STUDY OF MODAL, PROMODAL, TENCEL SPORTS WEAR

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report "STUDY OF MODAL, PROMODAL,TENCEL SPORTS WEAR" is the bonafide work of M.ManojKumar (0910202308), M.Ragunathan(0910202313), P.Ragupathy(0910202314), G.SathishKumar (0910202317) who carried out the project work under my supervision during the year 2012-2013.

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ABSTRACT

An attempt has been made to study the functional properties of MODAL, TENCEL, PROMODAL sport wear fabric. To enhance the functional properties of sportswear fabric

Objective of this work is to explore whether the natural hydrophilic solvent spun cellulosic fibers could have the properties to enhance the moisture handling and other properties of sportswear fabrics .while at same time improving the aesthetics of the material

In this study, structural, physical and mechanical properties of MODAL, TENCEL, PROMODAL fabrics are compared.

Thermal conductivity, fastness properties, wickability, absorption, perspiration tests were performed for the testing of fabric characteristics, and all physical properties were also tested.

Application of this study is to improve the moisture management, comfort, thermal conductivity of the fabric.

CHAPTER 1

INTRODUCTION

SPORTSWEAR

A sportswear should have the fibers which are hydrophilic in nature .the cellulosic fibers are recognized as having excellent absorbency and breathability. Most synthetic fibers are hydrophobic and non- absorbent but can deliver strength and easy care properties. It should need to provide a comfortable environment for the wearer and consequently need to be able to handle, moisture vapor and sweat produced by the body. the need to help in controlling temperature and they need to feel good .

Mostly sports wear is made out of synthetic fibers Objective of this work is to explore whether the natural hydrophilic solvent spun cellulosic fibers could have the properties to enhance the moisture handling and other properties of sportswear fabrics .while at same time improving the aesthetics of the material

Our study is by using the solvent spun cellulosic fibers like MODAL, TENCEL,PROMODAL fibers has the properties to satisfy the requirement of sportswear fabric properties and it has to fulfill all the essential environment for the wearer.

MODAL

Modal is a type of rayon a semi synthetic cellulosic fiber made by a spinning reconstituted cellulose, in this care often from beech trees, modal is used alone or with other fibers (cotton,tencel,etc….)

It is about more than 50% more hygroscopic (water absorbent) per unit volume than cotton, takes dye like cotton, colour- fast when washed in warm water, resistant to shrinkage and fading but little prone at stretching and pilling. It is also claimed that mineral deposited from hard water do not stick to the fabric surface. It is smooth and soft ., more so than mercerized cotton, though some perceive it to having a synthetic texture. Modal fabrics should be washed at lower temperature and like cotton ,are often ironed after washing. It is more softer. Due to merceriziability and high alkali resistance ,is ideal for sportswear , it has tone-tone dyeing. It is more sheen, softness, and naturalness for textiles.

TENCEL

Tencel (or) lyocell is a regenerated cellulose fiber made from dissolving pulp (bleached wood pulp). It was developed and first manufactured as tencel in 1980s by courtauddy fibers UK as of 2010 it is manufactured by LENZING AG of lenzing Austria . under the name “lyocell by lenzing” and under the brand name TENCEL.

It shares many properties with other cellulosic fibers such as cotton, linen, ramie, rayon, same main characteristics of tencel fibers are they are soft, absorbent, very strong wet and dry and resistant to wrinkles, it can be dyed many colors and can simulate a variety of textures. It is eco-friendly of the naturally regenerating fiber, it is more absorbent than cotton, softer then silk and cooler than linen.

It absorbs moisture completely and naturally and then release it to the outside it has extremely small hairs are the tiniest components which make up the fiber sub microscopic channels between the individual fibrils regulate absorption and release of the moisture . thus , there tiny fibrils assure the optimum transportation of moisture.

PROMODAL

It is blend of two fibers modal and tencel. It is very promising since the fiber blend 2 unites softness and functionality, A homogeneous blending ratio of fibers in a specially calibarated blendomet gurantees on optimum quality.

It reveal a higher tear strength after mercerizing which can be passed on to the finished textile. The process realiability, which is improved by the higher tear strength, makes a high quality fiber for finishing. The bursting limit is another important property .the former is upto 20% higher compared to standard modal. It is naturally soft and pleasant on the skin, making it ideal for sports goods, for half a century now nothing has made fabrics softer than this softener in the fiber form . it makes every sportswear soft and supple.

It has low fiber rigidity and the special cross-section of transform the fiber into an expert of natural softness . the high softness makes it feel comfortable, unique for sportswear.

It has good moisture management , wickability, thermal conductivity, softness properties..

CHAPTER2
LITERATURE REVIEW

Hydrophilic natural fibers like cotton and wool and the man made cellulosic fibers are recognized as having excellent absorbency and breathability. Most synthetic fibers are hydrophobic and non absorbent but can deliver strength and easy care properties.

Sportswear fabrics need to provide a comfortable environment for the wearer and consequently need to be able to handle moisture vapor and sweat produced by the body, they need to help in controlling temperature and they need to feel good. Modern sportswear is most usually made from synthetic fibers. The objective of this work was to explore whether the natural hydrophilic properties of TENCEL a man made, solvent spun cellulosic fiber could be used to enhance the moisture handling and other properties of sportswear

2.1 THERMAL PROPERTIES

Design must consider the thermal insulation needs of the wearer. In hot situations, sportswear should allow the wearer to stay cool; while in cold situations, sportswear should help the wearer to stay warm.

Sportswear should also be able to transfer sweat away from the skin, using, for example, moisture transferring fabric. Spandex is a popular material used as base layers to soak up sweat. For example, in activities such as skiing and mountain climbing this is achieved by using layering: moisture transferring

materials are worn next to the skin, followed by an insulating layer, and wind and then water resistant shell garments.

