key to improve the absorbency behaviour of the terry fabric. Study of cross-section images of different fabric is the original work of the authors for supporting the concluding theory, mechanism and results.

Keywords: Capillary action, Dynamic water absorption, Static water absorption, Loop geometry, Terry fabric

1 Introduction

The performance of terry fabric is mainly assessed by its absorbency that refers to both the rate at which the fabric absorbs the water i.e. dynamic water absorbency; and the total water retention ability of the fabric i.e. static water absorption. Systematic research on water absorbency of terry fabric started in the first half of the 20th century[1-3] with the conceptual development of absorbency, the theory of absorption and suitable method of water absorption[4,5]. Research in the beginning of the second half of 20th century is focused on the absorbency performance of terry fabric after certain wet processing treatment and home laundering[6,7]. Later some research has been done to see the effect of different yarns on water absorbency characteristics along with the investigation of best suited test method[8-10]. More extensive work have been done in the end of the 20th century utilising capillary theory, surface tension, wetting, wicking, pore size and its distribution.[11-19].

Static and dynamic water absorptions have been studied in relation with fabric construction and yarn properties. Now in 21st century, numerous developments have been made towards increasing absorbency of terry fabric[20-32]. Zero twist yarn, low twist, wrap yarn, etc have entered in the terry fabric as pile yarn with the primary aim to increase the absorbency. Still the hunt is on for the ways to improve the absorbency of terry fabric. Recent research is focused on the loop geometry and its effect on water absorbency[33].

Wetting and wicking are quite distinct from each other[15]. Wetting is completely dependent on properties of fibre surface and wetting liquid while wicking is dependent on the arrangement of fibre and yarn into the fabric. Wetting characteristics of fibrous materials are important to their chemical processing and functional performance. Liquid must wet the fibre surface before being transported through the inter fibre pores by means of capillary action/capillary force. Absorbency characteristic of fibre assemblies depends on the geometry of fibre assemblies, especially surface roughness as well as pore size distribution[5,24]. The amount of water absorbed or the static water absorption by the terry fabric is important for its end use. However, it does not give any idea as how quickly a terry fabric absorbs the water, or how water absorption changes with time. This aspect of water absorbency is particularly known as rate of water absorption or dynamic water absorption which is also important from the practical point of view. So the terry fabrics must be evaluated in terms of static and dynamic water absorption. Optimum absorbency performance can be achieved by controlling the pore sizes and their distribution[24]. The objective of this study is to conclude all the research work related to the improvement of terry towels absorbency and support the outcome with the cross-section study of the terry towels.

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2 Theory of Water Absorption

The three primary phenomena, namely time lag, the dynamic absorption and the static absorption must be explained by would be successful theory of absorption mechanism[5]. The initial period during which no significant volume of liquid is absorbed is termed as time lag. The weight of water absorbed by unit weight of oven dry weight of the fabric per unit time is the dynamic water absorption while the maximum weight of water absorbed by unit weight of oven dry weight of the fabric is static water absorption. The dynamic water absorption (W_{dy}) can be defined as the ratio of absorptive forces (a) to the resistance of fabric wetting (r), as shown below:

$$\mathrm{w}_{dy} = \frac{\alpha}{r} \qquad \ldots (1)$$

The resistance (r) is the resistance to wetting centred in the initial contact areas. Number of contact pints between fabric and wet plate affects this resistance. Smoother fabric surface offer less resistance than surfaces having loops, e.g. terry fabric. The absorptive forces (a) can be determined by extension of the tangents to the curves relating maximum rate of flow and head to interception with the zero flow axis. All capillaries and channels contribute to the ultimate absorption whereas smaller ones are effective in initial phase of absorption, in which the maximum rate is observed. Following equation can represent the general water absorption behaviour of textiles[5]

$$\frac{w_t}{w_{st}} = 1 - e^{-\,t1/w_{st}} \qquad \ldots (2)$$

where w_t is the amount absorbed at time t; w_{st} , the static water absorption; I , the initial flow rate. Static water absorption (w_{st}) is the weight ratio of the absorbed water over the oven dry weight of the fabric. Static water absorption can be calculated using the following relationship:

$$\mathrm{w}_{\mathrm{st}}\,(\%) = \frac{w_w - w_d}{w_d} = 100 \qquad \ldots (3)$$

where w_{st} is the static water absorbency; w_w , the wet weight of fabric; and w_d , the dry weight of fabric. In spite of extremely complex pore structure, combination of several fabric attributes can qualify the overall fabric porosity. Porosity is a function of void space in a porous medium, as shown below:

$$\text{Porocity } (p) = 1 - \frac{\text{Fibre volume}}{\text{Fibric volume}} = 1 - \frac{p_{fa}}{p_{fi}} \qquad \ldots (4)$$

