TEXTILE DUST GENERATION FROM COTTON AND COTTON/POLYESTER BLEND FABRICS

Rajna MALINAR & Sandra FLINČEC GRGAC

Abstract: *Textiles generate large amount of particles, which are possible sources of infections. To explore different factors for dust generation, standard cotton and cotton/polyester blend fabrics were subjected to multiple washing and drying procedures, as base study for future research in reducing particle release in atmosphere. Samples were tested after 1, 5 and 10 washing and drying cycles. The results have shown considerable increase of dust generation within multiple washing and drying cycles. Cotton fabric had significantly higher dust output than cotton/polyester blend fabric due to differences in fibre surface morphology and sequentially higher friction between cotton fibres.*
Keywords: *cotton fabric; cotton/polyester; particle generation; textile dust; textile care.*

1. Introduction

As airborne diseases continuously generate problems of lesser and larger extent, effort can be made to diminish them from textile industry point of view. In large part, pathogens are transmitted through dust – airborne dust, which can be inhaled, or deposited dust, which can serve as feeding ground for bacteria and fungi [1–6]. Textile dust, which is most commonly organic in structure and also abundant in air, is therefore a source of transmission that can be reduced.

As previous studies have shown, textile dust generation increases with multiple washing procedures [7]. For larger scale investigation on possibilities for reduced textile dust generation, a baseline study with standard materials and standard washing procedure was needed. As most common materials, cotton and cotton/polyester blend fabrics were chosen. Since textile dust generation can be connected with mechanical damages, tensile properties were monitored as well.

2. Material and Methods

For this research fabric by WFK was used; standard cotton (100%) and cotton/polyester blend (65%/35%).

Samples were washed in accordance with ISO 6330:2012 [8] in washing machine Wascator FOM71 CLS (Electrolux). Program 6N with washing temperature of 60°C and Reference detergent with phosphates and without optical brighteners were used. Washing procedure was performed 10 times and samples were separated after first, fifth and tenth washing cycle. Between every washing cycle, all of the samples were dried on a roller (Elektronska industrija, type E/750).

Tensile strength and elongation were determined for said samples on MesdanLab Strength Tester in accordance with BS EN ISO 13934-1 [9], applying sample length 100 mm, clamp speed 100 mm/min, pretension 2 N.

Particle generation was measured on laser particle counter LasAir III (Particle Measuring Systems) connected to particle generator inside laminar air-flow cabinet (Fig.1). Sample was mounted on particle generator and exposed to controlled flexing. Number of released particles during testing is measured in following size categories: 0,3 μm for particle sizes 0,3-0,5 μm; 0,5 μm for particle sizes 0,5-1 μm; 1 μm for particle sizes 1-5 μm; 5 μm for particle sizes 5-10 μm; 10 μm for particle sizes 10-25 μm; 25 μm for particle sizes larger than 25 μm. Sample size was 5. This method was adopted from EN ISO 9073-10 [10], with adjustment of testing time to 30 min.

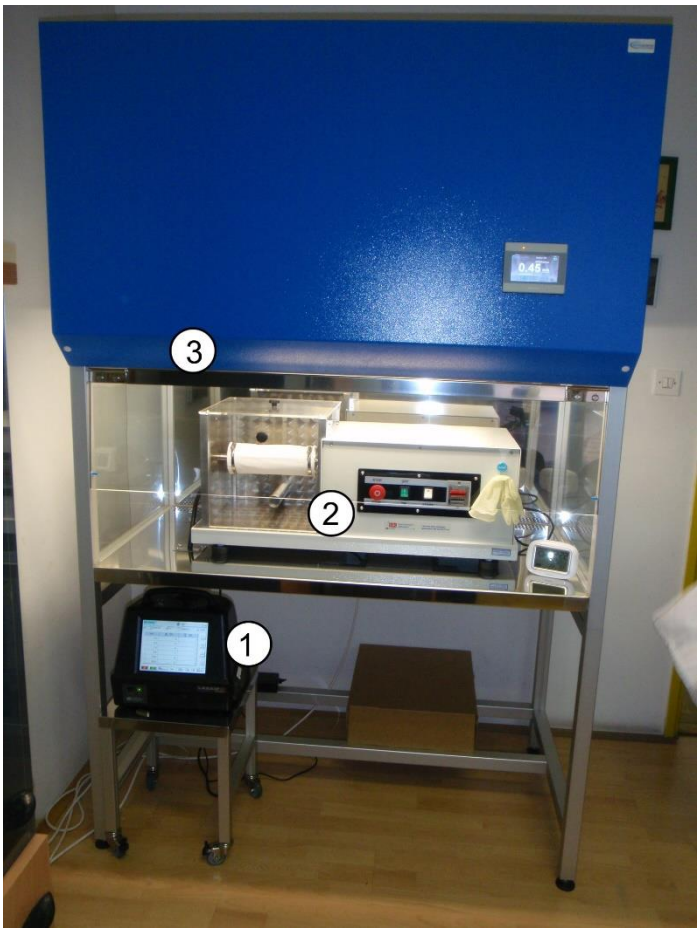


Figure 1: Particle counter (1) connected with a hose to particle generation unit (2) inside laminar air-flow cabinet (3)