2.2 MOISTURE-WICKING FABRICS

Moisture-wicking fabrics are a class of hi-tech fabrics that provide moisture control for an athlete's skin. They move perspiration away from the body to the fabric's outer surface where it can evaporate. These fabrics typically are soft, lightweight, and stretchy—in other words, they are perfectly suited for making active wear. This broad category of fabrics is used to make garments like T-shirts, sports bras, running and cycling jerseys, socks, tracksuits, and polo-style shirts for any physical activity where the goal is to keep your skin as cool and dry as possible. Moisture-wicking fabrics are used to make apparel for outdoor activities such as hiking, fishing, mountain biking, snow skiing, and mountain climbing. Due to the popularity of garments made from these fabrics, more variations are being introduced to the market

2.3 MOISTURE MANAGEMENT

“Moisture management” in relation to a fabric refers to its ability to transport, store and dispose of liquid water released from the body.

2.4 BREATHABILITY

Refers to the ease with which gases including water vapor can pass through the fabric. Liquid water released by the body is known as sensible perspiration. To be removed from the body it must be wicked through the fabric structure and then evaporate from the outside of the fabric. When it evaporates heat is removed which helps to control the temperature of the body.

Water vapor or insensible perspiration can pass through openings between fibers and yarns in a breathable fabric. When water vapor is produced by the body, heat is removed giving a direct cooling effect.

During exercise, both insensible and perspiration and sensible perspiration are produced, but the latter increases in response to rising body temperature producing liquid at the surface of the skin. Fabrics used for active sportswear must have the ability to transport moisture away from the skin to the fabric surface for evaporation. The most effective fabrics will spread moisture over a wide area to maximize the surface area available for evaporation and hence cooling.

2.5 CELLULOSIC FIBERS IN SPORTSWEAR

100 % cellulose fiber garments are widely used for general sports clothing and street wear, but the only fabrics actively promoted for high performance sportswear are made from synthetic fibers. Consumers and sportswear manufacturers have the view that cellulosic fibers are unsuitable for use in sportswear for high activity where sweat production needs to be dealt with. The

reasons for this view of cellulosic fabrics are real and need to be addressed if the use of cellulosic fabrics in sportswear is to be increased.

Cellulosic fabrics absorb water into the fiber structure and become heavy. This leads to stretching of the fabric, sticking to the skin and when activity ceases the fabric may feel cold against the skin. Higher levels of moisture absorbed in the fabric mean longer drying times. However, cellulosic fabrics are generally perceived to be more comfortable than synthetic fabrics when worn for normal day-to-day activities. They are preferred for a wide range of apparel fabrics where visual aesthetics, handle and comfort are important. In these areas synthetic fibers

Lenzinger Berichte, 85 (2006) 44-50

45 are only used in blend with cellulosic fibers or where price and/or easy care performance are considered more important. In order to deliver these positive properties of cellulosic fibers and to eliminate the negative aspects of performance, a new approach is needed. A successful cellulosic containing fabric will need to have a much lower absorbent capacity than a 100 % cellulosic but must also deliver the good visual aesthetics, handle and touch that cellulosic fibers are known for. The fabric would also have excellent moisture handling capability and be easy care. The hypothesis which is tested in this work is based on this thinking.

2.6 BASIC CONSIDERATIONS

The most common strategy used to give high performance in synthetic fiber based active sportswear is to use a two layer fabric with a hydrophobic skin contact layer and a hydrophilic outer layer. Sweat is pulled through the fabric by the hydrophilic fiber on the outside and then spreads through the fabric outer surface to maximize the area available for evaporation. This leaves the skin contact layer feeling dry because the moisture has been transported to the outside. Because the

fabric has a low moisture content as moisture is not absorbed directly by the fibers it will dry rapidly.

100 % polyester two-layer fabrics perform well in general, but do have some disadvantages. The hydrophilic surface finishes used for the fiber on the outside can be removed as the garment is washed and worn. Hydrophilic polyester fibers are specialty products and carry a premium price. For 100 % polyester fabrics the only aesthetic options possible are a synthetic appearance, hand and touch which does not appeal to all users.

2.7 HYPOTHESIS

TENCEL is naturally and permanently hydrophilic. It has a high water absorption capacity which means that if it were used as 100% of the outer layer of a sportswear fabric it would suffer from the disadvantages described above. However, if it were blended with polyester, the absorbent capacity could be controlled to an acceptable level by the blend ratio and the TENCEL would deliver the hydrophilicity needed for transport of moisture through the fabric and for spreading across the outer surface. To work effectively, the TENCEL would need to be present in sufficient quantity to give a continuous network of fibers in the fabric to provide an uninterrupted path for the moisture to follow.

To achieve this goal a blended yarn containing atleast 20 % TENCEL should be adequate to give good wicking and liquid spreading.

3.6 BASIC INVESTIGATIONS: WATER ABSORBENCY AND WETTING

The test measures the amount of water absorbed by a sample when water is delivered at zero pressure to a point at the center of a disc of fabric. For the fabric to absorb, it must positively pull the water into its structure.

The 50 % TENCEL fabric has the highest water absorption capacity and absorbs at a similar rate to the 100 % TENCEL fabric. The 30 % TENCEL / 70 % absorbs at a lower rate but matches the total absorbency of the100 % TENCEL.

WATER VAPOUR PERMEABILITY

The water vapor permeability index for all of the TENCEL containing fabrics is much better than for the Nike and Reebok benchmark fabrics. The double layer piquet construction shows extremely good breathability.

This intermediate level project is designed for members with some clothing project experience. Learn guidelines for planning active sportswear outfit, compare garments you make with similar ready-to-wear ones, practice construction techniques and evaluate fabrics for active sportswear, and plan accessories for your outfit.

Lenzing is a supplier of high-quality, innovative products made from cellulose fibers and specialty polymers including carbon fibers precursor. Lenzing is a business-to-business company.