So, the static water absorption as a function of porosity (p), water density (ρ_{w}) and fibre density (ρ_{fi}) can be given as[14]

$$w_{\mathrm{st}} = \frac{\rho_w}{\rho_{fi}}\left[\frac{p}{1-p}\right] \qquad \ldots (5)$$

The proposed mechanism[14] of water absorption depends on pore size, pore size distribution, pore connectivity, and total pore volume. Inside a capillary, the liquid is taken up by the net positive force (Δf) across the liquid-solid interface (Fig. 1), as shown below:

$$\Delta f = f - h\rho_w g \qquad \ldots (6)$$

where ρ_w is the water density (g/cm^3); g, the gravitational acceleration (cm/s^2); and h, the height of liquid rise (cm). The internal wetting force (f_w) in the capillary area (πr^2) is known as the capillary force (f), which is given by the following Laplace equation[34,35]:

$$f = \frac{fw}{\pi r^2} = \frac{2\gamma\cos\theta}{r} \qquad \ldots (7)$$

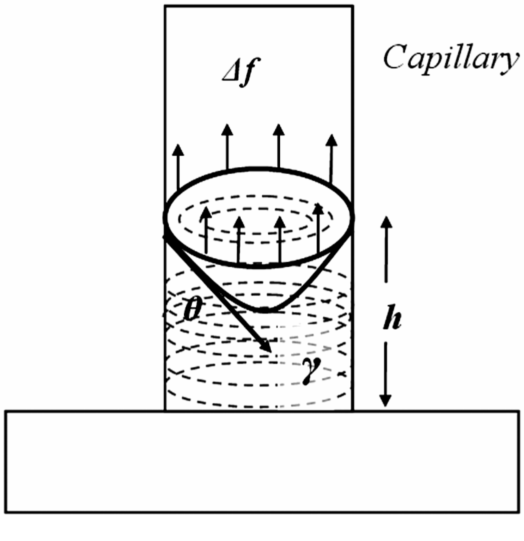

Fig. 1— Capillary action

where γ is the liquid surface tension (dyne/cm); r, the inner radius of capillary (cm); and θ, the liquid-solid contact angle. When weight of the liquid ($h\rho_w g$) is lower than the capillary pressure (f), the liquid is taken up by the positive force. At equilibrium point where weight of liquid column inside capillary is equal to the capillary pressure, the net driving force becomes zero and the liquid stops going above the equilibrium water column height inside the capillary.

Hegen-Poiseuille's law of laminar flow [36] can explain the volumetric liquid flow through textile structure, as explained below:

$$\frac{dV}{dt} = \frac{\pi r^4}{8\eta h}\,\Delta f \qquad \ldots (8)$$

$$\frac{dV}{dt} = \frac{4\pi r^4}{8\eta h}\left[\frac{2\gamma\cos\theta}{r} - h\rho_w g\right] \qquad \ldots (9)$$

Linear flow rate (dh/dt) in equilibrium is based on Hagen-Poiseuille's equation considering $dV=dh\ \pi r^2$ (ref.37), as shown below:

$$\frac{dh}{dt}\left[\frac{r\gamma\cos\theta}{4\eta h}\right] \qquad \ldots (10)$$

Under the influence of gravity of the risen liquid, linear flow rate changes, as shown below:

$$\frac{dh}{dt}\left[\frac{r\gamma\cos\theta}{4\eta h}\right] - \frac{r^2\rho_w g}{8\eta} \qquad \ldots (11)$$

After integration and simplification, Lucas-Washburn equation can be written as

$$h = \mathrm{m}\sqrt{t} \qquad \ldots (12)$$

This equation [Eq. (12)] is known as Lucas-Washburn kinetics. Here

m = rate constant and $t = \sqrt{\left(\frac{r\gamma\cos\theta}{r\eta}\right)}$

Further research[38] modified the above relationship [Eq. (12)], as the time exponent is less than 0.5 and C is a constant, as shown below:

$$h = Ct^{\mathrm{m}} \qquad \ldots (13)$$

Actually, the water column rises until the surface tension is equal to the weight of the water column, whereas Eq. (11) suggests that it should rise continuously with time. The researchers[39-42] have not considered all factors i.e. change of contact angle with increase of water level and effect of gravity and moment of inertia, which is the basis of controversy over the Washburn equation. Despite the limitations mentioned above, Lucas-Washburn theory effectively addresses the liquid behaviour during absorption[43]. Several researchers[24, 44, 45] tried to accommodate the effect of gravity into the Lucas-Washburn theory. Landau's theory[46], special form of Hagen-Poiseuille's law for laminar viscose flow, gives the rate of liquid rise considering gravity and the angle of capillary to the vertical, as shown below:

$$\frac{dh}{dt}\left[\frac{r\gamma\cos\theta}{4\eta h}\right] - \frac{r^2\zeta g\cos\beta}{8\mu} \qquad \ldots (14)$$

where ζ is the liquid density; μ, the liquid viscosity; β, the angle of the capillary to the vertical; and h, the liquid rise along the tube axis. The changes of the contact angle was experimentally investigated by researchers[41] and proved that it is variable and reduces with as the liquid rises, as shown below:

$$\cos\theta_d = \cos\theta_0 - 2(1+\cos\theta_0)\left(\frac{\eta v}{\sigma}\right)^{½} \qquad \ldots (15)$$

where θ_d is the dynamic contact angle; θ_0, the static advancing contact angle; η, the viscosity; υ, the velocity; and σ, the surface tension of the liquid. A study[45] on the kinetics of the vertical liquid penetration into a capillary, considering the effect of gravity, gave the following equation for liquid rise (h) with time (t):

$$\mathrm{A}t = -Bh - \mathrm{In}(1 - Bh) \qquad \ldots (16)$$

where $\mathrm{A} = \frac{\rho^2 g^2 r^2}{16\sigma\mu\cos\theta}, B = \frac{\rho g r}{2\sigma\cos\theta}$

Using two dimensional Ising's model and the Monte Carlo simulations, researchers[46] described the wetting process and concluded that travelling rate of liquid is inversely proportional to the packing density and the liquid column width is inversely proportional to the height due to balance of surface tension and gravity. The study[24] of wicking mechanism of textured twisted and untwisted vertical yarn under variable tension found that wicking height is inversely proportional to twist but directly proportional to the tension. The study also concludes that the heterogeneity of pore size, shape and orientation affects the penetration and retention of liquid leading to saturated, unsaturated and dry zones in the yarns. The study[47] of liquid uptake by various knitted structure with different yarns further developed the theoretical model for liquid uptake considering gravity, as shown below:

$$w_{\mathrm{dy}} = \frac{\rho_l}{\rho_y}\left(\frac{p}{1-p}\right)Ax\left[1-exp\left(-\frac{2\gamma r\cos\theta_0}{8\eta h}t\right)\right] \quad \ldots (17)$$

where A is the fabric area; x, the fabric weight; p, the fabric porosity; ρ_l, the liquid density; and ρ_y, the yarn density. The role of geometric and material (yarn/fibre/filament section) parameters on the moisture conduction has also been studied earlier[48]. The relationship between fibre number and liquid wicking height and velocity by a uniform arrayed fibre bundle has also been studied. Zhang *et al.*[48] have beautifully discussed the effect of different fibre cross-section on the moisture transmission behaviour.

Time lag depends on the fabric-liquid contact angle. Contact angle depends on the surface roughness of the fabric surface and surface tension of the water[13]. Higher fabric surface roughness and low liquid surface tension reduces the contact angle thus promotes wetting. If the contact pressure of the cloth against the porous plate is low, initially the fabric is wetted only at elevated points of the fabric like cross-over points of warp and weft (in plain fabric) and at some portion of the loop (in terry fabric) as shown in Fig. 2. These elevated points of the fabric surface which comes in contact with the water containing surface like porous plate, promote the rapid water absorption.

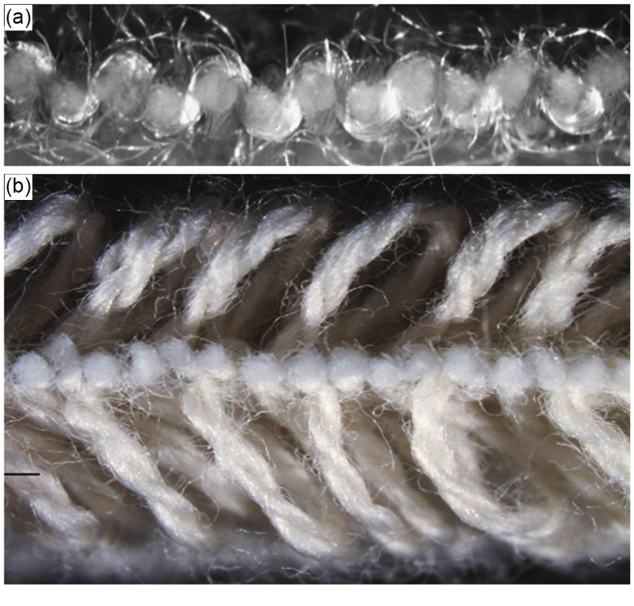

Fig. 2— Cross-section view of (a) plain fabric, and (b) terry fabric

At the cross-over points, the inter fibre spaces were filled rapidly as the water is drawn into the fibre bundle. Dynamic water absorption is low due to the small volume of these spaces. The continuous inter fibre absorption wets the walls of inter yarn spaces and further capillary action fills these spaces[48]. This is the point of significant flow and maximum dynamic water absorption. These actions occur at the same time, i.e. in certain portion of the sample inter-yarn absorption is in progress while in other portion this action is still waiting for the completion of the inter-fibre action. Inter yarn wall surface progressively gets more and more wet due to more amount of water drawn into the cloth, causing the rapid increase in the volume effect.

