A novel method to measure the quick-dryability of textile fabrics

Mohammad Mahbubul Hassan*, Samuel J Leighs

Food & bio-based Products Group, AgResearch Limited, Cnr Springs Road & Gerald Street, Lincoln 7608, Canterbury, New Zealand.

Abstract

Quick-dryability is an important attribute for fabrics used in sports apparel. There is no specific standard test method available to measure the actual quick-dryability of a fabric. Some of the test methods cited in the literature use a method where a droplet of water is placed on a fabric sample and the time taken for the water to evaporate is measured. These methods are not practical as the quick dryability depends solely on the wicking property of that fabric. For example, a hydrophilic polyester fabric, when fully soaked with water, may bind more water molecules compared to the untreated polyester fabric (hydrophobic) resulting in an increase in drying time. Using current test methods, it may show better quick-dryability compared to the untreated polyester fabric, although it may actually take longer to dry than the untreated polyester. In the work presented here, we developed a new test method based on the rate of evaporation of water from a fully soaked fabric sample at body temperature (37°C) and at 50% relative humidity. In this method, a certain size of fabric sample is placed in a water solution containing 0.25 g/l wetting agent and then the sample is hydro-extracted at 2000 rpm for 2 minutes. The quick dryability measurement was repeated ten times and the standard deviation of the quick-drying results were within an acceptable range. We measured the quick dryability of several cotton, wool and nylon fabrics using this new method. Because of high moisture regain, wool fabrics usually dry quite slowly. However, it was found that some of the commercially available so-called quick-drying polyester fabrics performed quite badly compared to wool fabric.

Keywords: quick-drying, test method, textile fabrics

1. Introduction

Drying involves the removal of relatively small amounts of water remain in the fabric after squeezing or hydro-extraction. The amount of water remains in a fabric depends of the thickness of the fabric and also the chemical interaction between the water molecules and the surface of that fabric. If the fabric is hydrophilic, then during wetting of the fabric it will absorb more water and also will retain more water during hydro-extraction than a hydrophobic fabric. In the process of drying, heat is necessary to evaporate water or moisture from the fiber in a fabric and a flow of air is needed to carry away the evaporated water/moisture. There are two basic mechanisms involved in the drying process of textiles; the migration of moisture from the interior of an individual fiber in the fiber assembly in a fabric to the outer surface of the fiber and the evaporation of the moisture from the surface to the surrounding environment. The rate of drying is determined by the moisture content of the particular fiber, the drying temperature, the relative humidity and the velocity of the air in contact with the fiber.

Fourt *et al.* found that if various types of fabrics contain the same quantity of water, all fabrics dry at the same rate if the drying conditions are same [1]. However, they found that the times of drying depends upon the amount of water originally held in the fabric and depending on that factor some fabric dry faster than the others. Some natural fabrics such as jute and wool have high moisture contents and therefore during washing they absorb a large quantity of water. On the other hand, some hydrophobic synthetic fibers made from polyester and polypropylene fibers absorb very little water and therefore dry quite quickly.

Wet cloth is felt uncomfortable next to our body skin and therefore it is necessary to dry the cloth we are wearing. Comfort is one of the decision making factors that affect the buying behavior of consumers. Clothing is known as the second skin and therefore the clothing intended for next-to-skin applications shouldn’t feel wet. If the cloth worn becomes wet, it will need to dry very quickly otherwise it would be uncomfortable as nobody likes to wear wet cloths. The next to skin apparels need to be highly breathable. Sports apparel having quick drying properties is becoming increasingly popular. Synthetic fibers (mainly polyester) are the dominant fibers used in this kind of apparel as they dry rapidly as well as manages quick moisture transfer. The moisture content of polyester is only 0.4% whereas the moisture content of wool is 15 to 25% depending on the relative humidity.