Lenzing actively maintains an international network of partner companies in the supply chain, from development to processing and retail

Lenzing is the innovation leader and pacemaker of the cellulose fiber industry and a leading developer of high-quality polymer products for niche markets.

Lenzing's research and development activities are far above the industry average.

Decades of expertise provide the foundation for the further development of production processes and attributes specific to Lenzing fibers. Innovative

marketing strategies and a flexible organization with teams geared to project work and inter-site cooperation create a high level of market awareness and fast response.

GLOBAL PRESENCE

Lenzing is the only global cellulose fiber producer with production facilities in all key markets and an international network of sales and marketing offices.

Lenzing's global customer and technical service is unique and recognized as setting industry standards.

Lenzing is where its customers are: Business Unit Textile Fibers has a clear focus on Asia, the place of future textile growth. Fast delivery, low cost, local production – Lenzing offers all of these to Asia's growing markets. Nonwovens serve its customers globally. Locations in Europe, the USA and Asia secure long-term customer cooperations.

The focus of Plastics is currently still on Europe and North America. Future growth will take place with high-tech products, but on a global basis.

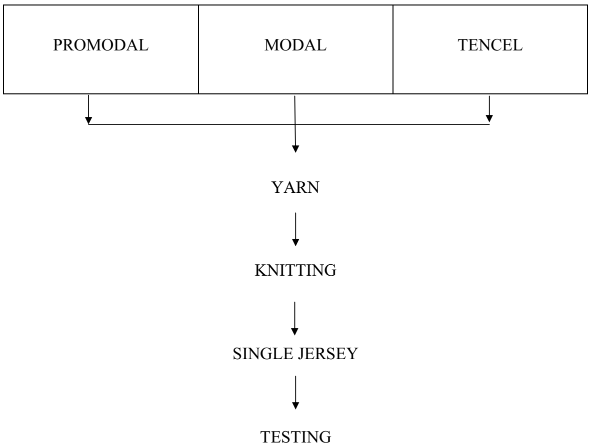
SUSTAINABLE GROWTH

Lenzing focuses on long-term quality growth. Lenzing uses renewable resources with low impact on climate change, such as pulp, and applies ecologically sound and energy efficient production processes to the greatest possible extent.

Lenzing takes care to maintain a long-term raw material supply base.

CHAPTER 3

3.1 METHODOLOGY



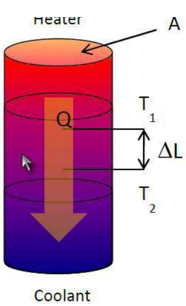
As per the methodology of the project work we bought the yarn modal promodal tencel 40's count. We made in to a single jersey fabric using single track knitting machine with 24 gauge and 28" dia

CHAPTER 4

TESTING

- Absorbency/wetting
- Thermal conductivity
- Water vapor permeability
- Washing fastness
- Perspiration water
- Wickability
- Bursting strength
- Gsm

4.1 THERMAL CONDUCTIVITY



Thermal conductivity of textile material

PROCEDURE

It is done by the Lee's disc method.The Lee's disc set up is shown in the fig below. The steam is passed through the chamber. As heat gets conducted into the brass disc through the fabric, it gets heated up. The temperature is noted from time to time. At one stage the temperature becomes steady. When the temperature becomes steady for at least 10 minutes, the steady temperature is noted as (Θ_2^0 c). The temperature of steam is noted (Θ_1^0 c). Now the fabric is removed and the brass disc is heated in direct contact with the steam chamber until the temperature rises about 5^0 c above the steady state temperature. The disc is now separately suspended from the ring after removing the steam chamber. Temperatures are noted in steps of 30 seconds from (Θ_2 +5^0) c to (Θ_2 -5^0) c and the values are tabulated. A graph is drawn with the temperature in Y axis and the time on X axis. A horizontal line is drawn corresponding to steady temperature Θ_2^0c. The time dt for fall of temperature at Θ_2^0c is found by taking two points one degree above 2 and the other one degree below. Note down the mass (m) of the brass disc B as noted over it or determine its mass using balance. Its diameter is found and hence the radius (r) is determined using vernier callipers and the thickness (l) of the brass disc is found using vernier callipers and thickness of the bad conductor (d) with a screw gauge.

Calculation:

Thermal conductivity (K) = $\frac{Msd\,(r+2l)\,(d\Theta/dt)}{\pi r^2\,(2r+2l)\,(\Theta_1-\Theta_2)}$ w m^{-1} k^{-1}

Where,

M= mass of the disc placed over the experimental disc (x10^{-3} kg)

S= Specific heat of the material of the disc (j/kg/k)

d= thickness of the fabric in meters

r= radius of the brass disc in metres

Θ_1 = temperature of the steam in degrees

Θ_2 = steady temperature in degrees

$d\Theta/dt$= Rate of heat radiation of the brass disc at Θ_2 k/second

Guarded or unguarded heat flow meter method (ASTM C518, E1530 Test Methods)

These techniques involves the use of a flux gauge. The flux gauge is very similar, in its purpose, to the references in the comparative cut bar method. In practice, the reference material has a very low thermal conductivity and, therefore, it can be made very thin. Usually, a large number of thermocouple pairs are located on both sides of the reference plate, connected differentially to yield directly an electrical signal proportional to the differential temperature across it.

1 2 S R S ΔT + ΔT 2 K =K ΔT

The assembly is cast into a protective coating for durability. This type of flux gauge is mostly used with instruments testing very low thermal conductivity samples, such as building insulations. In a similar fashion, flux gauges can be constructed from just about any material, thick or thin, depending on the material's thermal conductivity. Common requirements for all flux gauges are that the material used for the measuring section be stable, not affected by the thermal cycling, and the gauge be calibrated by some method independently. A very large variety of testing instruments use this method. 4 TPN-67

Guarded Hot Plate Method (ASTM C 177 Test Method)

Guarded hot plate is a widely used and versatile method for measuring the thermal conductivity of insulations. Although the specimens are often rather large, this usually presents no difficulty. A flat, electrically heated metering section surrounded on all lateral sides by a guard heater section controlled through differential thermocouples, supplies the planar heat source introduced over the hot face of the specimens. The most common measurement configuration is the

conventional, symmetrically arranged guarded hot plate where the heater assembly is sandwiched between two specimens . In the single sided configuration, the heat flow is passing through one specimen and the back of the main heater acts as a guard plane creating an adiabatic environment.