3 Effects of Fabric Variables on the Absorbency Performance of Terry Fabric

Now, it is clear that the terry fabric is quite different from normal plain fabric and so are its absorbency characteristics. It is important to identify the key fabric variable so that one can alter it to produce highly absorbent fabric.

3.1 Fabric Variables Affecting Dynamic Water Absorption

A time dependent water absorption property of terry fabric is known as the dynamic water absorption or the rate of water absorption. It is one of the most important properties of terry fabric which tells that how quickly a fabric can absorb water. Dynamic water absorption can be measured by various methods, like porous plate method; and Bureau Veritas Consumer Products service BV S1008 etc. Study[25] shows that fabric and yarn parameters are important for dynamic water absorption. Around 65 % of water is absorbed during the first 30 s of contact and rest 35% take another 270 s to absorb so the complete absorption curve can be approximated with logarithmic curve. Yarn type has the most significant effect on dynamic water absorption properties of terry fabric. Ring-spun single ply yarn has the quicker water absorption than ring-spun double ply yarn which itself has quicker water absorption than rotor-spun single ply yarn. Double ply rotor spun yarn has lowest dynamic water absorption. Figure 3 shows the cross-section view of the terry fabrics made from rotor pile yarn and ring pile yarn. It is clearly

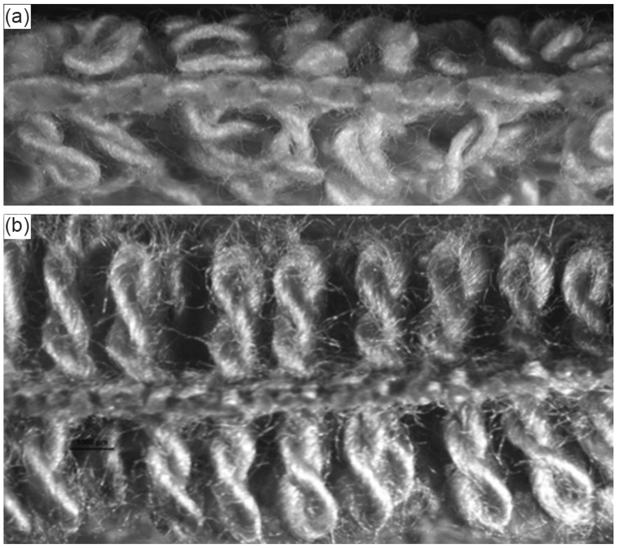

Fig. 3─ Cross-section view of terry fabric made of (a) rotor and (b) ring pile yarn

visible from Fig. 3 that the terry loops made from rotor pile yarn have snarls, falling on the fabric surface. This reduces the bulk of the fabric and increases the tortuosity of the capillaries which explains lower dynamic water absorption. Probably, these may be the reasons that make the above-mentioned results more realistic than those of Swani *et al*[10]. The reason behind the different loop structure is the higher twist level and shorter fibre used for the production of rotor yarn.

Warp density, weft density and pile height have only a small effect on the percentage of the water absorption speed of terry fabrics, which is not worth considering while designing them[25]. This result seems contradictory to the latest findings by the researchers[30]. Here, it has been illustrated that the dynamic water absorption increases with loop density and loop length. Fabric cross-section image is shown in Fig. 4 which clearly shows that how fabric and loop geometry changes with change in loop density and loop length. Loop becomes straighter with increase in loop density and loop shape factor increases with increase in loop length. More straight loops have more straight capillaries and higher loop shape factor has more space to accommodate water. Probably, these may be the reason behind the improved dynamic water absorbency.

Looking into the structural details of the terry fabric, it can be found that loop density is directly proportional to the warp and weft density and loop length is directly proportional to the pile height. It has also been found that fabrics produced from pile yarn having high staple length fibre, low twist, combed and porous structure gives high dynamic water absorbency. Terry loop having high loop shape factor also gives high dynamic water absorbency. Researchers[26] measured the dynamic water absorption using image processing technique and studied the effect of pile height and different process variables on it. Their method measures the rate of change of wet spot area. Principally they have measured the rate of water flow in a horizontal plane. Since the presence of loops on surface of terry fabric makes it different from two dimensional fabrics. It becomes nearly 3D or more precisely 2.5D fabric. So it becomes important to consider the water flow in all possible directions and their method seems not doing the right thing. Their conclusion regarding the effect of pile height differs from that of Behera and Singh's[30]. However, another research work[22] supports the finding of Behera and Singh, i.e. dynamic water absorption of water increases with increase in pick density and pile length. They also compared the absorption phenomenon in plain and terry fabric, and found that dynamic water absorption is almost constant with the increase in weft density and fabric areal density for plain fabric. Cross-section view of the terry fabrics (Fig. 4) clearly shows the structural changes due to pick density and pile height. Loops become straighter with the increase in loop density

