Linen: A Study on Comfort Performance

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November 2014
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STUDY OBJECTIVES

- Qualify and quantify the comfort performance of linen
- Compare the performance to that of standard textile fibres
- Raise the awareness of professionals and users on linen performance and on the added value it can bring to certain markets: ready-to-wear, sportswear, sports & leisure, bed linen, bath & spa, etc.
MATERIALS AND METHODS
5 ring spun yarns with equivalent yarn count:
* 100% linen, long fibre
* 100% cotton
* 50% linen 50% cotton
* 100% viscose
* 100% polyester
= 5 standard materials for knits

18-gauge knitting
Bleaching and drying
30% H2O2 at 92°C + additives

1/ PERMEABILITY TO AIR
NF EN ISO 9237 (1995)

2/ SKIN MODEL
NF EN 31092: 1994
/ ISO 11092: 1993
=> RET + RCT + IMT

3/ WATER BEHAVIOUR
NF G07 – 165 (1993)

4/ MMT
AATCC Test Method 195 – 2009
1 / DETERMINATION OF PERMEABILITY TO AIR – NF EN ISO 9237 (1995)

The device produces a constant airflow that travels vertically through the specimen.

The surface area tested is 20 cm².

The higher the value obtained, the more permeable to air is the specimen.

The permeability is expressed in mm/s.
The test conditions are close to those for the human body, with vapour production (perspiration) during moderate sport exercise in temperate environment:

- Atmospheric temperature: 20°C
- Relative humidity of the environment: 40%
- Stable temperature: no peak periods of sports activity

Device description:
Measuring unit with regulated temperature and water supply:
- metal plate, roughly 3 mm thick
- minimum surface area of 0.04 m²
- heat-conducting metal block containing an electric heating element
TESTS: MATERIALS AND METHODS


Principle:

**RCT: THERMAL RESISTANCE**
Determines if the fabric holds in heat. The higher the value obtained, the better the insulation.

**RET: WATER–VAPOUR RESISTANCE**
Determines a fabric’s ability to allow water vapour (perspiration) to pass through it. The lower the value obtained, the more breathable the fabric.

**IMT: WATER–VAPOUR PERMEABILITY INDEX**
Expresses the equilibrium (ratio) between the insulation (RCT) and the breathability (RET), with values from 0 to 1. The closer the value is to 1, the more comfortable the article is to wear. 

\[ i_{\text{int}} = S \cdot \frac{R_{ct}}{R_{et}} \]

\[ S = 60 \, \text{Pa/K} \]

Description
- Specimen substrate: glass plate (± 20 cm x 20 cm)
- A dropper that delivers 33 drops per milliliter + stirrer
- Grade 3 water at 20 °C ± 2 °C
- A ruler to measure length in mm

Process
First one, then two drops of water are placed on the surface of a dry fabric. We then observe
- drop absorption capacity (instant or slow)
- drop diffusion (direction and distribution)
Determination of a fabric’s moisture wicking capacity

The specimen to be tested is placed between the two sensors, with the “skin” side up.

The MMT deposits drops of a quantity of artificial perspiration (prepared and calibrated for the test) on the top “skin” side of the fabric.
4/ MMT: MOISTURE MANAGEMENT TESTER – AATCC TEST METHOD 195 2009 (AMERICAN STANDARD)

The sensors record the evolution of the perspiration within the fabric from both sides for 120 seconds.

A series of indices from 0 to 5 is defined and calculated to characterize how well the fabric manages the moisture.

- The fabric’s overall behaviour with respect to the water is indicated on a textile classification scale from 1 to 7.
RESULTS AND INTERPRETATION
1 / PERMEABILITY OF FABRICS TO AIR – NF EN ISO 9237 (1995)

The permeability values are adjusted for thickness in order to compare the intrinsic values.

The best ventilation results were obtained with 100% linen and 100% viscose, in comparison with the other knits in the study.

The ventilating action contributes to a cooling effect. This is of interest, for example, for a sports activity in temperate or warm environment.
100% LINEN IS THE MOST BREATHABLE (3.8 m²Pa/W), followed by cotton.
100% linen ranks 2nd for insulation (retaining heat) with an RCT of 0.044 m²k/W, which is still relatively low (on a scale of 0 to 1).

Linen offers a good compromise between coolness and heat retention.

This gives a product that is comfortable in summer, and which could also be of interest for winter with a tailored choice of yarn and weave.
100% LINEN has the highest comfort index: it provides moderate insulation with an RCT of 0.044, and the most breathability in the study, with an RET of 3.84.
100% linen absorbs the liquid instantly and diffuses it over the largest surface area, thereby promoting better wicking.