This is an absolute method of measurement and its applicability requires: (a) the establishment of steady-state conditions, and (b) the measurement of the unidirectional heat flux in the metered region, the temperatures of the hot and cold surfaces, the thickness of the specimens and other parameters which may affect the unidirectional heat flux through the metered area of the specimen.

Three different categories of measurement systems can be distinguished: apparatus working around room temperatures, apparatus working below room temperatures (down to about -180oC), and apparatus working at high temperature (600oC or above). A given apparatus is most often best adopted for measurement in one of these temperature ranges.

Hot Wire Method (ASTM C1113 Test Method)

Hot wire methods are most commonly used to measure the thermal conductivity of "refractories" such as insulating bricks and powder or fibrous materials. Because it is basically a transient radial flow technique, isotropic specimens are required. The technique has been used in a more limited way to measure properties of liquids and plastics materials of relatively low thermal conductivity. Relatively recent modification of this long-established technique is the "probe method". This configuration is particularly practical where the specimen conductivity is determined from the response of a "hypodermic needle"

probe inserted in the test specimen. Thus the method is conveniently applied to low-conductivity materials in powder or other semi rigid form. A probe device can be used to measure the thermal properties of soils in situ, but most commonly a closely controlled furnace is used to contain the sample and produce the base temperatures for the tests. The probe contains a heater and a thermocouple attached to it. When a certain amount of current is passed through the heater for a short period of time, the temperature history of the heater's surface will take on a characteristic form. In the initial phase, the temperature will rapidly rise, and as the heat begins to soak in, the rate of rise becomes constant. When the thermal front reaches the outer boundary of the sample, the rise will slow down or stop altogether due to losses into the environment. From the straight portion of the rate curve (temperature vs. time) the thermal conductivity can be calculated.

$$\boldsymbol{k = msd(r+2l) \Big/ \pi r^2(2r+2l)(\theta 1-\theta 2)}\;\left[\frac{d\theta}{dt}\right]$$

M=800× $\boldsymbol{10^{-3}}$

S=372J/kg/k

R=5.57× $\boldsymbol{10^{-2} m}$

l=0.995$\boldsymbol{10^{-2} m}$

$\boldsymbol{\theta = 98}$

Wick ability

You can use this procedure to compare how well different fabrics absorb moisture and how quickly the fabrics dry out. The quicker the absorbency and evaporation, the better the wick ability.

A risk assessment must be carried out before you start any practical work.

4.2 GSM

Fabric mass is calculated from the mass of a specimen the length and width of which have been measured as directed in one of the procedures in Test Method D 3773 and D 3774

Apparatus

Scale, with a capacity and sensitivity sufficient to weigh the full piece, roll, bolt, or cut units to within 60.1 % of their gross mass. The accuracy of the scale should be certified by a recognized authority.

Balance, having a capacity and sensitivity to weigh within 60.1 % of the mass of the specimens being tested.

Cutting Die, either square or round with an area of at least 13 cm2 or 4 in.2

Conditioning

Condition test specimens as directed in Practice D 1776.6.2 All weighing tests should be made in the standard atmosphere for testing textiles (20 6 1°C (70 6 2°F), 65 6 2 % RH), after the specimens have been conditioned in the same atmosphere. It may be impractical to condition the specimens in Option A or non conditioned testing may be agreed upon by the purchaser and supplier. When the full rolls or bolts of fabric cannot be properly conditioned in a reasonable time with

available facilities, perform the tests without conditioning and report the actual conditions prevailing at the time of the test. Such results may not correspond with the results obtained after testing adequately conditioned specimens in the standard atmosphere for testing textiles.

Option A for the determination of mass per unit area of woven fabrics may be used for acceptance testing of commercial shipments since it has been used extensively in the trade.

In case of a dispute arising from differences in reported test value when using Test Methods D 3776 for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens which are as homogeneous as possible and which are from a lot of material of the type in question. The test specimens should then be randomly assigned in equal numbers 1 these test methods are under the jurisdiction of ASTM Committee D-13 on Textiles and are the direct responsibility of Subcommittee D13.60 on Fabric Test Methods, Specific.

Current edition approved April 10, 1996. Published June 1996. Replaces Sections 35 to 41 of Methods D 1910 – 64 (1975). Originally published as D 3776 – 79. Last

Previous edition D 3776 – 85(1990).

2 Annual Book of ASTM Standards, Vols 07.01.

3 Annual Books of ASTM Standards, Vol 07.02.

The average results from the two laboratories should be compared using student's *t*-test for unpaired data and an acceptable probability level chosen by the two parties before testing is begun. If a bias is found, either its cause must be found and

corrected or the purchaser and the supplier must agree to interpret future test results in the light of the known bias.

Sampling—As a lot sample for acceptance testing, take at random the number of rolls of fabric as directed in an applicable material specification or other agreement between the purchaser and the supplier. Consider rolls of fabric to be the primary sampling units. Consider the rolls of fabric in the lot sample as the laboratory sample and as the test specimens.

Procedure

Measure the length of the full piece, roll, bolt, or cut by the hand procedure in Test Method D 3773. Measure the width by the tension-free alternative of Option A of Test Method D 3774. Weigh the fabric, with shell and holder, if any, to the nearest 0.1 % of its mass. Weigh the holder, if any, to the nearest 0.1 % of its mass.

4.3 BURSTING

A is clamped over an expandable diaphragm. The diaphragm is expanded by fluid pressure to the point of specimen rupture. The difference between the total pressure required to rupture the specimen and the pressure required toinflate the diaphragm is reported as the bursting strength.

