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Liquid Sorption and Transport in Woven Structures

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Abstract
Investigations in liquid sorption and transport were performed with three different variants of terry woven structures. Terry fabrics were produced using linen warp pile yarns and cotton or linen ground warps and wefts. The process of liquid sorption from the first moment when the water drop beads up the fabric's surface until there is a complete loss of the drop's specular reflectance and an absolute absorption of the liquid i.e., when the wetted spot remains stationary. A method for measuring dynamic water absorption in and through terry fabric is suggested. The action of terry fabric in contact with a liquid drop and liquid transport through it depends on the structural characteristics of the terry material, the kind of impact or finishing operation and its intensity. The character of liquid penetration through terry fabric is different when analysing grey woven material, and which is affected by intensive impact/finishing. All the kinds of regressions investigated generally showed a very good match with experimental data. The results of the research determined the dynamics and character of the sorption process in woven terry fabrics and could be used for creating new textiles with desired properties.

Key words: *impact/finishing, liquid transport, sorption, structure, terry fabric.*

Introduction

Textiles with high liquid sorption qualities, which absorb dyes and chemical finishes could be used for applications in direct contact with human skin in order to help cool the body by readily absorbing moisture or perspiration. Absorption and permeability properties as well as moisture transmission through textiles are important for textile design and especially relevant for the comfort of clothing created for wear or use in damp and warm environments, such as bathroom and sauna clothes, headdress, footwear, towels as well as for medical and sport textiles, amongst others [1 - 4].

The interaction of liquids with textile could involve some fundamental physical phenomena: wetting of the fibre surface, transport of the liquid into assemblies of fibres, adsorption of the fibre surface, and diffusion of the liquid into the interior of the material [5]. On the basis of the relative amount of liquid and mode of liquid-fabric contact, the wetting and wicking processes can be divided into such groups: wetting/wicking from an infinitive liquid reservoir and from a finite (limited) liquid reservoir. The second one is exemplified by a drop wetting/wicking into the fabric.

Generally terry materials absorb water perfectly. Of course, the absorption capacity depends on the yarn material and type as well as the fabric structure [6]. It was shown that the type of yarn used in terry fabrics had the most significant effect on static water absorption properties. In [7] Karahan experimentally investigated the dynamic water absorption properties of terry fabrics using a method of electronic balance. It was assumed that water the absorption speed for each time interval would provide a more direct understanding of the dynamic water absorption behaviour of the textile. It was found that depending on the yarn type, around 26 - 40% of the total water absorption capacity is absorbed in the first 10 s. After 30 s, water absorption continues at a decreased speed. Water absorption continues even after 300 s but at a very low rate, which cannot be considered from a practical point of view.

The transport of a liquid into yarns and fabrics may be caused by external forces or by capillary forces, i.e. wicking. Because capillary forces are caused by wetting, wicking is a result of spontaneous wetting in a capillary system [5]. The kinetics of capillary filling depends on the pore radius [8]. During wicking, flat continuous filament yarns show typical capillary liquid flow due to the number and length the filaments running parallel to each other [9]. In yarns the way in which filaments pack together determines the amount of void space between filaments [10], and an increase in the number of filaments, yarn tension and twist has a significant effect on the yarn wicking performance. Microscopic examination proved that yarns with more twist exhibited a reduced wicking trend with a sudden increase in wicking performance at high twist levels due to spiral wicking [9].

The degree of hydrophility of towel material has already been investigated using the sinking test [11]. The experiment showed that the type of softener affects the degree of hydrophility. The sinking time of towels produced with dyed yarns was higher than that of towels dyed in a fabric form, and the hydrophility degree of uncut pile towels was found to be better than that of velvet towels. Besides this, it was determined that the pile height decreases the sinking time. However, there must be a limit depending on the yarn number, twist, type of raw material and density of the pile height, beyond which the hydrophility degree tends to decrease. It was found that the washing process appeared to be an important parameter in defining the sinking time – in washed towels it became lower than that of towels which did not undergo any washing procedure.

Moisture transmission through textiles along with wetting and wicking play a significant role in maintaining thermo-physiological comfort. Scientific understanding of the processes involved in moisture transmission through textile materials, as well as factors affecting these processes and mathematical modelling are significant in the design of new textile systems [1, 2]. It was determined that the vital lack of correlation between water vapour permeability, the thickness of knitted fabric and surface porosity results from the character of media transport by free convection and the general high porosity of knitted fabrics [12]. The influence of soaking in water to realise the optimum swellability of linen yarns in fabrics was studied in [13].

In many process techniques and end-use characteristics, the surface wettability of textiles and technical fibres is a key factor. In dyeing, finishing or coating proc-

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esses, the wetting properties affect the process parameters and final qualities of textiles. The wettability of long fibres like flax, ramie, jute, sisal and sunhemp has already been determined and compared [14]. It was found that the wettability of fibres depends on the properties of the binder, the properties of the fibre surface and the nature of the fibre. With an increase in the concentration of polyvinyl acetate solution from 5 to 10 %, the wettability decreased in all the natural fibres studied, depending on the chemical and physical characteristics of the fibre.