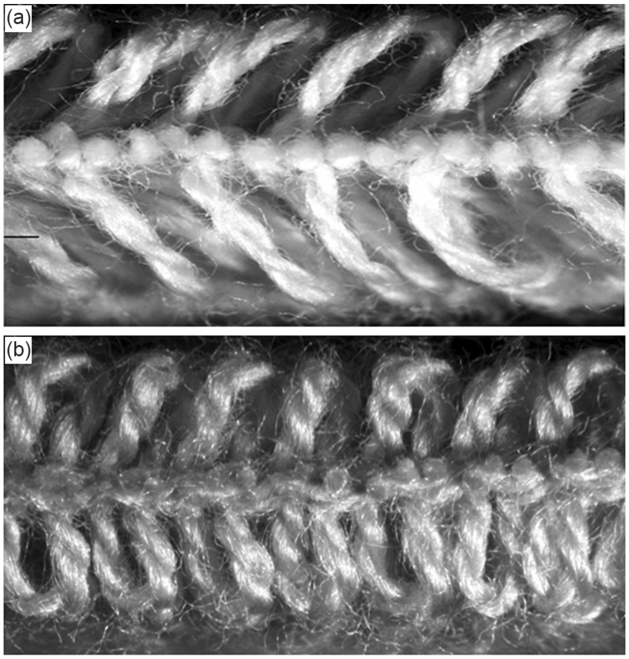

Fig. 4─ Cross-section of terry fabric having (a) high loop length low loop density (b) low loop length and high loop density

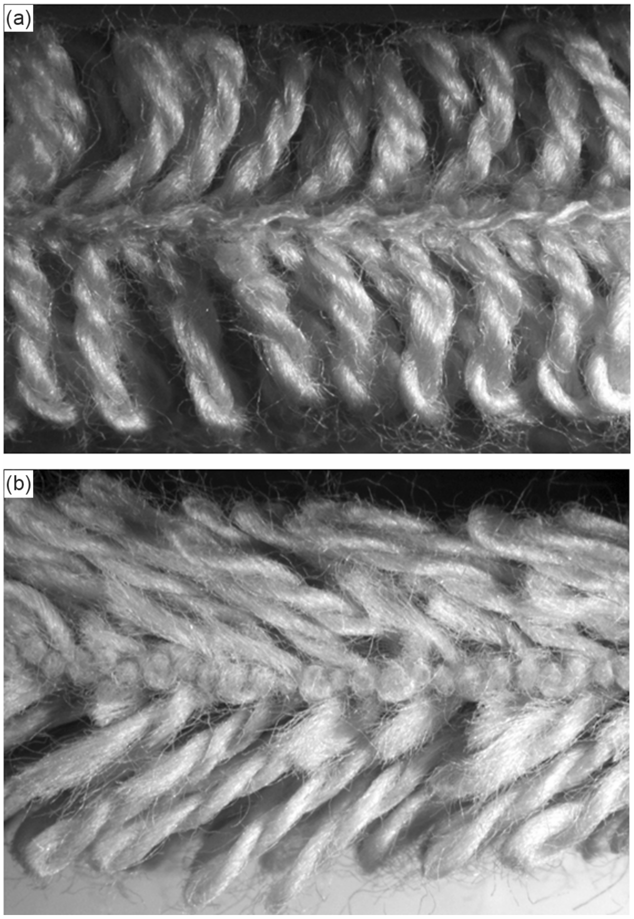

Fig. 5— Cross-section of fabric made up of (a) double-ply and (b) single-ply yarn