This method for the determination of diaphragm bursting strength of knitted, nonwoven and woven fabrics is being used by the textile industry for the evaluation of a wide variety of end uses. In cases where test results obtained using the procedures

Test Method D 3786 have not been correlated with actual performance, Test Method D 3786 is considered satisfactory for acceptance testing of commercial shipments of textile fabrics for bursting strength since the method has been used extensively in the trade for acceptance testing. In cases where disagreement arising from differences in values reported by the purchaser and the supplier when using Test Method D 3786 for acceptance testing, the statistical bias, if any, between the laboratory of the purchaser and the laboratory of the supplier

APPARATUS AND MATERIALS

A testing machine that meets the requirements of . In cases of dispute, a motor-driven tester shall be used unless the purchaser and the supplier agree otherwise.

Clamps,for firmly and uniformly securing the test specimen between two annular, plane, parallel, and preferably stainless steel surfaces, without slippage during the test. Use sufficient pressure to effect the practicable minimization of slippage.

The upper and lower clamping surfaces shall have a circular opening at least 75 mm (3 in.) in diameter and coaxial apertures of 31 6 0.75 mm (1.22 6 0.03 in.) in diameter: The surfaces of the clamps between which the specimen is place shall have concentric grooves spaced not less than 0.8 mm(1⁄32in.) apart and shall be of a depth not less than 0.015 mm(0.0006 in.) from the edge of the aperture. The surfaces of the clamps shall be metallic and any edge which might cause a cutting action shall be rounded to a radius of not more than 0.4mm (1⁄64 in.). The lower clamp shall be integral with the chamber in which a screw shall operate to force a liquid pressure medium at a uniform rate of 95 6 5 mL/min against the rubber diaphragm.

. Diaphragm —A 48 mm (1.875 in) diaphragm of molded synthetic rubber, 1.80 6 0.05 mm (0.070 6 0.002 in.) In thickness with reinforced center, clamped between the lower clamping plate and the rest of the apparatus so that before the diaphragm is stretched by pressure underneath it the center of its upper surface is below the plane of the clamping surface.

The pressure required to raise the free surface of the diaphragm plane shall be 30 6 5kPa (4.3 6 0.8 psi). This pressure shall be checked at least once a month. To test, a bridge gage5 may be used, the test being carried out with the clamping ring removed. The diaphragm should be inspected frequently for permanent distortion and renewed as necessary.

Pressure Gage A maximum-reading pressure gage of the Bourdon type of appropriate capacity graduated in pounds and accurate throughout the entire range of its scale to within a value of 1 % of its maximum capacity. The capacity of the gage shall be such that the individual readings will be not less than 25 % nor more than 75 % of the total capacity of the gage.

Hydraulic Pressure System A mean of applying controlled increasing hydrostatic pressure to the underside of the diaphragm until the specimen bursts through a fluid displaced at the rate of 95 6 5 mL/min. The fluid is displaced by a piston in the pressure chamber of the apparatus.The recommended chamber fluid is USP chemically pure 96 % glycerin. The hydraulic system, including the gages shall

bemounted so as to be free of externally induced vibrations. Means shall be provided at the instant of rupture of the specimen for stopping any further application of the loading pressure and for holding unchanged the contents of the pressure chamber until the total bursting pressure and the pressure required to inflate the diaphragm indicated on the gage have been recorded.

4.4AIR PREMABILITY

The rate of air flow passing perpendicularly through a known area of fabric is adjusted to obtain a prescribed air pressure differential between the two fabric surfaces. From this rate of air flow, the air permeability of the fabric is determined.

This test method is considered satisfactory for acceptance testing of commercial shipments since current estimates of between-laboratory precision are acceptable, and this test method is used extensively in the trade for acceptance testing.
In case of a dispute arising from differences in reported test results when using this test method for acceptance testing of commercial shipments, the purchaser and the

supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias.

As a minimum, the two parties should take a group of test specimens that are as homogeneous as possible and that are from a lot of material of the type in question. Test specimens then should be randomly assigned in equal numbers to each
laboratory for testing. The average results from the two laboratories should be compared using the appropriate statistical analysis and an acceptable probability level chosen by the two parties before testing is begun. If a bias is found, either its cause must be found and corrected, or the purchaser and the supplier must agree to interpret future test results with consideration of the known bias.

Air permeability is an important factor in the performance of such textile materials as gas filters, fabrics for air bags, clothing, mosquito netting, parachutes, sails, tentage, and vacuum cleaners. In filtration, for example, efficiency is directly related to air permeability. Air permeability also can be used to provide an indication of the breathability of weather resistant and rainproof fabrics, or of coated fabrics in general, and to detect changes during the manufacturing process.

Performance specifications, both industrial and military, have been prepared on the basis of air permeability and are used in the purchase of fabrics where permeability is of interest.

Construction factors and finishing techniques can have an appreciable effect upon air permeability by causing a change in the length of airflow paths through a fabric. Hot calendaring can be used to flatten fabric components, thus reducing air

permeability. Fabrics with different surface textures on either side can have a different air permeability depending upon the direction of air flow.

For woven fabric, yarn twist also is important. As twist increases, the circularity and density of the yarn increases, thus reducing the yarn diameter and the cover factor and increasing the air permeability. Yarn crimp and weave influence the shape and area of the interstices between yarns and may permit yarns to extend easily. Such yarn extension would open up the fabric, increase the free area, and increase the air permeability.

Increasing yarn twist also may allow the more circular, high-density yarns to be packed closely together in a tightly woven structure with reduced air permeability. For example, a worsted gabardine fabric may have lower air permeability than a woolen hopsacking fabric.