Traditionally household clothing are dried outside of house in air under sun with the drying rate is enhanced by the velocity of the air flow along with the intensity of heat of the sun, i.e. drying very much depends on the weather conditions. Because of lack of space and enough sunshine, in some countries in the urban areas, cloths are usually machine dried at home or at a commercial laundry by using electric driers. If the fabric has poor dryability, it will take longer time than usual to dry in the drying machine, which will eventually increase the energy demand and carbon footprint. According to the Textile Rental Service Association (TRSA) of America, a laundry uses 1.80 kWh/kg of garments with 65% of this attributable to drying [1-2]. If the energy consumed in drying could be reduced by 10% at a laundry facility this would result in total energy reduction of 1309,651 kWh and savings of A$57,257 annually (assuming a facility handling 11.35 million kilograms/year at 1.76 kWh/kilogram and the energy price is A$0.04/kWh). A load of wet laundry weighing 130 kg contains approximately 65 kg (50%) of water, which must be evaporated before the laundry is considered "dry" and can be moved to other processing steps such as ironing or folding [2]. Thus the reduction of water absorption of textiles can significantly shorten their drying time and the energy demand.

A range of so-called quick-drying fabrics are commercially available but there is no guarantee that these fabrics after washing will dry faster than other normal fabrics. Several test methods are available to measure the quick-dryability of fabrics but all of them are based on the wicking properties of fabric and not represent the actual quick-dryability. Some of the fabrics may show high quick-dryability measured by those methods but actually can take longer time to dry if the fabric is fully soaked in water.

2. Methods

2.1 Materials

Fabric made with various types of fibers and blends and also various constructions were procured from various sources. Sandozin MRN, a non-ionic wetting agent, was purchased from Clariant Chemicals Limited (Switzerland). The specifications of the fabrics examined are shown in Table 1.

2.2 Assessment of Quick-dryability and moisture regain

The assessment of quick-dryability was carried out at 37±1 °C and 50±2% relative humidity in a Contherm Humidity Cabinet. A battery-powered, four digit micro balance was placed inside the cabinet. Five fabric samples of 10 cm × 10 cm were cut from each type of fabric. The samples were conditioned at 37±1 °C and 50±2 relative humidity for 24 hours and their dry weight was measured (W_f). Each sample was then placed into a 200 ml solution of distilled water containing 5 drops of Sandozin MRN (wetting agent) for five minutes. The sample was then removed, immediately weighed, and placed into a 50 mL centrifuge tube. The tube had a metal sieve placed in the bottom to prevent the samples from contacting the hydro extracted excess liquid collected at the bottom. The centrifuge was set to 2000 rpm for 30 s. The sample was immediately transferred to the

Contherm Cabinet and the weight was recorded (W_i). The oven dry weight (W_f) was measured by drying the fabric at 105±2°C until constant weight was observed. The change of weight (W_o) of the samples was then recorded at 10 minute intervals, until the weight was equal to the dry weight of the fabric. The water remaining in the fabric sample (%) was calculated according the following equation:

$$Water\ remaining\ in\ the\ fabric\ (WR\%) = \frac{W_0 - W_f}{W_i - W_f} \times 100 \qquad [1]$$

For each fabric type, five measurements were conducted and the average is reported here. The moisture regains of the control and the various treated wool fabrics were assessed according to the ISO Test Method 6741-1987 at 20±2°C and 65±2% relative humidity. A nylon taffeta fabric was used to assess the reliability and robustness of this developed test method.

3. Results

3.1 Reliability of the quick-drying method

To check the reliability of the developed quick-drying test method, five samples were cut from a 2/2 twill wool fabric and their quick-dryability was measured. We also carried out statistical analysis, e.g. we measured standard deviation (SD) and coefficient of variation (CV) of the results obtained for five samples. The results are shown in Table 1, which indicate that the test method is quite reliable as the SD and CV of results of five samples is quite negligible as the highest CV was only 3.3%. It indicates that the developed test method is quite robust and produced reproducible results.

