EVALUATION OF SURFACE WATER ABSORBENCY OF TERRY FABRICS

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Abstract: *The main aim of this paper was to evaluate the surface absorbency of loop terry fabrics using a new method. Evaluated loop terry fabrics with the different material composition and structural parameters were intended for the manufacturing of terry towels. After the detailed analysis of the thread as well as fabrics themselves, the new measurement method was used for determination of the surface water absorbency and subsequently, the drying time of terry fabrics was also specified. The results of measurements indicate that the surface water absorbency is not related to the material composition, but the drying time is closely connected with the given composition. Based on the observation and investigation, the surface water absorbency is related to the structural parameters of fabric and threads. The new testing method could be included into the new evaluation methods of surface water absorbency or it could be even used instead of current methods which are applied for assessment of the terry fabrics absorbency.*

Keywords: *surface water absorbency, drying time, height and number of terry loops, loop terry fabric, material composition and structure of fabric.*

1 INTRODUCTION

Bath body cleansing is the most natural and the most common activity which leads to the refreshment of human skin and regeneration of all human body. After hygienic body cleansing the towel is used in order to wipe the skin and this is the moment when the towel in the close contact with human body skin. Generally, the towels, which are used in our bathrooms, have to meet the following requirements: a high absorption capacity, moisture wicking, tactile softness and fineness [1].

Other requirements that should be characterized in relation to terry towels are: non-allergy, antibacterial effects, antimycotic effects, odour resistance, fast drying up and easy maintenance [2]. Some of these properties are described in this. Moreover, a very important component of the towel comfort is the wet thermal feeling, which was not studied in the submitted manuscript [3].

In relation to the towels assortment, the process or course of the water transfer does not exhibit the same features in comparison with the clothing fabrics where the water is transferred from the skin through clothes and then it gets quickly to the ambient environment. In the case of the towels, the transfer of water is divided into two specific phases [4]. In the first phase, the water is quickly transferred from the skin to the towel. Taking into account the specific time interval after the first phase, the second phase occurs. In relation to this second phase, the moisture evaporates from terry towel to the environment and long-term desiccating process occurs. Based on the predetermined investigation procedures and steps, the following evaluation is introduced in this paper:

- evaluation of the first phase of surface water absorbency in relation to the terry towel,
- evaluation of the second phase, which stands for the time interval of the terry towel desiccating process, which is based on the water evaporation to the environment [4].

The main objective of the paper was to specify the influence of the material composition and the influence of the basic parameters of terry fabrics on their surface water absorbency as well as the time of desiccating process. The measurements were repeated after every washing (max. number of washing procedures = 5 times). The new method was designed and tested in relation to measurement of surface water absorbency, while the given method was based on the simulation of the practical application of the terry fabrics in order to determine their surface water absorbency during the hygienic body cleansing. Fabrics, which were used for investigation as samples, were made of cotton, regenerated cellulose, lyocell fibres, and their mixtures. Besides the thread and fabrics evaluation, the specification of number and measurement of loops height had been performed before the measurement of the surface water absorbency properties were investigated. The research program involved the measurement of the absorbency and wicking of the terry fabrics.

2 METHODS AND USED MATERIAL

2.1 Materials

Terry towels belong to the special type of fabrics. A terry towel is described as a textile product which has a loop piles on one or both sides, generally covering the entire surface or forming stripes, some areas or any patterns (with end hems or fringes and side hems or selvages) [5], (Figure 1). It is formed directly in the process of weaving through the warp thread system. Besides one type of weft threads, two systems of warp threads are required – basic warp and loop warp in relation to the production of these textiles. The loops are formed of terry warp, using the weaving in a special way. The stability of the woven system is based on lacing of basic warp threads with the weft threads. During the finishing treatment, the loops can be shortened by cutting.