The moisture content of fibres and the behaviour of liquid in contact with textiles are very important for both the processing and use properties of products especially for analysing test results of the new fibres and textiles for medical applications that could well possess biofunctions, carry medications, act as cell culture scaffolds, etc. [3]. [15] deals with the water inhibition of fibres, in which the water that in is within cell walls, inter-fibre spaces, or pores is measured.

The sorption of a drop can indicate the wettability of a textile material either by the time of its sorption by the fabric or by the area of the wet spot formed by the liquid [16]. Kissa states that in cases where the liquid can diffuse into the fibres, the kinetics of sorption and liquid transport are complicated. Diffusion of the liquid into fibres accelerates the sorption; however, the spreading rate of liquid within the fabric is reduced because absorption in fibres reduces the volume of liquid available for spreading in capillary spaces, which causes the swelling of fibres and decreases the spaces between them. The wettability of fibres with respect to water is the most important factor determining the detergency of oil in an aqueous bath; other factors are the viscosity of the soil, the detergent, wash temperature, agitation, etc.

In spite of the interest in the absorption process of textiles, no research has been conducted into the absorption of terry fabrics regarding various impacts or finishing, especially washing, softening and tumbling. The aim of our study was to conduct experimental investigations into the water sorption process and liquid transport in loop pile fabrics with respect to to various impacts/finishing operations and their duration.

Experimental

Object and method of investigation

The experiments were conducted using the three variants of terry woven structures presented in ***Table 1***. The main structure investigated was that of pure linen terry because of the excellent absorption properties of flax fibre and the popularity of such an assortment. The linen/cotton structures were analysed as additional items with a view to including larger amounts of terry material affected by various types of industrial finishing. ***Table 2*** shows the impacts/finishing applied to the terry fabrics.

During the macerating procedure, the specimen was placed into water for a time necessary to complete the macerating of the material. The detergent Felosan NOG (CHT R. Beitlich GmbH, Germany) was used for washing at a temperature of 60 °C, over a period of 60 minutes. The softening procedure was performed using silicone conditioner Tubingal SMF silicone conditioner (CHT R. Beitlich GmbH, Germany) over a period of 60 min, at a temperature of 40 °C. The purpose of softening is to give a soft and fluffy surface to the material. The tumbling operation gives a fuller volume and a more cushioned handle to the textile. To achieve the terry fabric softness that is in great demand nowadays, the samples were washed with detergent, conditioned, centrifuged and then tumbled for 5 periods of 30 to 150 min.

The experiments were performed using a SMZ 800 Nicon Stereoscopic Microscope and Coolpix 4500 Digital Camera; 7.0 PE-Live software was applied for analysis of video records. The absorption process was filmed from the start moment (SM) until the last moment (LM), i.e. from the moment when the drop of distilled water (of 0.110 g) fell onto the surface of the fabric until it was absolutely absorbed by the fabric. The height of the falling was as minimal as possible (it was chosen so that the drop could not touch the dropper and the surface of the fabric at the same moment). The test instruments used in the experiments are presented in ***Figure 1***. Two experiments were performed: filming from the upper side of the fabric (see ***Figure 1.a***) and filming from the underside of the fabric (see ***Figure 1.b***). The areas of the liquid spots were measured by investigating

Table 1. *Terry woven structures.*

Characteristic		Fabric variant		
		A8-A12	B7-B13	C1-C12
Pile height, mm		9	9	12
Linear density of yarns, tex	Pile warp	68 tex, unbleached linen, wet spinning	50 tex, bleached linen, wet spinning	68 tex, unbleached linen, wet spinning
	Ground warp	25 tex x 2, cotton	25 tex x 2, cotton	56 tex, unbleached linen, wet spinning
	Ground weft	50 tex, cotton	50 tex, cotton	56 tex, unbleached linen, wet spinning
Yarn density, dm^{-1}	Pile and ground warp	250		
	Weft	200		180

Table 2. *Impacts/finishing applied to terry fabrics.*

Fabric variant	Sequence of impacts/finishing and lasting
C1	Grey fabric (without any finishing)
C2	Macerating → draying in air
C3	Washing in water (without detergent) in 10 min → centrifuging → draying in air
C4	Washing in water (without detergent) in 30 min → centrifuging → draying in air
C5	Washing in water (without detergent) in 120 min → centrifuging → draying in air
C6	Washing with detergent → centrifuging → draying in air
B7, C7	Washing with detergent → softening → centrifuging → drying in air
A8, B8, C8	Washing with detergent → softening → centrifuging → tumbling in 30 min → drying in air
A9, B9, C9	Washing with detergent → softening → centrifuging → tumbling in 60 min → drying in air (if needful)
A10, B10, C10	Washing with detergent → softening → centrifuging → tumbling in 90 min
A11, B11, C11	Washing with detergent → softening → centrifuging → tumbling in 120 min
A12, B12, C12	Washing with detergent → softening → centrifuging → tumbling in 150 min
B13	Washing with detergent → calendering

pictures of video records, and changes in the spot's area over time were calculated.

Polynomial, linear, logarithmic, power, and exponential types of regressions, which can describe the results, were analysed.

