AUTEX 2022 Conference Proceedings 978-83-66741-75-1

DOI: 10.34658/9788366741751.14

INFLUENCE OF STRETCHING ON LIQUID MOISTURE TRANSPORT IN KNITTED FABRICS

Małgorzata Matusiak[1(*)], Sabrina Froschauer[2]

[1] Lodz University of Technology, Faculty of Material Technologies and Textile Design, Institute of Architecture of Textiles, 116 Żeromskiego str., Lodz, Poland
[2] Hochschule für Technik und Wirtschaft (HTW), Treskowallee 8, Berlin, Germany
[(*)] *Email:* malgorzata.matusiak@p.lodz.pl

ABSTRACT

Moisture management in clothing is defined as the transfer of moisture from human body to the environment through the clothing [1]. Water vapour and liquid water (perspiration) need to get away from the human body to outside to keep the body dry. This action should happen immediately to have the maximal comfort of clothing usage. The aim of work was to investigate the liquid moisture transport in the knitted fabrics for babies and children clothing. Three variants of fabrics were the objects of the investigations. Measurement of the properties characterizing the liquid moisture transport in fabrics have been performed by means of the M290 Moisture Management Tester (SDL Atlas) [1,2]. Fabrics were tested in the relaxed and stretched state. Stretching of fabrics was realized by using the MMT Stretch Fabric Fixture device [3]. The percentage of stretch was adjusted at 15 %. On the basis of the results the knitted fabrics were compared in the aspect of their ability to ensure a physiological comfort. Influence of stretching on the parameters characterizing the liquid moisture transport in the fabrics was statistically analyzed and discussed.

KEYWORDS

Knitted fabrics, stretching, moisture transport, physiological comfort.

MATERIALS AND METHODS

Three variants of commercially available knitted fabrics designed for children and baby's clothing were the objects of the investigation. The characteristic of the investigated fabrics is presented in the Table 1.

Table 1. Characteristic of the investigated knitted fabrics.

SYMBOL	TYPE	RAW MATERIAL	MASS PER SQUARE METER	COURSES/CM	WALES/CM	THICKNESS
	-	-	g m^{-2}	cm^{-1}	cm^{-1}	mm
KF1	Cut plush	CO80/PES20	172	12.5	9.8	1.01
KF2	Lop plush	PES100	310	13.4	10.7	3.10
KF3	Interlock	CO100	206	14.9	11.7	0.88

The structural parameters of the investigated fabrics were measured using standard procedures:

- mass per square meter – according to the Po-P-04613:1997,
- thickness – according to the PN-EN ISO 5084:1999,
- number of courses and wales – according to the PN-EN 1471:2007.

Measurement of the parameters characterizing the liquid moisture transport in fabrics were performed by means of the M290 Moisture Management Tester by SDL Atlas according to the AASTCC Standard [2,4]. The M290 MMT is an instrument designed to measure the dynamic liquid transport properties of textiles such as knitted and woven fabrics in three aspects [4]:

- absorption rate – moisture absorbing time for inner and outer surfaces of the fabric,
- one-way transport capability – one-way transfer of liquid moisture from the inner surface to outer surface of fabric,
- spreading/drying rate – speed of liquid moisture spreading on the inner and outer surfaces of fabric.

The instrument can calculate the following parameters:

- WTT, WTB – wetting time of top (T) and bottom (B) surface [s],
- TAR, BAR – absorption rate of top (T) and bottom (B) surface [%/s],
- MWRT, MWRB – maximum wetted radius for top (T) and bottom (B) surface [mm],
- TSS, BSS – spreading speed on top (T) and bottom (B) surface [mm/s],
- R – accumulative one-way transport index [-],
- OMMC – Overall Moisture Management Capacity [-].

The device is controlled by PC and the MMT290 SOFTWARE. Measurement is performed for samples cut into 80 mm x 80 mm squares. For each fabric 5 repetitions of measurement are performed. The knitted fabrics were measured in the relaxed and stretched state. In order to stretch the samples by a certain size the MMT Stretch Fabric Fixture device [3] was applied. The round sample of 140 mm diameter is placed on the table of the device, stretched to the percentage required and next locked in the fabric clamp (Fig. 1a). The excess fabric beyond the clamp circumference is trimmed. The sample prepared in such a way (Fig. 1b) is placed in the M290 MMT test area.