3.2 Effect of fiber types on the quick-dryability

The quick dryability of fabrics made with various types of fibers is shown in Fig 1.

3.3 Effect of fabric weight on the quick-dryability

4. Conclusions

4. References

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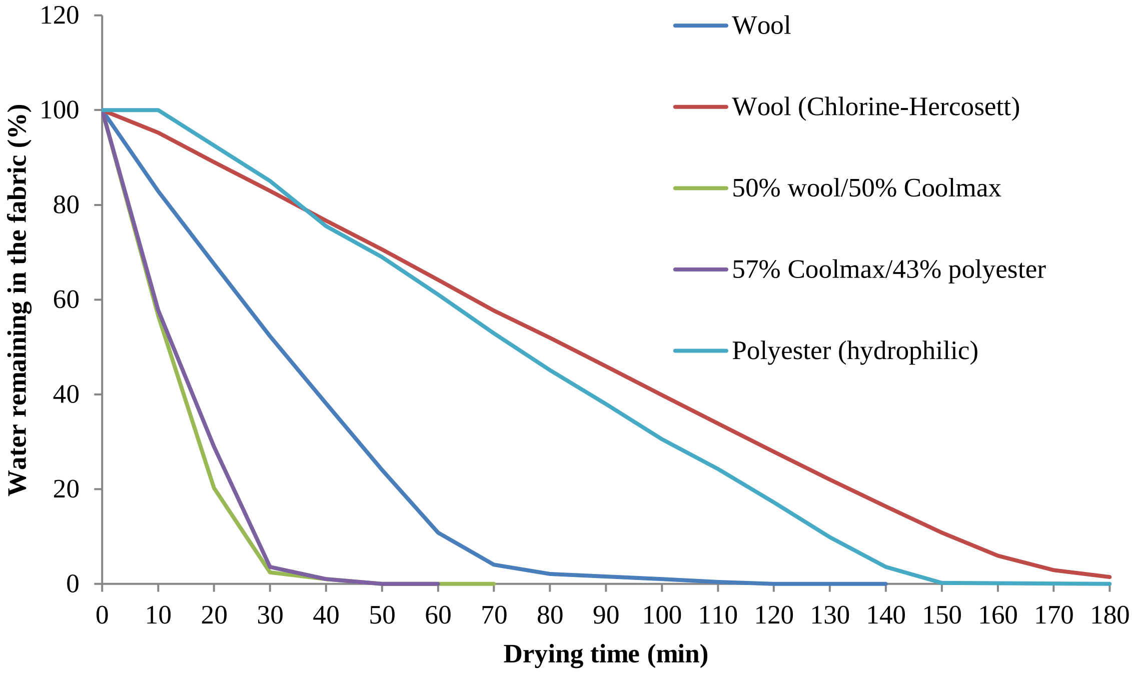

Fig. 1. Quick-drybaility of fabrics made with various types of fibers.