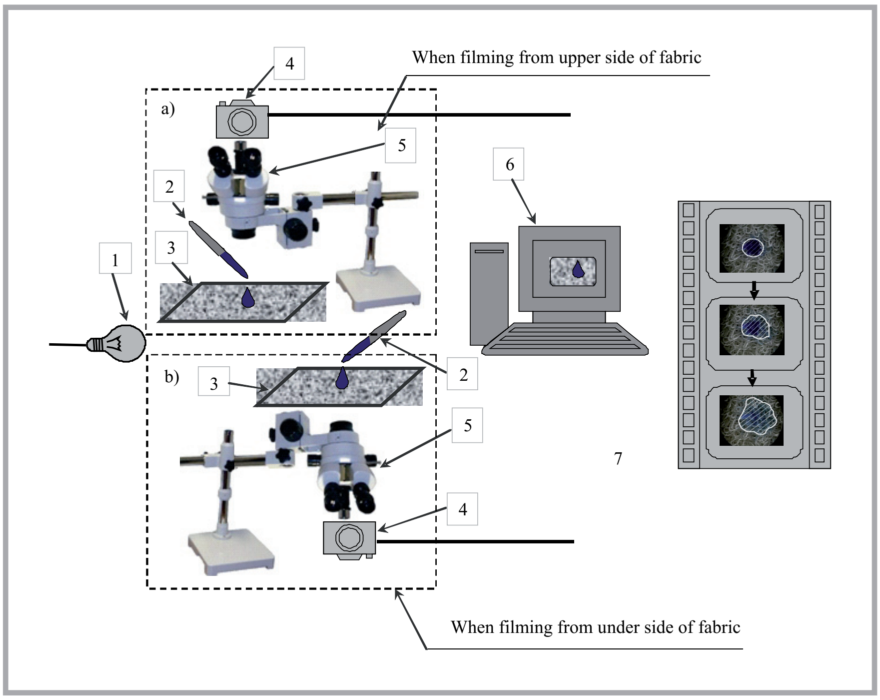

Figure 1. Test instruments used in the experiment: 1 - light source, 2 - dropper, 3 - fabric, 4 – digital camera, 5 – stereoscopic microscope, 6 – computer, 7 – pictures of video record.

Results and discussion

Sorption dynamics of pure linen grey fabrics, as well as after macerating and after washing procedures

The structure of loop pile in grey fabric is of regular geometry – the loops are rigid and range perpendicularly to the base of the fabric. When in contact with liquid this fabric acts in a very special manner. ***Figure 2*** shows the water absorption of grey terry fabric (C1 variant) over time. Further results of the absorption process, in which the fabric was filmed from the upper side, are presented.

It takes 370 s from the start moment to a complete loss of the drop's specular reflectance and the occurrence of absolute absorption when the spot becomes stationary. It is important to note that the rigid loop pile in grey fabric that was not affected by any liquid impact or finishing, which had been in previous contact with the drop, demonstrated resistance to water uptake. We determined that the drop holds its full specular reflectance for approximately 5 seconds and even up to 15 seconds from the SM till the moment when the specific shape of the drop disappeared and only a sloppy or wet spreading spot was observed. The research [5] stated that most textile materials are not isotropic, thus the spreading liquid does not usually form a circle with a well defined radius; besides, the wicking process is kinetically quite different when capillary penetration is accompanied by the diffusion of the liquid into the fibres. We found that the wetting pattern is uniform at the beginning of the sorption process. After the period when the drop loses its full specular reflectance, the liquid spreads almost as a regular continuous front, and an obvious "fingering" pattern was not determined. Supposedly, the capillary spaces in terry fabric are not uniform and the irregularity of pores between fibres and yarns as well as the irregularity of the distribution of pores could change the wetting progress. The water was absorbed at an uneven speed in all the intervals investigated, from SM till LM. At the beginning, i.e. for a period of SM to 10 s the absorption runs slowly. Such behaviour between the drop and fabric surface is inherent only for grey fabric. Later on the sorption progresses. During the period of 10 to 40 s the spot's area changed 1.38 times. The full absorption process took 370 s and it is the longest wetting compared with all other investigated variants. When analysing the SM/LM interval, it was observed that the change in the spot's area had increased by 225.9%. The polynomial relationship with the highest determination coefficient, $R^2 = 0.9881$, was determined between the water absorption time and the change in the spot's area. Other kinds of equations investigated also showed high determination coefficients, except the exponential one.

Macerating and washing changed the terry structure. It was determined that the sorption shortened very significantly, i.e. almost twice in the macerated sample (till 190 s) or even much more in samples washed in water for 10, 30 or 120 min (till 130 s). ***Figure 3*** shows pictures of the video record of macerated terry fabric (C2 variant). During the first inspected period from SM to 10 s, the spot's area increased by 29.9% and 42.6% after macerating (C2 variant) and washing in water for 30 min (C4 variant), respectively. The change in spot area of variants C2 and C4 appeared to have increased by 282.5 % and 211.3 %, respectively which analysing the period SM - LM. The change in the LM's in the spot area in the macerated

