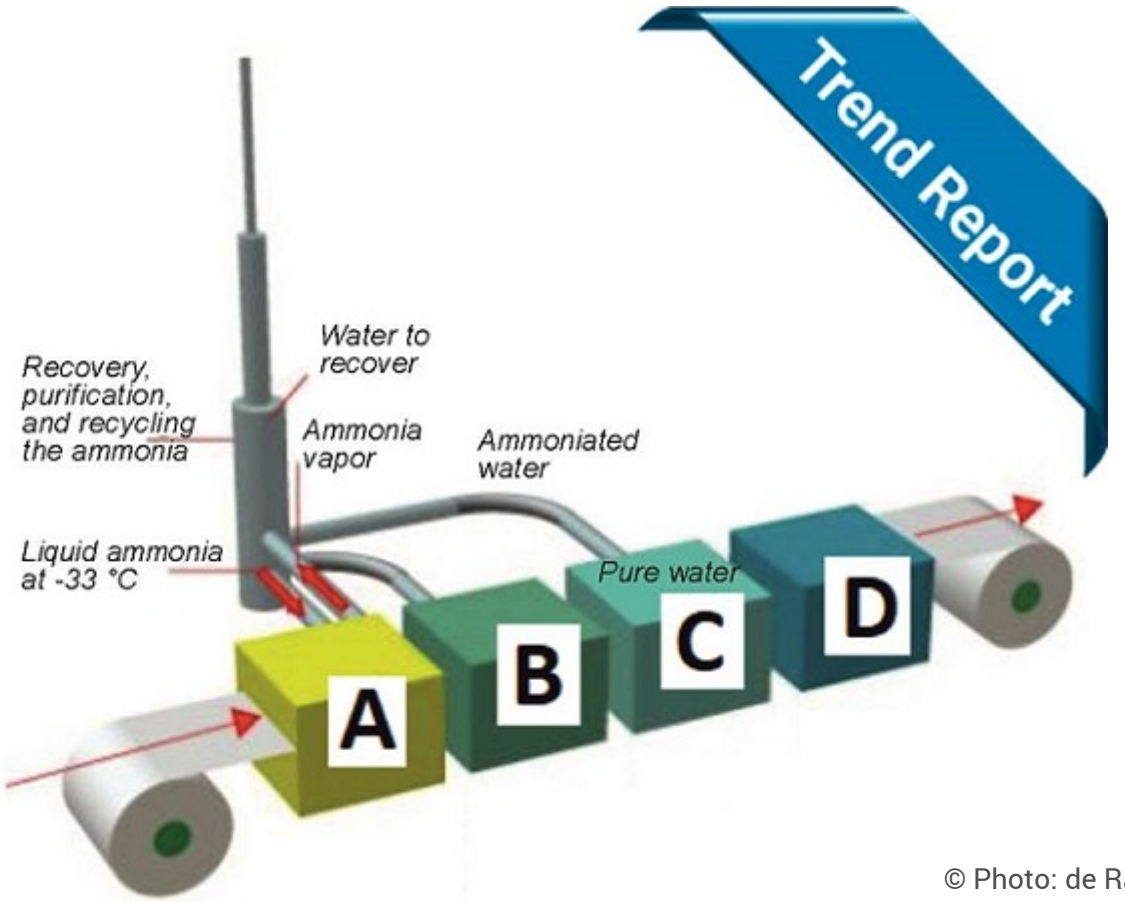
techtex TRENDS

Home › News › Fibers / Yarns › Durable, bio-based fibers: Revealing the potential of hemp-based textile materials

Durable, bio-based fibers

Revealing the potential of hemp-based textile materials

06.12.2019 Hemp fibers are receiving increasing interest as potential durable alternative for the widespread usage of cotton and flax fibers.The appealing cultivation characteristics of the hemp plant (Cannabis sativa) are various: substantial lower water consumption level during growth in comparison with cotton, limited/no need for pesticides, high fiber yield rates (short vs. long fibers), purification of (contaminated) soil, local fiber cultivation, etc. Different parts of hemp plants are multivariable applicable: hemp shives in shed beddings and panels, medicinal (THC/CBD), hemp seeds, hemp oil, textile fiber source etc. Hemp4All, a 2-year TETRA project at FTI Lab (2018-2019; financially supported by VLAIO), aims to explore the potential of hemp textile materials. This publication focuses on: the validation of hemp materials as a valuable option for the creation of casual and workwear; a screening of essential comfort parameters of hemp textiles; and the impact of liquid ammonia treatment onto hemp fabrics.