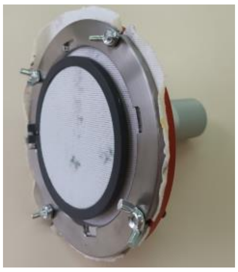
a)  b) 

Figure 1. Preparation of the stretched sample by means of the MMT Stretch Fabric Fixture device.

The multi-factor analysis of variance (AVOVA) available in the STATISTICA software was applied to analyse statistically the results.

RESULTS AND DISCUSSION

The results of liquid moisture transport measurement of the relaxed fabrics are presented in the Tables 2 and 3. On the basis of the results it was stated that the fabrics differ between each other in the range of all determined parameters characterising the liquid moisture transport in the fabrics. In order to summarize an assessment of the knitted fabrics from the point of view of their ability to ensure the physiological comfort two last parameters are the most important and useful: R – accumulative one-way transport index and OMMC – Overall Moisture Management Capacity. A fabric with good accumulative one-way transport from the inner fabric side to the outer side (high value of the parameter R) offers good sweat management to the wearer. It is due to the fact that with high accumulative one-way transport index the fabric keeps the skin of the wearer dry due to the transporting the perspiration towards the outer side of the fabric which is away from the skin. Positive and high values of the R parameter show that liquid sweat can be transferred from the skin to the outer surface easily and quickly [5]. The value of OMMC is calculated using formula presented in AATCC Test Method 195-2011 [4]. Generally, the OMMC is based on absorption rate for bottom surface, spreading speed for bottom surface and one-way transport capability. The value of the OMMC parameter can be in the range from 0 to 1. The highest value of the OMMC parameter the best moisture transport capacity.

Table 2. Results from the MMT M290 device for the relaxed knitted fabrics.

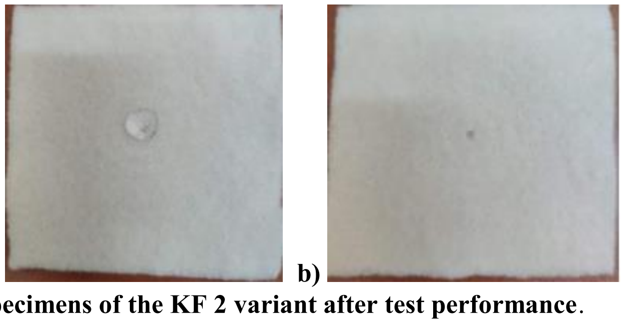
SYMBOL	WTT	WTB	TAR	BAR	MWRT	MWRB
	s	s	%/s	%/s	mm	mm
KF1	3.28	5.99	66.67	58.11	27.00	21.00
KF2	53.73	53.15	231.35	23.26	3.00	3.00
KF3	7.39	7.51	73.43	75.51	18.00	16.00

Table 3. Results from the MMT M290 device for the relaxed knitted fabrics. Continuation.

SYMBOL	TSS	BSS	R	OMMC
	mm/s	mm/s	-	-
KF1	0.43	2.49	-219.95	0.26
KF2	0.40	0.36	-105.93	0.25
KF3	0.45	2.25	-199.42	0.29

It can be stated that the investigated fabrics are not good from the point of view of liquid moisture transport from the top side to the bottom side. The R values are negative for all fabrics. The values of the OMMC parameter confirmed this assessment. In the case of the investigated fabrics the values of the OMMC parameter are lower than 0.3. It means that the liquid moisture management capacity of the fabrics can be assessed as poor [2].The results are surprising, however they are in agreement with the results obtained by Öner et al. [6]. They received high negative R values for the single jersey and rib cotton fabrics.