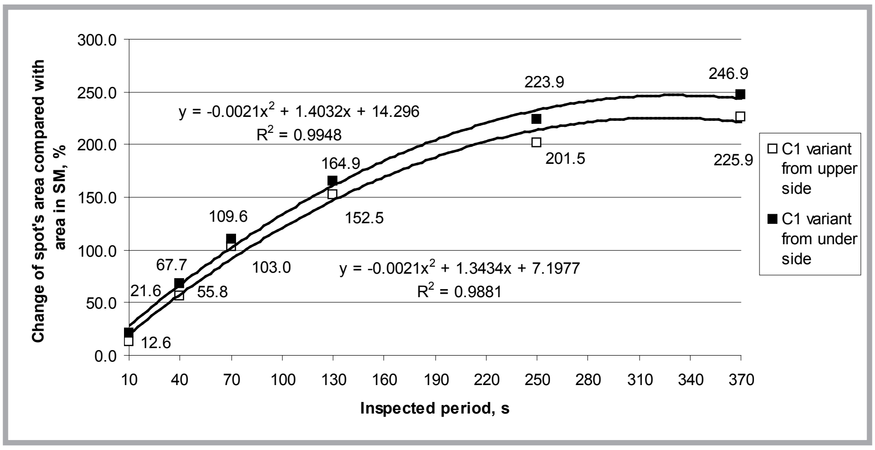

Figure 2. Change in the spot's area in grey terry fabric, C1 variant; (filming from the upper and under sides).

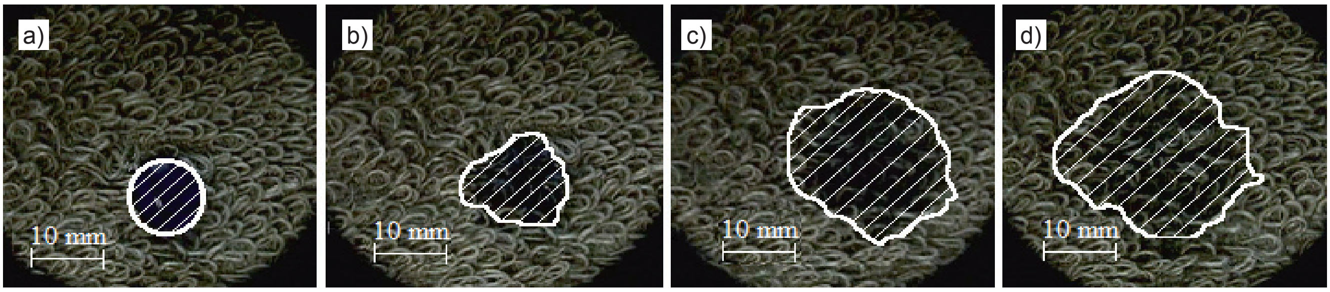

Figure 3. *Pictures of video record of macerated terry fabric (C2 variant): a – SM, b – after 70 s, c – after 130 s, c – after 190 s (LM); (filming from the upper side).*

fabric was the largest compared to all the other changes obtained in pure linen fabrics (see ***Figures 2, 4 - 6***). Such values reveal how significantly the fabric was influenced by even short and not intensive impacts, such as the macerating one. The highest determination coefficients are $R^2 = 0.9981$ (C2 variant) and $R^2 = 0.9956$ (C4 variant), which are best described by polynomial equations; but some other kinds of equations also show a very good match with the experimental data. The speed of change in the spot's area in C2 and C4 fabrics is not the same. The peak of water spreading was observed at the beginning, i.e. for a period of SM - 10 s and at the end of the process, i.e. after 130 - 190 s in macerated samples. Here the changes in the spot's area increased 1.30 and 1.37 times, respectively. The fabric washed in water (for 30 min) showed absorption with a constantly decreasing speed during the period investigated: at the beginning (SM - 10 s) the spot's area increased 1.43 times, whereas over a 100 s - LM period the spot's area increased 1.07 times.

Wetting through washed, softened, and calendered terry structures

The structures of terry fabrics after finishing operations were investigated: washing with detergent, softening, and calendaring. ***Figures 5*** & ***7*** show the absorption dynamics of terry fabrics after washing with detergent and softening (B7, C7) as well as after the calendering procedure (B13). During all the industrial washing cycle, which includes such impacts as water, mechanical, heat, and chemical, modification of the terry structure occurs. The additional factor of softening conditions the loss of loop pile stiffness throughout, resulting in the terry fabrics becoming soft and gentle. Calendering, by contrast, decreases the pores between yarns and fibres, with the loops being bent and flattened to the base of fabric, and decreases the thickness of the textile. When pure linen and linen/cotton terry fabrics were analysed after washing with detergent, and softening, calendaring, the water absorption continued for 130 s whereas only 70 s after calendaring, i.e. nearly 3 times and in some cases more than 5 times longer compared to grey fabrics, respectively. The sorption speed is highest at the beginning, i.e. up to 10 s in washed and softened fabrics. During the period of SM - 10 s, the spot's area changed 1.34 (C7 variant) - 1.32 (B7 variant) times. Later on the wetting proceeded more slowly. Consequent deceleration was especially visible in the case of pure linen terry fabric. Although these two curves (see ***Figure 5***) correspond to the different fabric structures, both fabric samples showed the same character of water sorption over time, except LM; here the spot's area changed by 190.3% for the C7 fabric and 221.3% for the B7 fabric. Regression analysis was applied to the experimental data, and the poly-