© Photo: de Raeve

Fig. 1 Beau-Fixe process (Veramtex)

Alexandra De Raeve, Tom Van Hove
University College Ghent, Ghent/Belgium

Physical properties of hemp tissues – a comparison with cotton

The tested fabrics are:

- Hemp tissue: bleached; undyed; plain weave; 207 g/m2 (Libeco Lagae, Meulebeke/Belgium)
- Hemp tissue: dyed (green); plain weave; 147 g/m2 (Ecological Textiles, Roermond/Netherlands)
- Hemp/organic cotton tissue 55/45: dyed (blue); twill; 324 g/m2 (Ecological Textiles)
- Hemp/polyester tissue 55/45: bleached; undyed; twill; 278 g/m2 (Ecological Textiles)
- Cotton tissue: bleached; undyed; Panama bond; 250 g/m2 (Concordia Textiles NV, Waregem/Belgium)

Determination of the essential, physical characteristics of the mentioned tissue types is done based on the test matrix presented in Table 1.

The main observations (Table 2) are:

- Hemp tissues can offer essential, mechanical properties within market-proof margins for casual and workwear.
- The tested 100 % hemp tissues show limitations with regard to abrasion resistance, pilling tendency and susceptibility to crease formation.
- The drawbacks of pure hemp can be (partially) overcome by means of application of intimate yarn mixtures e.g. hemp/organic cotton or hemp/recycled polyester.
- Only in the case of the low weight, green hemp tissue has an acceptable seam slippage limit value of 3 mm (cf. jeans) been exceeded.
- Concerning dimensional stability during industrial washing at 60 °C, hold maximal deformation limits are normally within ± 2 %. None of the tested substrates reach this level in both directions (warp, weft).

Impact of liquid ammonia treatment on cellulosics

Liquid ammonia treatment can be done under subcontracting at Veramtex S.A., Brussels/Belgium (B – Beau-Fixe process). The treatment scheme is presented in Fig. 1. Step A stands for the substrate dipping into liquid ammonia (-33 °C) at atmospheric pressure during less than 10 seconds. Steps B and C intend the complete ammonia removal afterwards over heat treatment (120 °C) respectively rinsing in water (80 °C). The last step (D) is formed by substrate drying on a stenter system. More than 99 % of the applied ammonia is finally recovered by means of adequate distillation. The Beau-Fixe treatment is Standard 100 and STeP by Oeko-Tex certified.

The impact of ammonia treatment onto cellulosic fibers (CO, CV, L) is highly comparable with mercerization. The individual cotton fibers lose their typical torsions (up to 60 torsions/cm) while heavily swelling. Crystalline and semi-crystalline zones become permanently modified by this. A stabilized material is finally formed. A distinctive example is given in Fig. 2.

Fig. 2 Positive impact of Beau-Fixe treatment onto shape retention during washing

This study aims to give a practical insight in the transferability of the Beau-Fixe treatment from cellulosic materials like cotton and flax to hemp. The earlier mentioned physical test protocol (Table 1) has been worked out on the bleached cotton and hemp tissue selection. Results are summarized in Table 3.

Table 1
Physical test protocol

Physical parameter	Norm
Tensile strength/strain	Strip method cf. ISO 13934-1
Tear strength	Elmendorf cf. ISO 13937-1
Abrasion resistance	Martindale cf. ISO 12947
Pilling (tissue – tissue)	Modified Martindale method cf. ISO 12945-2
Crease susceptibility	a) Wrinkle recovery test cf. AATCC Test method 128
	b) Smoothness after industrial (cf. ISO 15797 – 60 °C) washing cf. ISO 7768
	c) Decreasing angle (dry) cf. ISO 2313-1
Dimensional stability after industrial washing (cf. ISO 15797 – 60 °C)	Preparation cf. ISO 3759; shrinkage determination cf. ISO 5077
Seam slippage	ISO 13936-2 (fixed load method: 60 N / 120 N)
Tactility – hand – touch	Fabric Touch tester (FTT @SDL Atlas) – no existing norm
Moisture management	Moisture Management Tester (MMT @SDL Atlas) cfr. AATCC; Test method 195

In case of the bleached cotton tissue a significant upgrade of physical properties is attained after ammonia finishing: a) tensile strength in warp direction: +13.8 %; b) abrasion resistance: 15,000 turns 35,000 turns; c) less crease susceptibility; d) deformation after industrial washing ≤ 2 %. Seam slippage values heighten (read: lower yarn slip resistance compared to rounder fiber cross-section), but are still below 3 mm (see ECLA guidelines). FTT analysis reveals a completely similar haptic aspect before and after ammonia processing of the bleached cotton tissue.