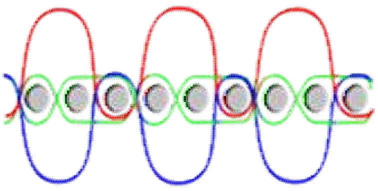

Figure 1 Cross-section of double-sided terry fabrics [5]

The selection and evaluation was closely connected with the terry woven fabrics, the weaving system of which was based on a trivalent or tetravalent cross rips according to [5]. The warp wise was formed by threads of basic warp along with the threads of loop warp in the ratio of two warp threads to the two loop threads (2:2). This interlacing was repeated in the case of all woven samples except the sample designated as n.5, where the ratio was determined for one warp thread and the one loop thread (1:1). Assortment of terry fabrics was used for preparation of individual samples for which a detailed structural analysis of the following characteristics was made: dimensional changes according to [6], area density of fabric and fineness of thread according to [7], the thickness of the fabric according to [8], number of threads in the fabric according to [9], (Table 1). The height and number of loops of terry fabrics was also assessed. The measurement of the loops was done using a metal measuring instrument which was placed between the individual lines of loops (Figure 2). The measurement was repeated ten times for each sample after every washing process. After the loops had been straightened, the height of these loops was measured in various sites of terry towel. Based on the microscopic observation, the images with the minimum and maximum height of loops were selected. From Figre 2, it can be seen that the shorter loops on the fabric were formed into a U-shape and the longer loops twisted themselves along their length. Table 2 shows that the average height of loop terry fabric was different. The height of loops, measured after each washing process, was changed minimally. The number of loops over the area of 100×100 mm was also measured. The given number was counted in the warp and weft direction after each washing process. Table 2 shows the average value of the number of loops. The number of loops was also changed minimally after each washing process.

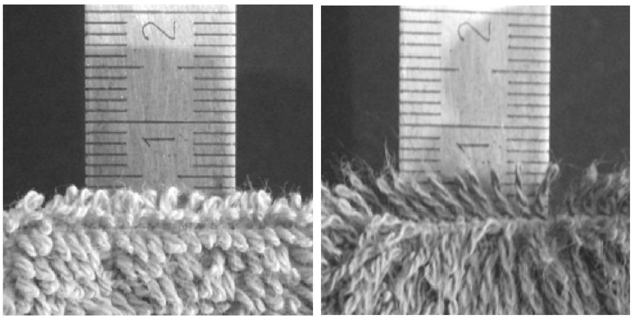

Figure 2 Measurement of height of the loops – sample n.4 (left) and sample n.9 (right)

Table 1 Properties of terry fabrics and threads

n.	Materials	Thickness [mm]	Unit weight [gm^{-2}]	Fineness [tex] weft/2 warps
1	100% cotton	400	2.22	35/56/35
2	100% cotton	450	2.23	38/61/35
3	100% cotton	500	2.39	38/60/34
4	100% cotton	600	3.21	38/57/55
5	100% microcotton	400	2.63	48/60/44
6	70% cotton 30% tencel	450	2.05	40/60/37
7	60% cotton 40% regenerated cellulose	450	2.05	40/57/37
8	55% cotton 45%regenerated cellulose	450	2.16	41/63/37
9	50% cotton 50%regenerated cellulose	450	2.56	37/57/38

Table 2 Average height and number of loop terry fabric

n.	Properties	
	Height *l* [mm]	Number *n* [100x100mm]
1	3.7	3840
2	3.1	4216
3	4.0	4480
4	2.3	4096
5	3.3	4080
6	2.8	4464
7	3.3	3840
8	4.0	4096
9	5.4	4224

2.2 Measured surface water absorbency

The main objective of this work was to measure the surface water absorbency of the terry fabrics. After the each measurement of the mentioned properties, the washing process of towels was carried out. Washing conditions were determined according to [10] as follows: temperature of the wash bath was 60°C, the ratio of solution to the sample was 50:1, the number of rinses in cold water was 2 and washing time was 60 min. ECE detergent [3] was used as a testing washing agent for preservation of colour fastness. A new type of device was designed and constructed for simulation of the surface water absorbency. Figure 3 shows the components needed to construct the given device.

Relating to surface absorbency ability of terry towels, the tests were performed under the strict conditions determined for tested samples. Two measurement points or areas were designated for the each one sample. At first, the tested sample was fixed in the holder and then, 50 ml of distilled water was poured into the funnel, from which the given water flowed down onto the surface of the terry fabric. To preserve the same conditions for all tested samples relating to water speed, the speed of the water flow was determined to be constant and it was 8 s. The testing procedure was connected with determination or detection of the overflowed distilled water which was not absorbed by terry fabric [11].