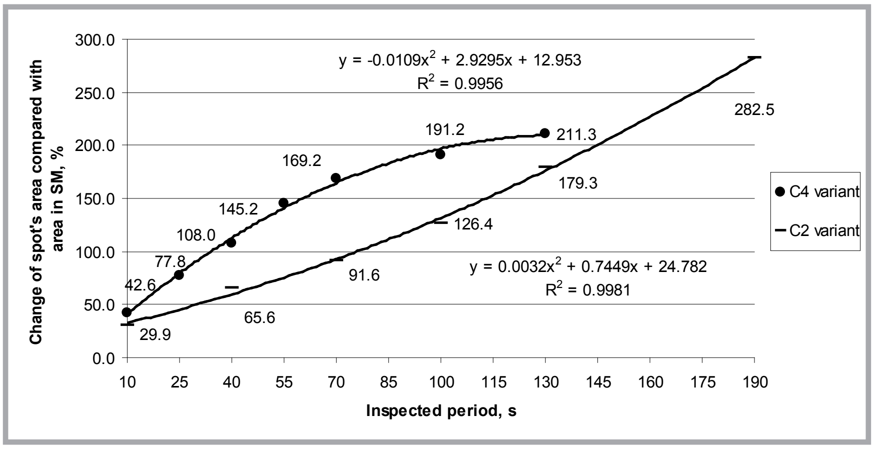

Figure 4. *Change in the spot's area in macerated terry fabric, C2 variant, terry fabric washed in water (in 30 min) , C4 variant; (filming from the upper side).*

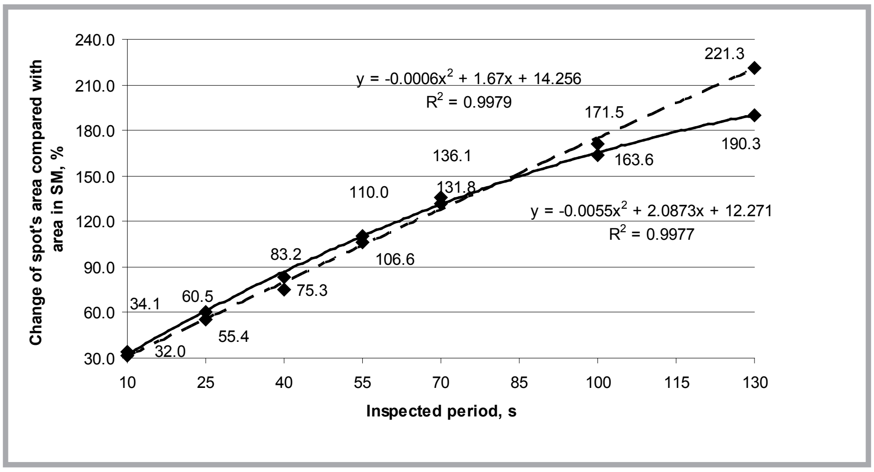

Figure 5. *Change in the spot's area in terry fabrics washed with detergent and softened: ----- B7 variant, C7 variant; (filming from upper side).*

nomial curves showed a perfect match with the experimental data; but very high determination coefficients proved that this is a very good or good match for both fabrics with respect to the other regressions under investigation: linear, logarithmic, power, and exponential. It was found that $R^2 = 0.9977$ (polynomial) - 0.8635 (exponential), which is the investigated data for the C7 variant, and $R^2 = 0.9979$ (polynomial) - 0.8731 (logarithmic), for the B7 variant.

The calendered fabric started to absorb water at a high speed, which then decreases continuously till LM. In contrast with the washed and softened fabrics, the calendered one's absorption finished with an increase in the area of the spot of 131.7% (see ***Figure** 7*). It may be conditioned by alterations in the fabric structure after calendaring, during which the loop pile lost its looseness, becoming smoother and tighter, and as a consequence the rigidity of the textile increased and the air spaces decreased significantly. All the kinds of regressions investigated showed a very good match with the experimental data: $R^2 = 0.9986$ (power) - 0.9375 (exponential).

Absorption behaviour of tumbled fabrics

The structure of the fabric after tumbling is modified much more compared with other impacts or finishing. Tumbling gives a fluffy handle and softness to the textile. The spaces between loops and yarns increase, the loops become bulk and sometimes a spiral or snarl loop structure can appear after this procedure.

15 pure linen and linen/cotton woven structures were investigated for various tumbling times, from 30 min to 150 min (see ***Table** 2*). ***Figure 8*** shows pictures of the SM after 40 s and 70 s (LM) of tumbling terry fabrics (C10 variant). When investigating video records, it was found that the behaviour of liquid in contact with tumbled terry woven structures is different compared with other variants. In all tumbled samples the absorption process shortened considerably – by 5.3 times compared with grey fabrics. The spot became still after 70 s in all tumbled fabrics despite further tumbling and the fabric structure. As this absorption is very quick, it was divided into 5 intervals from SM to LM, i.e. after 10, 25, 40, 55 and 70 s. ***Figures 6** & **9*** show the absorption process of different structures of terry fabrics tumbled for 90