3. Results and Discussion

Tensile properties of samples are presented in Table 1. Cotton fabric samples show a little less strength than blend fabric, as can be expected due to higher strength properties of polyester fibres. After 5 washing cycles, breaking force decreases due to mechanical damages. The increase after 10 washing cycles is caused by shrinking of fabric.

Table 1: Breaking force and elongation

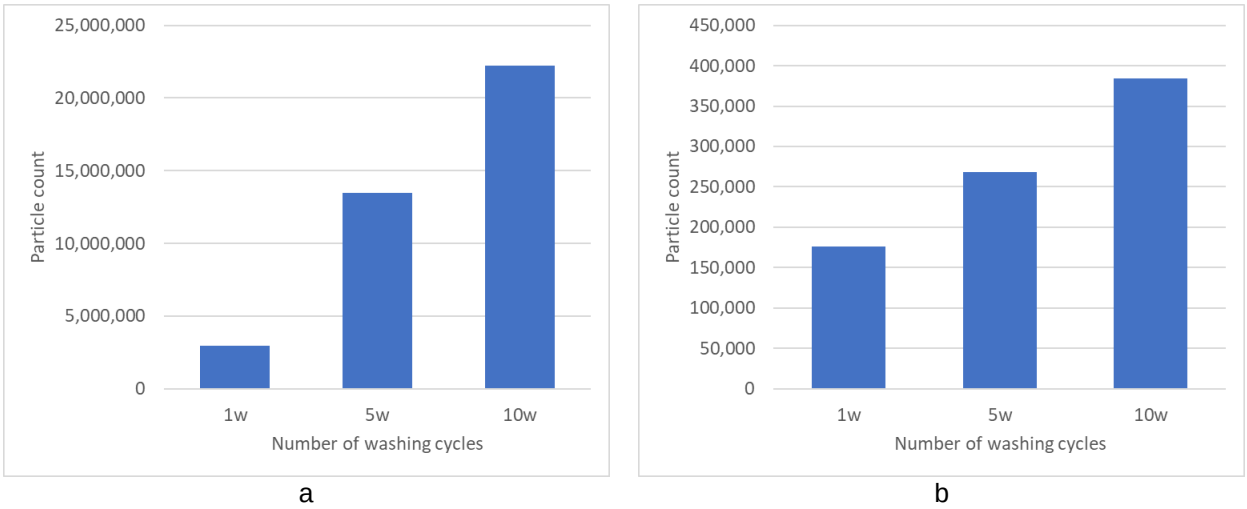
Material	No. of washing cycles	Warp		Weft	
		Average of breaking force [N]	Average of elongation [%]	Average of breaking force [N]	Average of elongation [%]
Cotton	1	864.0	14.70	967.3	27.10
	5	797.5	16.80	782.3	25.60
	10	850.3	17.70	943.3	28.40
Cotton/ polyester	1	1225.7	17.40	1052.7	28.30
	5	1176.0	15.90	1040.7	30.00
	10	1186.5	16.65	1059.5	29.85

Particle count for all samples is shown in Table 2. Differences between cotton and cotton/polyester blend fabric are evident. In average, cotton fabric has produced 30 times more particles than cotton/polyester blend. This is noticeable across all particle sizes, with emphasis on particles smaller than 5 μm. Possible reason for better performance of cotton/polyester blend is less friction between fibres due to the smooth surface of the polyester fibres. Also, since cellulosic fibre is prone to repeated swelling in multiple washing cycles, its surface is likely to deteriorate more quickly than polyester.