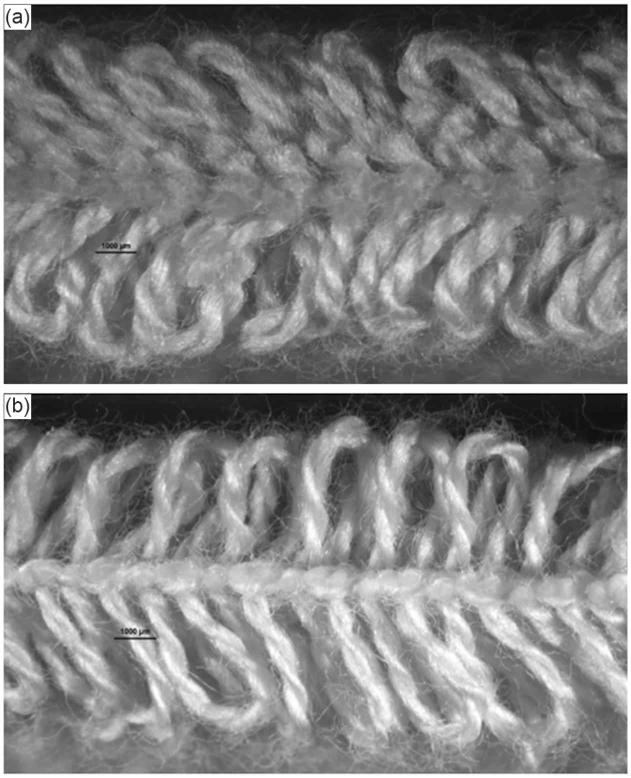

Fig. 6— Cross-section of fabric having loops of (a) lower shape factor and (b) higher shape factor

and loop shape factor increases with the increase in loop length. Loops produced from double yarn show more stability and do not fall on the fabrics surface; have more air space as compared to that produced from single ply yarn. The reason behind this is that the double ply yarn has twist balance and less chances of snarling or twisting of the loop as shown in the cross-section of the fabrics (Fig. 5).

The researchers[48-55] studied the absorbency behaviour of pile fabrics and found that pile yarn having dense and even splits have more micropores, so that they can absorb much liquid at high speed. Separated microfibres form dense voids with each filament, so that effective capillary pressure can be created. Hence, the water absorption properties of pile knit rely heavily on the splitting of multi-filaments and also on the uniform distribution of the split microfibres. It seems that the capillary size and their distribution are the key factors to govern the dynamic absorption of water. The studies conducted on the absorbency of terry fabric[30] show the effect of pile yarn count, pile yarn twist, fibre quality, combed yarn and yarn structure. These entire factors affect the capillary size and their distribution. High dynamic water absorption has been found with fabric made of pile yarn having finer count, low twist, high staple length, combed yarn and porous yarn. The fabric cross-section made from finer yarn and coarse yarn is shown in Fig. 6. Finer yarn is usually produced from high staple length fibres using low twist which helps to form long continuous and less tortuous capillaries causing high dynamic water absorption. Combing process removes the short fibre from the raw material to improve its staple length, hence producing the above condition. Porous yarn is produced by mixing poly vinyl alcohol fibres with cotton fibre before spinning. After weaving, the fabric goes into wet processing where the poly vinyl fibre is washed out at 100° C leaving behind a void space, thus producing large number of capillaries. Loop density can be increased by increasing weft density and warp density. In both the cases, ground of the fabric becomes compact thus reducing the capillaries continuity and increasing their tortuosity which will reduce the dynamic water absorption of the ground fabric. But the higher number of loops per unit area increases the overall capillary population in the loops, consequently increasing the dynamic water absorption of the terry fabric. Loop shape factor is a measure of the circularity of the loops. The portion of the loop in contact with water increases with increasing circularity of the loops. Thus, exposing more and more number of capillaries to the water and hence increasing the dynamic water absorption of the terry fabric. Terry loops produced from finer yarn will have the higher loop shape factor and hence the higher dynamic water absorption which is clearly visible from Fig. 6.

3.2 Fabric Variables Affecting Static Water Absorption

The weight ratio of amount of water absorbed to the dry weight of the terry fabric is known as the static water absorption properties. It indicates the maximum amount of water that can be absorbed by the terry fabric. Dynamic water absorption can be measured by various methods like porous plate method; Bureau Veritas Consumer Products service BV S1008, etc.

In a systematic research[22], the effect of weft density, fabric areal density and mean pile length on the absorbency of terry fabrics have been studied. Authors found that the static water absorption increases with increasing weft density, fabric areal density and mean pile length. But increasing weft density and fabric areal density for plain fabric do not change the static water absorption. This can be explained by the fact that the increase in said parameters makes the fabric more compact and reduces the capillary size and air space inside the fabric. Thinner capillary promotes the dynamic water absorption but reduces the static water absorption. In another research[23], the effect of warp density, weft density, pile height and pile yarn type has been studied and it is found that ring-spun yarn gives more static water absorbency than rotor-spun yarn. Double ply yarn gives more static water absorption than single ply yarn due to the fact that double ply yarn can produce terry loop with higher shape factor which is clearly visible from the fabric cross section shown in Figs 5 and 7. Loops produced from double yarn show more stability and do not fall on the fabrics surface; and have more air space as compared to that produced from single ply yarn. The reason behind this is that the double ply yarn has twist balance and less chances of snarling or twisting of the loop. These results are very well supported by the latest research[30]. Karahan and Eren[23] also found that an increase in warp and/or weft density reduces the static water absorption which is contradicted by both Yamamoto *et al.*[22] and Behera and Singh[30]. Yamamoto *et al.*[22] and Behera and Singh[30] found that higher warp and weft densities give higher static water absorption. In another research[12], it was found that the water absorption increases with increase in fabric areal density and pile height. The reasons in support to these results have been in the previous section. Double ply yarn gives more static water absorption than single ply yarn. This is due to the fact that the double ply yarn is more voluminous as compared to its equivalent single ply yarn along with higher loop shape factor.