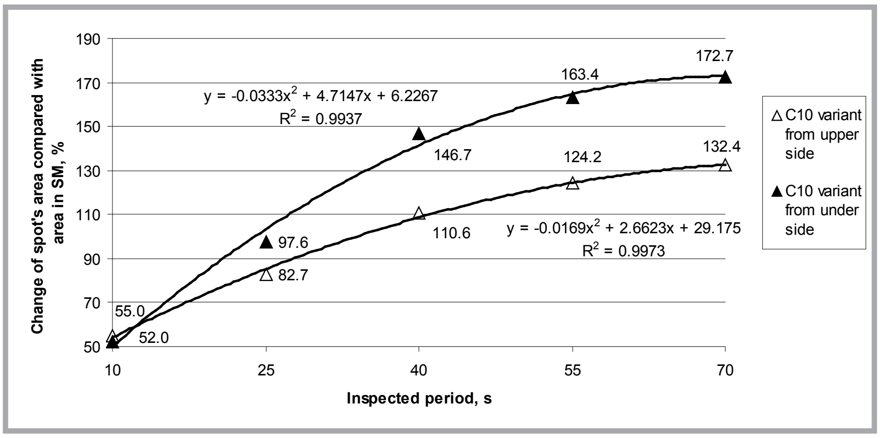

***Figure 6.** Change in the spot's area in tumbled (in 90 min) terry fabric, C10 variant; (filming from upper and underside).*

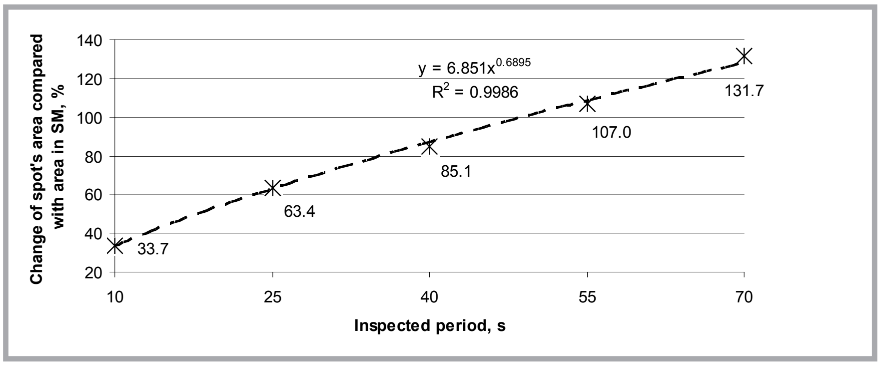

***Figure 7.** Change in the spot's area in calendered terry fabric, B13 variant; (filming from upper side).*

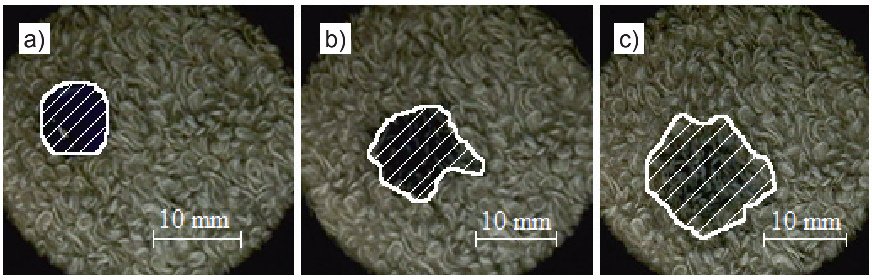

***Figure 8.** Pictures of the video record of tumbled (in 90 min) terry fabric of C10 variant: a – SM, b – after 40 s, c – after 70 s (LM); (filming from upper side).*

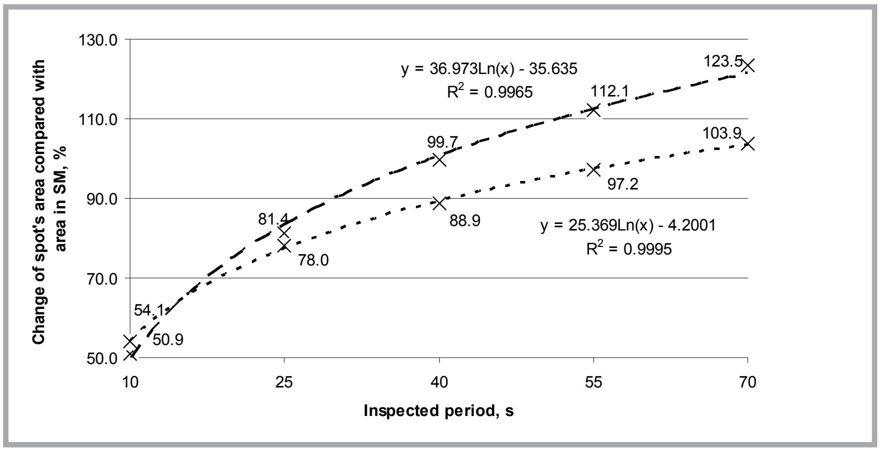

***Figure 9.** Change in the spot's area in tumbled (in 90 min) terry fabrics: .... A10 variant, ----- B10 variant; (filming from upper side).*