The effect of liquid ammonia finishing on the dyeability behavior is evaluated. All performed dyeing processes obtain a higher dyeing yield under the condition of NH3 pretreatment: rising color depths are indicated by higher K/S and lower L values. Each time a visible color difference for the human eye (i.e. delta E > 1) is observed. Rubbing (dry/wet bleeding) and washing (bleeding vs. degradation) fastness levels are determined over normalized tests: ISO 105-X12 respectively ISO 105-C06: C1M (60 °C). Out of this it can be concluded that ammonia pretreatment does not influence the fastness properties of the dyed materials.

The basic hydrophilic character of bleached and/or dyed cotton and hemp tissue types is determined by means of a Moisture Management Testing system. The evaluated hemp tissues in pure and mixed form show a similar and good interaction with water (minimal degree of 3.05), comparable to that of equivalent, cotton tissues.

Table 2
Physical properties of hemp and cotton tissues – test values

	Hemp tissue – bleached	Hemp tissue – dyed (green)	Hemp/organic cotton tissue 55/45	Hemp/polyester tissue 55/45	Cotton tissue – bleached
Weight [g/m²]	207	147	324	278	250
Tensile strength [N] /strain – warp [%]	659.05/11.54	371.17/12.77	1136.25/28.18	1620.02/16.64	840.61/10.01
Tensile strength / strain – weft	648.31/8.96	284.32/11.32	626.21/10.60	665.72/12.96	825.62/10.08
Tear strength – warp [N]	47.01	34.52	71.88	43.74	27.62
Tear strength – weft [N]	53.99	34.38	83.82	64.16	29.07
Abrasion resistance [turns]	4,000	2,000	18,000	35,000	15,000
Average weight loss at break [%]	-9.22	-18.94	-7.69	-8.57	-9.22
Pilling – Martindale (2,000 tr)	1	2/3	3	3	4/5
Crease susceptibility:					
a) Wrinkle recovery test	1/2	1/2	3	2	1/2
b) Smoothness after: → 1 * industrial washing at 60 °C → 5 * industrial washing at 60 °C	 2/3 2	 4 4	 3/4 4	 3 2/3	 1 2/3
c) Decreasing angle – warp [°] Decreasing angle – weft [°]	64.25 65.25	65.75 68.50	73 68.75	61.75 87.50	59.75 67.50
Dimensional stability – warp → 1 * industrial washing at 60 °C [%] → 5 * industrial washing at 60 °C [%]	 -5.2 -5.8	 +0.5 -1.3	 -4.0 -3.0	 -6.3 -3.8	 -4 -5
Dimensional stability – weft → 1 * industrial washing at 60 °C [%] → 5 * industrial washing at 60 °C [%]	 -2.0 -3.3	 +2.1 +2.5	 -1.5 -3.0	 0.0 0.0	 -5 -5.8
Seam slippage – warp [mm]	1.7	3.6	1.7	1.1	1.3
Seam slippage – weft [mm]	1.8	3.7	1.3	1.1	1.3

Table 3
Impact of NH_3 treatment on physical properties of bleached cotton and hemp tissues

	Cotton tissue – bleached	Cotton tissue – bleached and NH_3 treated	Hemp tissue – bleached	Hemp tissue – bleached and NH_3 treated
Weight [g/m²]	250	270	207	227
Tensile strength [N] /strain-warp [%]	840.61 / 10.01	956.50 / 8.74	659.05 / 11.54	864.19N / 7.35
Tensile strength [N] /strain-weft [%]	825.62 / 10.08	820.41 / 19.13	648.31 / 8.96	582.62 / 21.19
Tear strength – warp [N]	27.62	35.03	47.01	50.77
Tear strength – weft [N]	29.07	32.49	53.99	45.29
Abrasion resistance [turns]	15,000	35,000	4,000	4,000r
Average weight loss [%]	-9.22	-5.63	-9.22	-10.06
Pilling – Martindale (2,000 turns)	4/5	4/5	1	1
Crease susceptibility:				
a) Wrinkle recovery test	1/2	3	1/2	2
b) Smoothness after industrial washing → 1 * washing at 60 °C → 5 * washing at 60 °C	 1 2/3	 2/3 3	 2/3 2	 2 2
c) Decreasing angle – warp [°] Decreasing angle – weft [°]	59.75 67.50	79.25 68.75	64.25 65.25	65.50 73
Dimensional stability – warp → 1 * washing at 60 °C [%] → 5 * washing at 60 °C [%]	 -4 -5	 0 -2	 -5.2 -5.8	 -4.1 -5
Dimensional stability – weft → 1 * washing at 60 °C [%] → 5 * washing at 60 °C [%]	 -5 -5.8	 0 -0.5	 -2 -3.3	 +2.6 +2.6
Seam slippage – warp [mm]	1.3	2.3	1.7	2.4
Seam slippage – weft [mm]	1.3	1.7	1.8	1.7

Beau Fixe, Oeko-Tex = registered trademarks

Top Companies