In another research[27], the effect of pile height on the static water absorption has been studied. They found that fabric with high pile height gives more static water absorption. This result is also supported by another research[29]. The studies conducted on the absorbency of terry fabric[30] show the effect of pile yarn count, pile yarn twist, fibre quality, combed yarn and yarn structure. These entire factors affect the capillary size and their distribution. High static water absorption has been found with fabric made of pile yarn having finer count, low twist, high staple length, combed yarn and porous yarn. Finer yarn usually

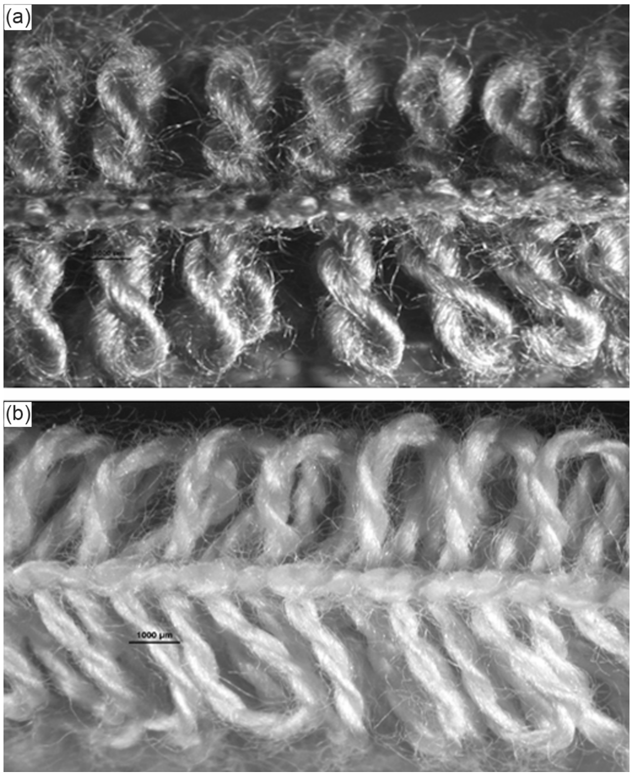

Fig. 7— Cross-section of terry fabrics produced from (a) single ply and (b) double ply yarn

produced from high staple length fibres using low twist helps to form long continuous and less tortuous capillaries, leading to bulky structure which causes high static water absorption. Combing process removes the short fibre from the raw material to improve its staple length, thus producing the above condition. Research work done by Lukas[56] supports the above inference.

Porous yarn is produced by mixing poly vinyl alcohol fibres with cotton fibre before spinning. After weaving, the fabric goes into wet processing where the poly vinyl fibre is washed out at 100° C leaving behind a void space, thus producing large number of capillaries which leads to bulky structure. Loop density can be increased by increasing weft density and warp density. In both the cases, ground of the fabric becomes compact, thus reducing the capillaries and increasing their tortuosity which will reduce the static water absorption of the ground fabric. But the higher number of loops per unit area increases the overall capillary population in the loops, consequently increasing the static water absorption of the terry fabric. Loop shape factor is a measure of the circularity of the loops. The portion of the loop in contact with water increases with increasing circularity of the loops. This exposes more and more number of capillaries into the contact of the water and increases the static water absorption of the terry fabric. Fig. 8 shows the fabric cross-section produced from zero twisted and low twisted high stable cotton. It is clearly visible here that the loops are not in proper shape neither their shape factor can be defined, but the surface is really more fluffy and bulky which explains the high dynamic water absorption but low static water absorption of such fabrics.

4 Effect of Processing Factors on Absorbency Performance of Towel

Apart from the raw material and fabric construction related factor, there are other factors that affect the performance of terry fabric. Considerable amount of research has been directed towards this area. In an important research[6] where the effect of home laundering and fabric areal density has been studied, it is found that the maximum dynamic absorption increases with the number of washing cycles until the finish is completely removed. The study shows no significant change with additional wash cycles, indicating that fabric surface is the important factor in dynamic water absorption. The areal density does not have any effect on dynamic water absorption. Static water absorption increases consistently with the increase in number of wash cycles and fabric areal density. Measuring static absorption per gram of fabric indicates the importance of fabric construction as the absorption per gram of fabric is higher for fabrics of lower areal density. The results of effect of wash cycles are also supported by earlier research work[5]. Fabric conditioner has no effect on physical characteristics, such as porosity and pore size, and hence on the static water absorption of terry fabric.