4.5ABSORBTION

A terry fabric product with hems or with both hems and elvages (such as a bathtowel), or a terry fabric without hems or without both hems and selvages (such as a terry fabric cut from a roll) is prepared for testing by preconditioning and conditioning. Specimens are placed one at a time in an embroidery hoop and then the hoop/specimen assembly is placed at an angle on the base of the apparatus. After water flows down the surface of each specimen, the amount of water retainedy each specimen is measured. Six specimens are tested, three on the face of the fabric and three on the back of the fabric. The six observations are averaged to determine the surface water absorption of the fabric.

This test method may be used to test the surface water absorption of terry fabrics for bath towels, bath sheets, hand bathrobes, and the like. Different specifications may be needed for each of these fabrics because of different applications.5

It is recognized that surface water absorption is only one of the characteristics that the ultimate consumer may use in determining which terry fabric is acceptable. Consult Specification D 5433 for other characteristics that may be applicable to terry fabrics.

This test method is recommended for quality control testing of terry fabrics during manufacturing and product comparisons of different terry fabrics by manufacturers, retailers, and users.

This test method may be used for the acceptance testing of commercial shipments of terry fabrics, but caution is advised since inter laboratory precision is known to be poor. Comparative tests as directed in may be advisable.

In case of a dispute arising from differences in reported test results when using this test method for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of laboratory sampling units (such as towels) that are as homogeneous as possible and that are from a lot of material of the type in question. The laboratory sampling units should then be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using appropriate statistical analysis for unpaired data and an acceptable

probability level chosen by the two parties before the testing is begun. If a bias is found, either its cause must be found and corrected or the purchaser and supplier must agree to interpret future test results with consideration of the known bias.

Apparatus and Materials

Water Flow Tester—This tester is not commercially available, but it is not difficult or expensive to build. The tester can be made from the parts and the series of steps described in Annex A1; however, there are other acceptable ways to build the tester. Sections 6.1.1-6.1.4 indicate the critical factors which must be incorporated into the design of the tester.

The hoop/specimen assembly must be at 1.1 rad (60°) to the table top

The 50-mL graduate mounted on the apparatus must be parallel to the table top

The pour spout on this graduate must be 3.0 6 0.2 cm (1.18 6 0.08 in.) down from where the adjustment screw bracket joints the outer hoop and 0.6 6 0.4 cm (0.24 6 0.16 in.) away from the hoop/ specimen assembly.

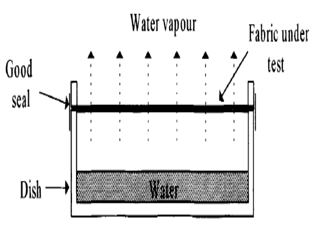
The funnel, valve, fittings, tubing, and graduate mounted on the apparatus must not restrict the flow of water. The time between the opening of the valve and the time the water has exited the graduate (except for a few drops) must be less than 8.0 .has a mean of 5.7 s and a standard deviation of 0.5 s.

The hoop specimen assembly must be mounted on the base in a manner to direct all water not absorbed by the specimen toward the pan. It is especially important that any water that passes completely through the specimen is directed toward the pan and is not allowed to be absorbed by the lower portion of the specimen, or the edge of the laboratory sampling unit, or held where the hoop contacts the base.

Embroidery Hoop, 15.3-cm (6-in.) outer diameter of inner hoop. If the hoop is made of wood, it must have a water-resistant finish (such as a marine varnish). 6.3 Graduate, Polymethylpentene (PMP) 50 ml. 6.4 Distilled or Deionized Water, at 21 6 1°C (70 6 2°F). 6.5 Laboratory Sampling Unit Conditioning Equipment, facilities such as a multiple shelf/rod conditioning rack (for example see Practice D 1776) or a clothesline and clothespins. For more information.

4.6WATER VAPOUR PREMEABILITY

Pour about 20 ml of water into each cylindrical box and cover the opening with the samples to be tested completely and seal them with the lid. The width of the material must be at least 5mm greater than the corresponding dimensions of the aperture. Weigh the sealed boxes from the cabinet and find out the final weight. From the mean loss in weight and the area of opening in the top of each box, find the water vapour permeability.



CALCULATION

Water vapour Permeability, Individual Specimens—Calculate the Water vapour permeability of individual specimens using values read directly from the test instrument in SI units as grams/m^2/day, rounded to three significant digits.

$$\text{Water vapour Permeability} = \frac{24M}{A \times t} \ \text{grams/m}^2\text{/day}$$

Where,

M =Mean loss in weight in grams

A =area of the disc in m^2

t= time in hours

4.7TESTS FOR WASHING FASTNESS

For testing wash fastness, a wash fastness tester which is known as Laundero meter is used .It is a stainless steel double-walled container equipped with a rotor on which eight jars are provided. The container can store water and is4 equipped with a heating coil for heating the water to the specified/required temperature. A thermostat controls the temperature.

There are five (5) wash tests which are application-specific. These will now be briefly considered.

A specimen measuring 10 cm 4 cm is cut out from the fabric to be tested for wash fastness. It is placed between two pieces of un-dyed (white) fabric measuring 10 cm 4 cm and three pieces are held together by stitching round the edges. In the case of yarn, a white yarn is entwined to make a composite sample, whereas in case of fiber, it is compressed in the form of a sheet of 10 cm 4 cm and held in place by sewing in between pieces of cloth measuring 10 cm 4 cm.

One of the white materials enclosing the specimen is the same as the dyed sample and the other is as indicated in Table. After the specimens have been prepared, a solution is made containing 5 gram per litre of good quality washing soap/detergent. Then the tests are performed as per the test procedures of Bureau of Indian Standards.

COLOURFASTNESS TESTING

Color Fastness to Domestic and Commercial Laundering (ISO 105 C06)Color Fastness to Domestic and Commercial Laundering using a non phosphate reference detergent incorporating a low temperature bleach activator (ISO 105 C08)

Color Fastness to Domestic and Commercial Laundering-Oxidative bleach response using a non-phosphate reference detergent incorporating a low temperature beach activator (ISO 105 C09)

Colourfastness to Laundering, Home & Commercial : Accelerated. (AATCC 61) Color fastness to washing is the common quality parameter, which is considered very important from the point of view of consumers. This test determines the loss & change of colour in the washing process by a consumer and the possible staining of other garments or lighter portion that may be washed with it.