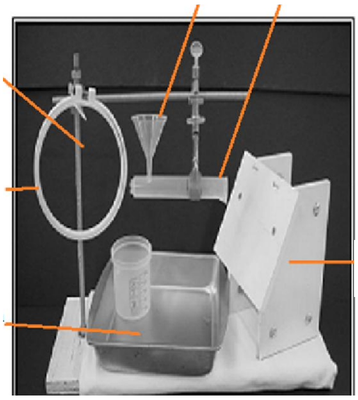

Figure 3 Parts of device necessary to measure the surface water absorbency of terry fabric

The overflowing water was collected in the collection box and then poured into a measuring cylinder. Subsequently, the value of overflowed water was subtracted from the original amount of distilled water (volume) and this calculation led to the result of the testing procedure and it was the determination of average value of surface water absorbency of the terry fabric in the predetermined area. After the each measurement of the mentioned properties, the washing process of towels was carried out. Terry fabric samples were washed for 5 times at all.

3 RESULTS AND DISCUSSION

The new method is based on descriptions in literature resources referring to surface water absorbency [3] and it is similar to the method for evaluation of the resistance of fabrics to surface wetting according to [12]. From Figure 4, it is clear that repeated washing process led to increase of the surface water absorbency.

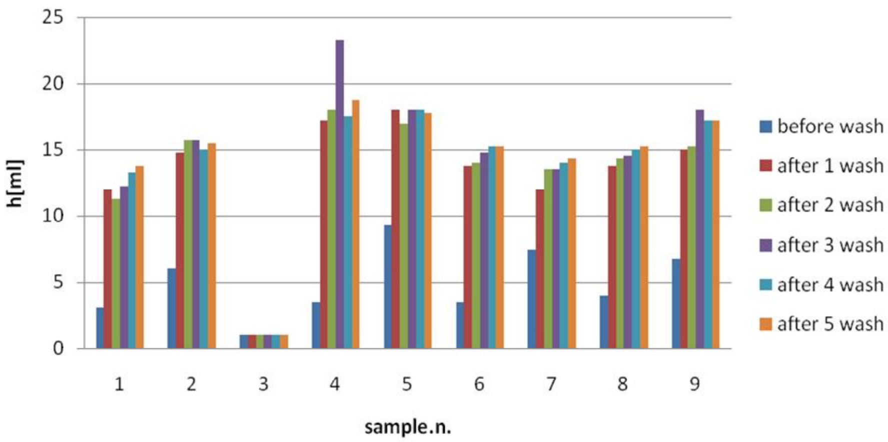

Figure 4 The average values of the surface water absorbency *n* (ml) of terry towels – reference samples (before washing - 0) and after 1, 2, 3, 4, 5 washing

The measurement was performed on one sample at two areas. The highest increase of surface water absorbency was observed for all the samples after the first washing process in comparison with these samples before the first washing process. The highest value of surface water absorbency was observed in the case of the samples designated as n.4 and n.5. The sample no.3 was an exception, because the value of the surface water absorbency was the lowest in comparison with all tested samples and moreover, the given value was not changed during the whole testing process. Table 3 shows the increase in surface water absorbency and thickness after the first and last washing process.

Table 3 Increase of surface and thickness

	Increase of surface water absorbency *n* [%]	Increase of thickness *h* [%]
1	15	8
2	5	18
3	0	19
4	9	7
5	1	9
6	11	25
7	19	24
8	11	24
9	15	21

The correlation dependences were used for the evaluation of the impact of structural parameters, such as thickness (Table 1, 2), on surface water absorbency. From the correlation dependence, it can be seen that the thickness of the towel has the main impact on surface water absorbency (Figure 5).

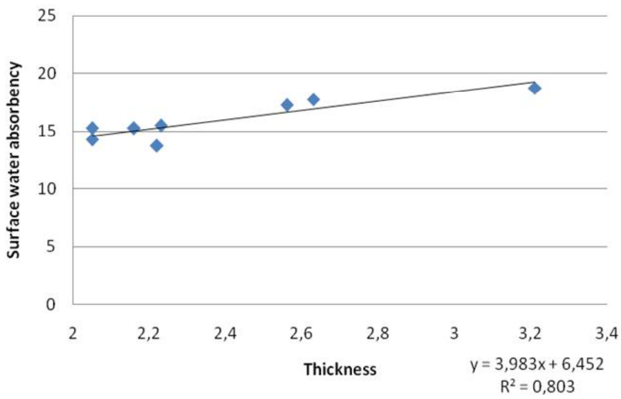

Figure 5 Dependence of surface water absorbency on the thickness

Increase in the thickness of the towel leads to the increase in the surface water absorbency. This dependence was evaluated and verified after the each repeated washing process. The obtained results after each one washing process are in the accordance with values, which can be seen in Figure 5, where the correlation dependence after the last wash is shown. The sample designated as n.3 was excluded from the correlation dependence due to different results of surface absorption (see Figure 4).