Viscose exhibits the next best results.
Fabric classification scale from 1 to 6

**Class 1** for PES: Slow absorption and diffusion with no penetration: the drop remains at the surface during the test

**Class 3** for Cotton: absorbs and diffuses water slowly

**Class 5** for Linen and Viscose: medium to rapid wetting and absorption, large diffusion surface, rapid diffusion

In the specific case of the linen/cotton blend, the results are linked to the structure of the twisted yarn: instant absorption, small diffusion surface on both sides of the fabric, and the water falls onto the plate (equivalent to a Class 6, but not comparable for this test).

100% Linen and 100% Viscose exhibited the best moisture management in the study = ✓ absorption + ✓ diffusion + ✓ large diffusion surfaces
CONCLUSIONS AND PROSPECTS
100% LINEN performs very well on all comfort criteria tested

- 100% linen and 100% viscose showed the best ventilation results, contributing a cooling effect
- 100% linen is the most breathable, followed by cotton
- 100% linen provides a good compromise between coolness and heat retention. A product that is comfortable in summer, and which could also be of interest for winter with tailored choice of yarn and weave.
- 100% linen has the highest comfort index
- 100% linen absorbs the liquid instantly and diffuses it over the largest surface area, thereby promoting better wicking, followed by viscose
- 100% linen and 100% viscose provide the best moisture management
APPENDICES
Yarns tested

- 100% linen, long fibre, Nm 39 – prepared for knitting
- 50% linen–50% cotton Nm 2/29 twisted ring spun
- 100% cotton Nm40 ring spun – torsion knitting – paraffined
- 100% viscose Nm 40 ring spun – torsion knitting – paraffined
- 100% PES Nm40 ring spun – torsion knitting – paraffined
Basis weight

- The basis weight is measured on a Mettler AM100 analytical balance
- Method according to the NF EN 12127 (1998) standard

Thickness

- A textile thickness gauge is used to measure the thickness according to the NF EN ISO 5084 (1996) standard
- A press plate 50 mm in diameter is connected to the gauge
- A 0.5 kPa load is applied
Permeability to air as a function of thickness – NF EN ISO 9237 (1995)

The values obtained were then adjusted for thickness to compare the intrinsic values. → see “Permeability of fabrics to air adjusted for thickness” in the Results section.
Founded in 1951, the European Confederation of Flax and Hemp [CELC] – a non-profit organisation under the Association Act 1901 – is a place for reflection, market analysis, industry concertation and strategic orientations.

The CELC is the only agro-industrial European organisation that covers all stages of production and processing of flax and hemp.

It is the chosen representative of 10,000 firms in 14 European countries, promoting the fibre from plant to finished product. Are represented also in sections, Agriculture, Retting/Scutching, Trading, Spinning, Weaving and Technical Uses. A whole ecosystem is based on heritage values, exceptional soil and expertise, all supported by continuous innovation.
MISSION OF CELC

The CELC's mission is to create an environment that promotes the competitiveness of industrial firms. It stimulates innovation based on the values of its natural flax and hemp fibres with their established environmental qualities. It promotes the European flax/linen industry in the fashion and lifestyle sectors. It encourages its manufacturers to be forward-looking towards new technical opportunities such as eco-construction and high-performance composite products.

The CELC offers the end consumer the guarantee of traceability with its two signature brands, CLUB MASTERS OF LINEN®, the guarantee of linen 100% made in Europe from plant, to yarn, to fabric and EUROPEAN FLAX®, the guarantee of traceability for premium linen fibre grown in Europe, for all its markets.

With its Bast Fibre Authority, CELC promotes fair labelling of products and contributes to the anti-counterfeiting protection, through the development of the first standardised bast fibre identification methodology and its platform of accredited laboratories.
ABOUT CETELORE

Cetelor (Centre d’Essais Textile Lorrain): the Textile Test Centre of the Lorraine Region

A University of Lorraine entity

3 main activities:
• ISO/IEC 17025 certified laboratory testing
• Broad range of tests, from fibres to finished products
  Accreditation 1–2401 (for scope, consult www.cofrac.fr)
• Applied R&D on fibrous materials (pilot lines)
• Basic research on fibres and composites

Cetelor is a member of the Bast Fibre Authority, a scientific platform created by the CELC for the identification of bast fibres and for product compositional analysis.
Notes
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