min. The results of absorption when the tumbled fabrics were filmed from the upper side will be presented primarily. It was determined that the changes in the spot's area increased in the following intervals: 54.1 - 103.9% (A10 variant), 50.9 - 123.5 % (B10 variant), and 55.0 - 132.4% (C10 variant). The liquid was absorbed very quickly at the beginning – during the first 10 s. For all the tumbled samples, regardless of the tumbling time, the absence of the drop's specular reflectance from the moment when it touched the surface of the fabric was determined. The tumbled fabrics snatched and sucked the liquid instantly. As is evident from ***Figures 6*** & ***9***, during the first time interval (SM - 10 s) the change in the spot's area increased significantly in all tumbled samples, i.e. by 1.55 (C10 variant) - 1.51 (B10 variant) times, but later on an evident and consequent decrease in the absorption speed was noticeable. During the final time interval (55 - 70 s), the absorption speed increased only 1.05 (B10 variant) - 1.03 (A10 variant) times. Besides this, the change in the spot's area in LM reached only 103.9% (A10 variant), which is the lowest value compared with the other tumbled variants: C10 and B10, as well as with all other fabrics affected by the various impacts/finishing (see ***Figures 2, 4 - 7 and 9***). Generally, when analysing LM, the values of changes in the spot's area in tumbled fabrics are lower compared with values in the LM of all the other variants investigated, except calendered fabric, where the difference is not statistically significant. The highest determination coefficients of regression for A10, B10 and C10 fabrics are respectively $R^2 = 0.9995$ (logarithmic), $R^2 = 0.9965$ (logarithmic), and $R^2 = 0.9973$ (polynomial). Such changes in the absorption of tumbled fabrics can be explained by the complex of long lasting impacts influencing the woven structure and, hence, the fabric's behaviour in contact with liquid.

Liquid transport in woven structures

With the purpose of analysing how a liquid penetrates a terry woven structure, an experiment was conducted using the scheme of instrument arrangement presented in Figure 1.b. A drop of liquid was dripped onto the surface of the fabric, and the absorption process was analysed by filming it from the underside of the textile. A video record was made from the dropping moment till the last moment when the area of the wetted spot remained stationary on the underside. In this experiment the start moment coincided with that mentioned before. Of course, it takes some time for the liquid to run through the fabric and to appear on the under side of the textile. Such an experiment was conducted with fabrics C1 and C10. ***Figures 2*** & ***6*** show the change in the spot's area with respect to the time when the textile was filmed from the underside. It was determined that the spot become visible on the underside of the fabric after 3 - 4 s and 2 s from the moment when the drop touched the surface of the upper side of the grey and tumbled fabric, respectively. With the purpose of relating the results and to compare them, the start moment was the same as that used in the experiments filming the behaviour of liquid from the upper side of the fabric. It was found that the change in the spot's area increased from 21.6% to 246.9% in grey fabric (see ***Figure 2***). The largest increase in the area of the spot (1.38 times) for grey fabric was determined in the second time interval (10 - 40 s), as in the experiment when the fabric was filmed from the upper side. Afterwards the speed of the spreading of the liquid slackened; the spot became still after 370 s. Trends of changes in the spot's area are similar, but the areas of the spot are slightly higher on the underside of the fabric; however, the differences are not statistically significant.

It was found that the change in the spot's area for tumbled fabric with respect to the SM/LM is 52.0 - 172.7%, in which the underside of the fabric was filmed. The water was absorbed at a constantly decreasing speed in all the time periods inspected in both experiments (see ***Figure 6***). At the beginning, i.e. in the time interval SM - 10 s, absorption occurs at the highest speed, i.e. the spot's area changed even 1.52 times on the underside of the fabric. It was determined that the area of the spot in tumbled fabric increased till 185.8 mm^2 (LM) on the underside of the fabric, whereas during filming from the upper side, it increased from 68.2 mm^2 (SM) to 158.3 mm^2 (LM). The absorption character is similar on the upper as well as on the underside of the fabric. The statistically significant differences between the values of spot area were determined from the 25th s of observation.

Statistical analysis of experimental data

The experimental results were statistically evaluated at the confidence level of $\alpha = 0.95$. Full statistical analysis was performed and the standard deviation, coefficient of variation, absolute error, and relative error were calculated.

Statistical analysis of the experimental data received while filming the fabric from the upper side showed that the coefficients of variation results for changes in the spot's area in many cases did not exceed 5.0% and varied in the interval of 2.0 - 7.0%; except some cases where they reached higher values, but did not exceed 10.6%. The relative errors varied in the interval 2.1 - 7.7%, except several cases where the values went up to 11.1%. Investigation of the experimental results received while filming the fabric from the underside showed that the coefficients of variation of changes in the spot's area varied in the interval 3.2 - 8.8%, and the relative errors varied in the interval 3.3 - 9.2%.

Conclusion

- Application of the suggested method for measuring the dynamic water absorption of terry woven fabrics enabled to analyse and evaluate the absorption speed and changes in absorbency with respect to time as well as to investigate and interpret the sorption ability of the fabric.
- The absorption process of pure linen and linen/cotton fabrics depends on the fabric characteristics as well as on the kind and intensity of impact/finishing. A significant difference exists in the absorption capacity of the different fabric treatments or impact number.
- The absorption process ran more quickly in fabrics affected by more and intensive impacts/finishing. It was found that the absorption process continued longest – even till 370 s – in grey pure linen terry fabric. In macerated fabric and fabrics washed in water without chemical treatment (independently to washing duration) or using detergent and softener, the absorption process was shorter - till 190 s and 130 s, respectively. The tumbling operation, irrespective of its duration, shortened the absorption process considerably – by more than 5 times compared with grey fabric.
- The pure linen grey fabric that not been affected by any impact like water, heat, mechanical or chemical in contact with the drop demonstrated resistance to liquid uptake. It takes

approximately 5 - 15 s for the drop to lose its full specular reflectance as well as to transform into a soppy glossy surface on the upper side of the fabric. In contrast an absolute absence of a drop's specular reflectance from the moment the drop comes in contact with the surface of a tumbled fabric, despite the fabric's structure and tumbling time was determined.