This test is used to predict the performance of any dyed or printed textile product to the common washing process using a detergent and additives. Some of the test conditions in ISO and all the AATCC conditions are designed to simulate the behaviour of the textile after 5 domestic or commercial launderings.

- Wash wheel pots and stainless steel balls
- AATCC & ECE Standard Reference Detergents

Assessment / Results and Interpretation

Colorfastness to washing is assessed in three ways:

hanger in shade – loss of colour or tone as compared to the original unwashed sample

Standard grey scales are used for the assessment where grades between 1 and 5 are given in half steps. Assessment needs to be done with clean grey scales using masks and under standardized lighting conditions in a dark room.

The test for colorfastness to washing is one of the most basic colorfastness tests used by customers to evaluate end products. The processor is required to understand the product and its requirements so as to select the colouration techniques and processes accordingly

CHAPTER 5

RESULT AND DISCUSSION

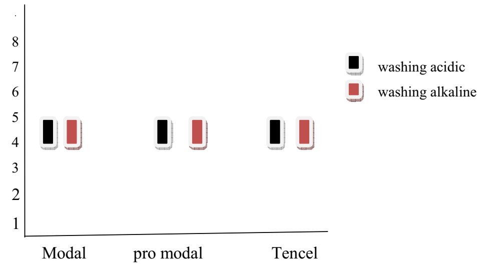
5.1FABRIC PARTICULARS

Particulars	100% Modal	100% Pro Modal	100% Tencel
GSM	100	100	98
Wales/inch	50	50	48
Course/inch	28	28	28
Loop length(mm)	1.2	1.2	1.2
Gauge(inch)	24	24	24
Diameter(inch)	28	28	28

5.2COLOR FASTNESS TO WASHING FASTNESS AT40°C

(ISO 105 E04:2008) GREY SCALE RATING

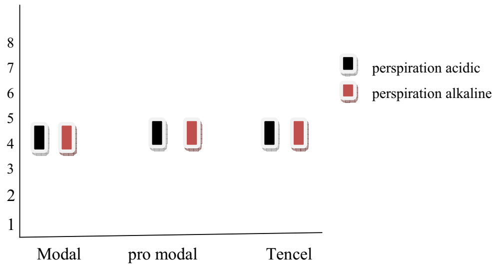
SAMPLE	PARTICULARS	ACIDIC	ALKALINE
MODAL	WASHING	4 to 5	4 to 5
PROMODAL	WASHING	4 to 5	4 to 5
TENCIL	WASHING	4 to 5	4 to 5
o			



5.3 COLOR FASTNESS TO PERSPIRATION

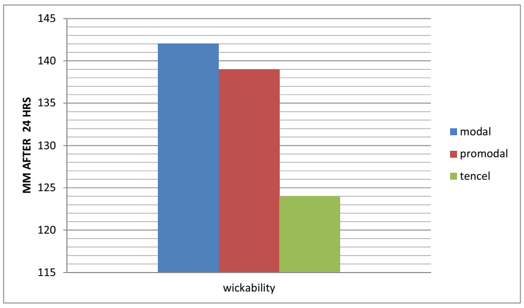
(ISO 105 E04:2008) GREY SCALE RATING

SAMPLE	PARTICULAR	ACIDIC	ALKALINE
MODAL	PERSPIRATION	4 to 5	4 to 5
PROMODAL	PERSPIRATION	4 to 5	4 to 5
TENCIL	PERSPIRATION	4 to 5	4 to 5



5.4 TEST RESULTS FOR WICKABILITY IN MM AFTER 24HR

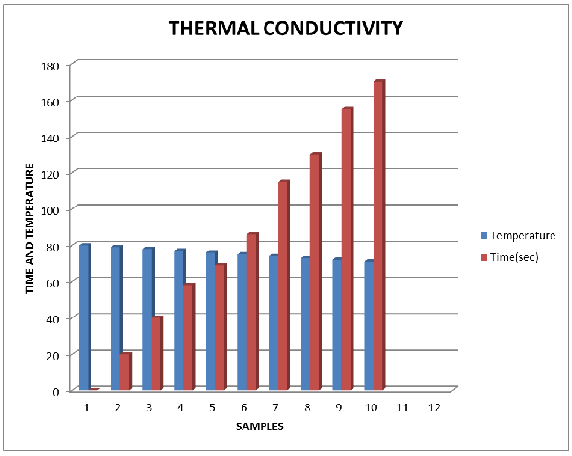
Sample particulars	Modal	Promodal	Tencel
Wickability in mm after 24hr	142	139	124



5.5THERMAL CONDUCTIVITY

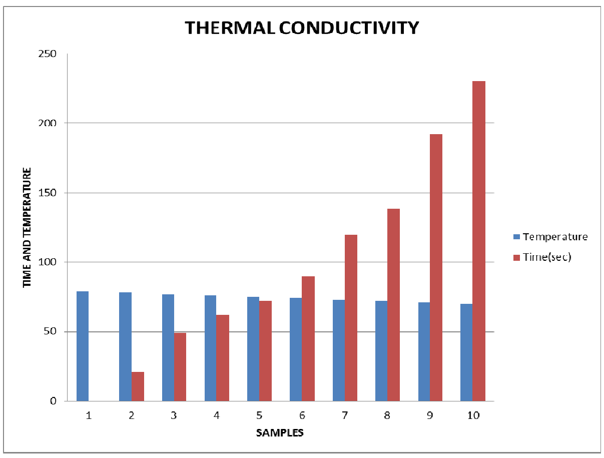
PROMODAL

S:no	1	2	3	4	5	6	7	8	9	10
Temperature	80	79	78	77	76	75	74	73	72	71
Time(sec)	0	20	40	58	69	86	115	130	155	170