Table 2: Sum of generated particles in 30 min by sizes

Material	No. of washing cycles	Average of 0,3 μm	Average of 0,5 μm	Average of 1 μm	Average of 5 μm	Average of 10 μm	Average of 25 μm
Cotton	1	310989.3	249744.5	173854.0	6864.5	1272.5	273.3
	5	1301249.2	931068.2	451463.8	13547.8	2451.0	272.6
	10	2140082.4	1541475.6	731622.2	22691.4	4149.4	387.0
Cotton/ polyester	1	17938.6	10743.6	5988.4	406.4	149.6	45.2
	5	31421.4	15471.8	6198.8	414.8	161.2	59.0
	10	45274.0	21650.4	9321.4	430.0	143.4	52.0

Multiple washing cycles have increased particle release from both samples. On Figure 2 is shown almost linear increase of dust generation by washing, with cotton sample showing higher leap between 1 and 10 cycles. This deterioration of material can be caused by mechanical and chemical influence during washing and drying cycles. Since tensile properties have not been reduced by much, it should also be noted that part of dust that is released from fabric could be from deposited particles, which are originally not from fabric itself. It is possible that detergent is not completely rinsed from fabric during washing process and, when dried, peels off during testing. The same is possible for mineral content from water used in washing. More washing cycles in future research could add insight into increased particle release as well as determine maximum of particle count/number of washing cycles ratio.



a b

Figure 2: Sum of particles of all sizes for a) cotton samples and b) cotton/polyester samples

As washing procedure influences fabric, so is possible that part of textile dust is retained in water. This aspect of textile particle generation was not subject of current research. Even though environment and consequences for textile particles released in washing procedure are different from textile dust in atmosphere, two problems are connected and similar results can be derived, both for material and multiple washing cycles [11, 12].

4. Conclusion

The study aimed to obtain data on textile dust generation from standard cotton and cotton/polyester blend fabric. Cotton/polyester samples have shown much better results for all particle sizes measured. Particle generation was measured after 1, 5 and 10 washing cycles for both sets of samples and rise in dust release has been noted with increase of washing cycles. Testing after more washing cycles is recommended. For purposes of future investigation, this data will provide baseline for comparison with fabrics with antimicrobial finishes and reduced particle release.

Acknowledgments

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References

[1] Sehulster, L. M.: Healthcare laundry and textiles in the united states: Review and commentary on contemporary infection prevention issues, *Infection Control and Hospital Epidemiology*, **36** (2015) 9, pp. 1073–1088, ISSN 0899823X
[2] Fijan, S. & Turk, S. Š.: Hospital textiles, are they a possible vehicle for healthcare-associated infections?, *International Journal of Environmental Research and Public Health*, **9** (2012) 9, pp. 3330–3343, ISSN 1660-4601
[3] Shiomori, T. *et al*.: Evaluation of bedmaking-related airborne and surface methicillin-resistant Staphylococcus aureus contamination, *Journal of Hospital Infection*, **50** (2002) 1, pp. 30–35, ISSN: 0195-6701
[4] Neely, A. N. & Maley, M. P.: Survival of enterococci and staphylococci on hospital fabrics and plastic, *Journal of Clinical Microbiology*, **38** (2000) 2, pp. 724–726, ISSN 1098660X, 00951137.
[5] Neely, A. N. & Orloff, M. M.: Survival of some medically important fungi on hospital fabrics and plastics, *Journal of Clinical Microbiology*, **39** (2001) 9, pp. 3360–3361, ISSN 1098660X, 00951137
[6] Licina, D. & Nazaroff, W. W.: Clothing as a transport vector for airborne particles: Chamber study, *Indoor Air*, **28** (2018) 3, ISSN, 1600-0668
[7] Malinar, R.; Flinčec Grgac, S. & Katović, D.: Generiranje tekstilne prašine kod tekstilija za jednokratnu i višekratnu namjenu, *in 11th International Scientific Conference on Production Engineering Development and Modernization of Production*, Hodžić, A.; Omer, S. E.; Hodžić, D. (Ed.), pp. 495–498, ISSN: 2566-3275 Sarajevo, 10. 2017., University of Bihać, Technical faculty, Bihać, (2017)
[8] ISO 6330 Textiles - Domestic washing and drying procedures for textile testing, 2012.
[9] BS EN ISO 13934-1 Textiles — Tensile properties of fabrics. Part 1: Determination of maximum force and elongation at maximum force using the strip method, 1999.
[10] ISO 9073-10 Textiles - Test methods for nonwovens - Part 10: Lint and other particles generation in the dry state, 2003.
[11] Cesa, F. S. *et al.*: Laundering and textile parameters influence fibers release in household washings, *Environmental Pollution*, **257** (2020), ISSN: 0269-7491
[12] Sillanpää, M. & Sainio, P.: Release of polyester and cotton fibers from textiles in machine washings, *Environmental Science and Pollution Research*, **24** (2017) 23, pp. 19313–19321, ISSN 1614-7499, Print ISSN 0944-1344

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