It should be mentioned here that the result for the fabric KF2 are diversified significantly. For three specimens the values of R parameter were negative and the values of the OMMC were 0, whereas for 2 specimens the results were quite opposite: the R values 837 and 673, the OMMS values appropriately 0.64 and 0.60. It means that in the case of two last specimens an assessment according to the OMMC values should be: very good. Observation made directly after test showed that in three specimens the drops of testing solution remained on the top surface of the fabric (Fig. 2a). The liquid did not go through the fabric during the test. It was for the specimens for which the OMMC value was 0. For two other specimens the small wet trace was observed on the surface after test performance (Fig. 2b). It means that the testing solution was transferred very quickly from the inner (top) surface to the outer (bottom) surface. The diversification of the results was probably caused by the place of dosage of the synthetic sweat on the specimen area. The KF2 fabric is a lop plush. Maybe the phenomenon of liquid moisture transfer depends on the place of the testing solution dosage: on the loop or between the loops. This phenomenon needs further investigations.



a) b)

Figure 2. Pictures of the specimens of the KF 2 variant after test performance.

The results for the stretched fabrics are presented in Tables 4 and 5. In this part of the research only two fabric variants have been the objects of the investigations: KF1 and KF3. The KF2 fabric was too thick to lock it in the clamp of the MMT Stretch Fabric Fixture device.

Table 4. Results from the MMT M290 device for the stretched knitted fabrics.

SYMBOL	WTT	WTB	TAR	BAR	MWRT	MWRB
	s	s	%/s	%/s	mm	mm
KF1	3.8748	5.747	57.5851	61.789	30	25
KF3	16.249	6.2528	46.0551	64.1734	15	13

Table 5. Results from the MMT M290 device for the stretched knitted fabrics. Continuation.

SYMBOL	TSS	BSS	R	OMMC
	mm/s	mm/s	-	-
KF1	5.5909	3.5641	-12.857	0.3987
KF3	0.932	1.1421	335.2804	0.546

The results confirmed that after stretching the liquid moisture transport in the knitted fabrics is different and more effective than the liquid moisture transport in the fabric in relaxed (no stretched) state. In the case of the KF1 fabric the value of the R parameter is still negative, but negative value is significantly lower than that for the relaxed fabric. According to the OMMC value the KF1 fabric can be assessed as good from the point of view of the liquid moisture transport capacity. In the case of the KF3 fabric the value of the R parameter is positive and high. According to the Grading Table presented in the MMT manual [2] the KF3 fabric was evaluated as very good from the point of view of the one-way liquid transport. The OMMC value also is high, acc. to grading principles it corresponds to a good rating [2].

Statistical analysis have been performed for the results for the KF1 and KF3 fabric variants before and after stretching. Statistical analysis be means the multi-factor ANOVA confirmed that both independent factors: fabric variant and state of the sample (relaxed or stretched) significantly influence the liquid moisture transport at the level of significance 0.05.

CONCLUSION

Performed investigations confirmed that the structure of the kitted fabrics significantly influence the phenomenon of liquid moisture transport in the investigated knitted fabrics. Investigated fabrics in the relaxed state do not show good properties of liquid moisture transport. Stretching the fabrics significantly improves the moisture management properties of knitted fabrics. It is very important observation because the knitted fabrics are usually stretchable and in majority of cases (sportswear for fitness, running etc.) the clothing made of knitted fabrics are worn in the stretched form.

ACKNOWLEDGMENT

The authors would like to express appreciation for the support of the sponsors [National Science Centre, Poland, Project No. 2016/23/B/ST8/02041].

REFERENCES

[1] Matusiak M., *Moisture Management Properties of Seersucker Woven Fabrics of Different Structure*, Fibres & Textiles in Eastern Europe 2019, vol. 27, no 3(135), pp. 43–50.
[2] M 290 MMT Moisture Management Tester. Instruction manual (2017) Rev. 1.2 SDL Atlas Ltd.
[3] MMT Stretch Fabric Fixture (2020), Instruction Manual. SDL Atlas Ltd Ver.1.0.
[4] AASTCC Test Method 195-2011. Liquid Moisture Management Properties of Textile Fabrics.

[5] Mangat M.M., Hussain T. Bajzik V., *Impact of Different Weft Materials and Washing Treatments on Moisture Management Characteristics of Denim*, Journal of Engineered Fibers and Fabrics 2012, vol. 7, no 1, pp. 38–49.
[6] Öner E., Atasağun H.G., Okur A., Beden A.R. Durur, G., *Evaluation of moisture management properties on knitted fabrics*, Journal of The Textile Institute 2019, vol. 104, no 7, pp. 699–707.