In the second phase of testing procedure of loop terry fabrics, the evaluation was focused on the ability to desorb and transport the moisture into the ambient environment. The tested samples were washed in detergent under according to the predetermined conditions and they were left to desiccate in air at relative humidity of 60±1% and ambient temperature of 21±1°C. The washing conditions and the composition of the wash bath are given and explained in part 2.2. In relation to the defined time intervals, samples were weighed on the analytical balance. The weighting of the samples was repeated until the value of the weight of the dried sample was the same as it was before the test. Table 4 shows the total desiccating time of individual terry fabric samples. After mutual comparison, drying speed and trend in humidity decrease are different because they are influenced by the various material compositions.

Table 4 Time of terry fabrics desiccating

Sample	1	2	3	4	5	6	7	8	9
Time of desiccating [h]	42	48	48	42	54	54	54	54	60

4 CONCLUSION

The work was focused on evaluation of loop terry towel (fabric). The surface water absorbency of predetermined areas or sites of terry fabrics was observed and evaluated in relation to material and structural composition. The main objective was to simulate real conditions of surface water absorbency of terry towels. The constructed device for measurement of surface absorbency of towels was designed and constructed. The given constructed device could be used for more precise measurement of the absorbency of the towels because it represents the reliable simulation of the surface absorbency of towel during its contact with the wet human skin. Compared to other methods, which have been used for determination and evaluation of water absorbency and of water absorption according to [13], wicking process according to [14], the evaluation of surface water absorbency is more impartial (objective) and more accurate for the given towel assortment. The results of the measurements show that samples designated as n.4 and n.5 have the best surface water absorbency. In the case of these samples, there is very good transport of moisture from the skin and therefore, they are a good representatives of wet sorption while this sorption is based on the structure of terry fabric. The impact of material composition and structural parameters of terry towel fabrics on surface water absorbency was also evaluated. Based on the obtained results, it is important to point out that material composition did not have any significant impact on changes of observed properties. Relating to findings, it can be concluded that the addition of tencel and regenerated cellulose to the cotton mixture does not have any impact on the increase of the surface water absorbency. In comparison with the cotton, the mentioned components exhibit better antimycotic and antibacterial properties as well as better odour resistance [2]. Repeated washing process and subsequent measurement of surface water absorbency of towels led to increase of the surface water absorbency after each one washing process. Moreover, the measured values are stabilized after the fifth washing. Interesting results were obtained in relation to sample designated as n.3, because there were not any changes observed after the repeated washing process (the given sample exhibited the same values of surface water absorbency after each washing and measurement) and it can be attributed to high surface tension, which is caused by significant deterioration of surface water absorbency leading to malfunctioning of terry towel fabrics. Terry towel fabric made of 100% cotton (samples designated as n.1, 2, 4) exhibited increase in surface water absorbency along with the increase in area density and thickness. The evaluation of the structure of terry towels, based on the number and the height of the loops lead to the interesting results because the increase in the number and height of loops led to the opposite effect in comparison with the expectations. Especially, the terry fabrics with lower number of loops and smaller height exhibited the higher surface water absorbency. In relation to the second phase standing for the evaluation of the desiccating process of towel samples, the given terry fabric samples, which contain cotton combined with other more absorptive component, exhibit much longer time interval of desiccating. The reason was mainly based on the different values for the humidity additions of regenerated cellulose and tencel in comparison with cotton.

Although the results of the introduced method are not so clear, the investigated measurement process of surface absorbency is more objective (in comparison with the older universal methods). Our task is to continue in the verification of the method, using the different types of towels. Moreover, models with satisfactory prediction for other structures of towels are going to be found. In addition, the wet thermal contact feeling could be included into the investigation processes as well as models.

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