Another research[7] shows that the absorbency and aesthetic characteristics are affected more by the type of softeners than by the number of laundering. Latest research[20] shows that the types of conditioners play important role in dynamic water absorption. Cationic fatty acid based surfactants are the main ingredients of the fabric conditioners and they cover the fibres with a fatty acid coating[16]. This mechanism may make the treated fabric surface more hydrophobic, leading into the reduction of water uptake. Pronounce effect of fabric conditioners on dynamic water absorption due to change in wettability (contact angle with water) of

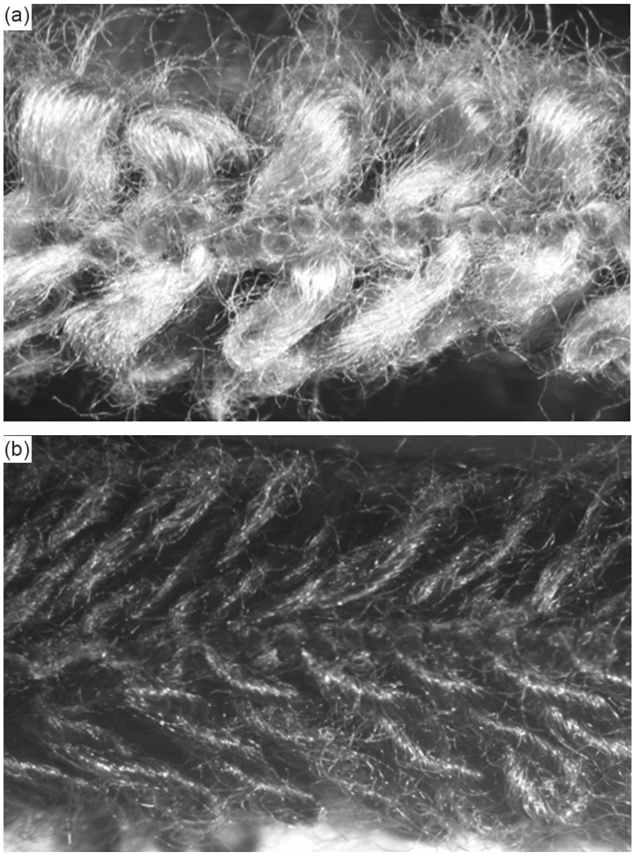

Fig. 8— Cross-section of fabric with (a) zero twisted and (b) long staple bamboo fibre yarn

cotton has also been recorded. Liposomal fabric conditioner reduces the dynamic water absorption up to a great extent, whereas isotropic formulation has no significant effect. Some of the enzymes like cellulase, when applied alone on cotton, produce detectable improvements in static and dynamic water absorption[57].

Another research[17] in support to above findings explains the suitability of hydrophilic softeners. Static water absorption of fabric increases with number of wash cycles[21]. Another research[58] says that softener type affects the degree of hydrophility. Fabric dyed samples show more hydrophility than yarn dyed samples. Wash cycles improve the static and dynamic water absorptions. Hydrophility of uncut pile towel is found higher than those of cut pile towel. Dynamic water absorption for washed fabric is higher than that for grey and macerated fabrics[26]. Static water absorption depends on the king and intensity of the finishing[28,29] applied to the fabric. Washing with detergent and water alone improves the static water absorption. Macerating also improves it a little but use of softeners reduces it. Tumbling process improves both the static and dynamic water absorption. All these results can be explained by the fact that washing and tumbling opens up the structure and makes it voluminous, thus increasing static water absorption. Recently, more extensive research[32] has been done and no considerable change is observed in the dynamic water absorption after repeated wash of the samples until 4th wash, beyond which it is decreased. Static water absorption increases with increasing number of wash until 8th wash after which it is decreased.

5 Conclusion

Producing highly absorbent terry fabric is the ultimate goal of the textile technologists in the industry which can be achieved by using longer, finer and hydrophilic fibre to produce soft, bulky, low twisted fine ring-spun pile yarn; further producing terry fabric having high loop density, optimum loop length, high thread density and loop shape factor. Macerating, tumbling, hydrophilic softeners and washing are the post production treatment for further improvement in absorbency. The crucial outcome of the latest research regarding the absorbency of the terry fabric is the loop shape factor which is the main factor behind the super absorbency of terry fabric. Fibre and yarn characteristics, fabric constructional parameters and wet processing treatments affect the loop shape factor which consequently affects the water absorbency performance of terry fabric. Therefore, further efforts are needed to increase the loop shape factor to get excellent water absorbency performance.

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