- The change in the wetted area increased by 12.6% during the first 10 s of investigating pure linen grey terry fabric, whereas an increase of 29.9 - 55.0% was obtained for fabrics impacted by macerating, washing in water (in 30 min), washing with detergent and softening or tumbling (in 90 min). When analysing the full period of absorption, the highest value of change in the spot's area (by 282.5%) was obtained in macerated fabric.
- When investigating the start/last moment, the change in spot area on the upper side of the fabric increased from 50.9 - 55.0% to 103.9 - 132.4% in different structures of tumbled terry fabrics.
- Many kinds of investigated regressions showed a very good match with experimental data: determination coefficient $R^2 = 0.9995 - 0.9881$. Mainly the results are best described by polynomial regressions, but in some cases the logarithmic or power equations represent experiments the best.
- With the aim of determining how a liquid runs through a textile, pure linen grey terry fabric and one which had been tumbled were investigated by analysing the change in the spot's area from the underside of the fabric. The same tendencies of absorption character and dynamics, compared with the results received from video records obtained from the upper side of the fabric, provide the possibility of obtaining a better understanding of dynamic water absorption properties and liquid transport in terry woven structures.
- Statistical analysis of experimental data showed that the coefficients of variation with respect to results of change in the spot's area varied in the interval 2.0 - 10.6%, mostly not exceeding 5.0%. The relative errors in many cases varied from 2.1% to 7.7%.

References

1. *Brojeswari Das, Das A., Kothari V.K., Fanguiero R., Araujo M., 'Moisture transmission through textiles. Part I: processes involved in moisture transmission and the factors at play', AUTEX Research Journal, 2 (7), 2007, pp. 100-110.*
2. *Brojeswari Das, Das A., Kothari V.K., Fanguiero R., Araujo M., 'Moisture transmission through textiles. Part II: evaluation methods and mathematical modelling', AUTEX Research Journal, 3 (7), 2007, pp. 194-216.*
3. *Petrulyte S., 'Advanced textile materials and biopolymers in wound management', Danish Medical Bulletin 1(55), 2008, pp. 72-77.*
4. *Petrulyte S., Baltakyte R., 'An investigation into air permeability of terry fabrics regarding the finishing processes', Tekstil 1/2 (57), 2008 pp. 15-20.*
5. *Kissa E., 'Wetting and wicking', Textile Research Journal, 10 (66), 1996, pp. 660-668.*
6. *Karahan M., Eren R., 'Experimental investigation of the effect of fabric parameters on static water absorption in terry fabrics', Fibres & Textiles in Eastern Europe, 2 (56), 2006, pp. 59-63.*
7. *Karahan M., 'Experimental investigation of the effect of fabric construction on dynamic water absorption in terry fabric', Fibres & Textiles in Eastern Europe, 3 (62), 2007, pp. 74-80.*
8. *Perwuelz A., Mondon P., Caze C., 'Experimental study of capillary flow in yarns', Textile Research Journal, 4 (70), 2000, pp. 333-339.*
9. *Nyoni A.B., Brook D., 'Wicking mechanisms in yarns – the key to fabric wicking performance', Journal of the Textile Institute, 2 (97), 2006, pp. 119-128.*
10. *Petrulis D., Petrulyte S., 'Properties of close packing of filaments in yarn', Fibres & Textiles in Eastern Europe, 1 (40), 2003, pp. 16-20.*
11. *Zervent B., Koc E., 'An experimental approach on the performance of towels. Part II. Degree of hydrophility and dimensional variation', Fibres & Textiles in Eastern Europe, 2 (56), 2006, pp. 64-70.*
12. *Wilbik-Halgas B., Danych R., Wiecek B., Kowalski K., 'Air and water vapour permeability in double-layered knitted fabrics with different raw materials', Fibres & Textiles in Eastern Europe, 3 (57), 2006, pp. 77-80.*
13. *Indu Shekar R., Kamal Kumar, Kotresh T.M., 'Development of closely woven breathable linen fabric for water storage applications', Indian Journal of Fibre & Textile Research, 3 (30), 2005, pp. 335-339.*
14. *Samajpati S., Sengupta S., 'Wetting characteristics of long vegetable fibres', Indian Journal of Fibre & Textile Research, 2 (31), 2006, pp. 262-266.*
15. *Rousselle M.A., Thibodeaux D.P., 'Cotton fiber properties and moisture: influence of variety, area of growth, and crop year', Textile Research Journal, 8 (76), 2006, pp. 655-659.*
16. *Kissa E., 'Wetting and detergency', Pure & Appl. Chem., 53, 1981, pp. 2255-2268.*

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