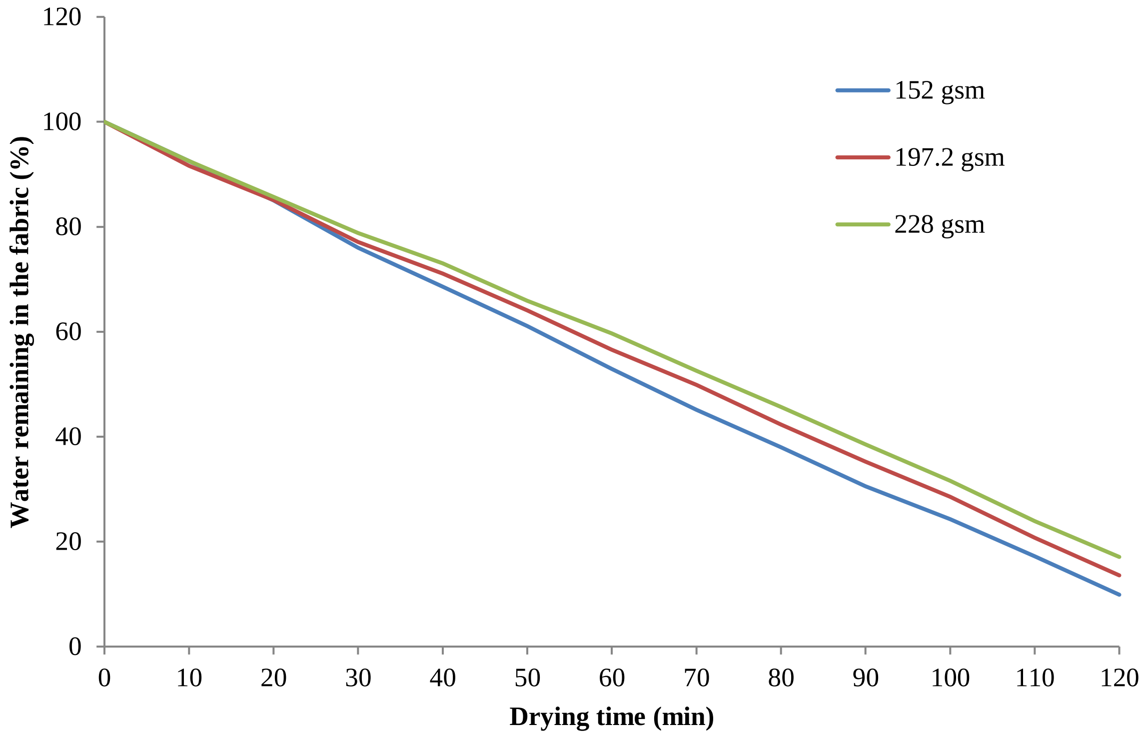

Fig. 2. Effect of fabric weight on the quick-dryability on its quick-dryability.

Table 1. Specifications of fabrics used.

Fibre type	Structure	Ends/cm or course/cm	Picks/cm or wale/cm	Weight/m^2 (g)
100% Wool	2/2 twill	28	26	190.0
50% Wool/50% Coolmax	Plain	24	21	155.7
50% Wool/50% Coolmax	Plain	24	20	152.7
53% Coolmax with Lycra/47% Polyester	2/2 twill	69	33	158.0
57% Coolmax with Lycra /43% Polyester	2/2 twill	81	34	170.0
53% Coolmax with Lycra/47% Polyester	Plain weave	68	50	142.0
100% Supertex	Double jersey	20	18	151.9
100% Supertex	Double jersey	12	12	197.2
100% Supertex	Double Jersey	16	15	228.0

Table 2. Standard deviation of coefficient of variation (%) quick-dryability of wool fabric

	Sam1	Sam2	Sam3	Sam4	Sam5	Mean	SD	CV(%)
0	100	100	100	100	100	100	0	0
10	82.89	81.97	82.63	83.31	83.45	82.85	0.590762	0.71305
20	67.79	67.31	66.9	68.24	67.46	67.54	0.505322	0.748181
30	52.47	51.54	51.87	53.11	52.36	52.27	0.601373	1.150514
40	37.78	37.88	38.55	37.95	38.34	38.1	0.329166	0.863952
50	23.9	23.35	24.6	24.3	24.1	24.05	0.469042	1.950277
60	10.89	10.6	10.15	11.12	11.34	10.82	0.464381	4.291879
70	4.09	4.2	3.93	3.88	4.05	4.03	0.127867	3.172881
80	2.12	2.25	1.98	2.05	2.1	2.1	0.09975	4.749985
90	1.62	1.49	1.5	1.55	1.44	1.52	0.068191	4.486244
100	0.97	1.04	1.1	0.99	0.9	1	0.075166	7.516648
110	0.42	0.4	0.42	0.38	0.4	0.4	0.016733	4.1833