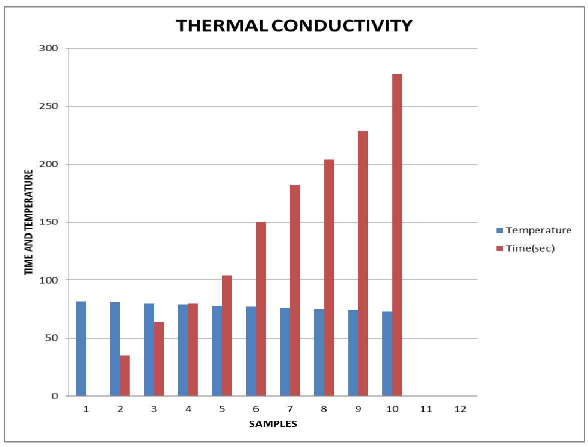
MODAL

S.no	1	2	3	4	5	6	7	8	9	10
Temperature	79	78	77	76	75	74	73	72	71	70
Time(sec)	0	21	49	62	72	90	120	138	192	230



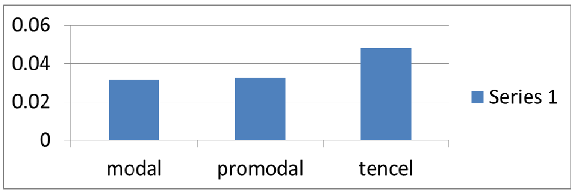
TENCEL

S.no	1	2	3	4	5	6	7	8	9	10
Temperature	82	81	80	79	78	77	76	75	74	73
Time(sec)	0	35	64	80	104	150	182	204	229	278



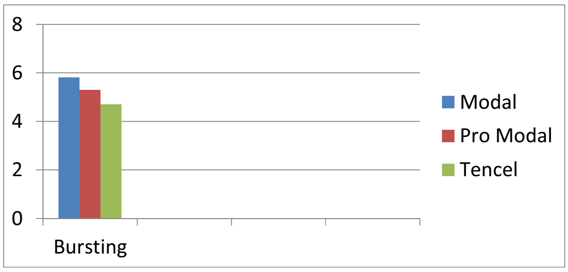
Thermal conductivity

s.no	modal	promodal	tencel
Thermal conductivity	0.0312	0.0327	0.0482



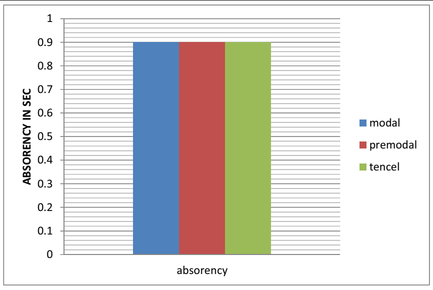
5.6BURSTING STRENGTH

s.n	modal	pro modal	Tencel
1	6.0	5.5	4.6
2	5.8	5.2	4.6
3	5.9	5.3	4.8
4	6.0	5	4.9
5	5.7	5.5	4.6
avg	5.8	5.3	4.7



5.7ABSORBENCY

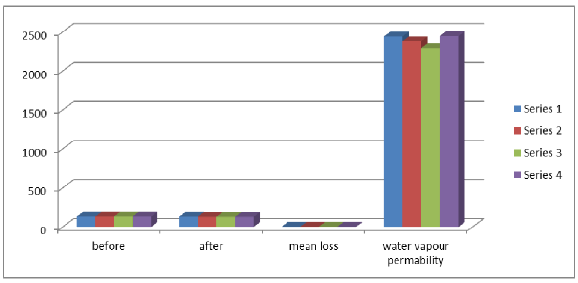
S:NO	MODAL	PRO MODAL	TENCEL
1	BELOW1	BELOW1	BELOW1
2	BELOW1	BELOW1	BELOW1
3	BELOW1	BELOW1	BELOW1



5.8WATER VAPOR PERMEABILITY

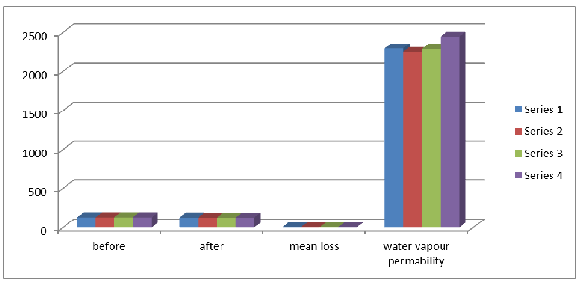
MODAL

S.no.	Proportions	Before Weight	After Weight	Mean loss	Water Vapour Permeability
1	100/0	164.86	156.30	8.56	7592.9998
2	90/10	161.31	153.40	7.91	7016.4285
3	80/20	125.66	117.96	6.7	5943.1190
4	70/30	140.8	134.68	6.12	5428.6400



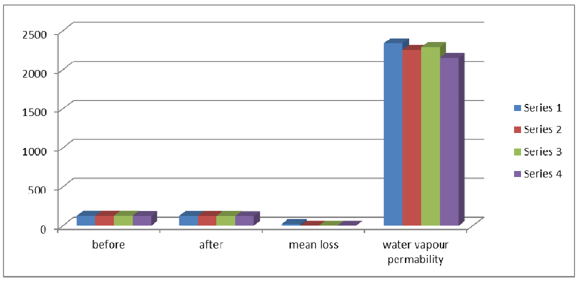
PROMODAL

S.no.	Proportions	Before Weight	After Weight	Mean loss	Water Vapour Permeability
1	100/0	164.86	156.30	8.56	2341.766
2	90/10	161.31	153.40	7.91	2253.063
3	80/20	125.66	117.96	6.7	2288.544
4	70/30	140.8	134.68	6.12	2155.489



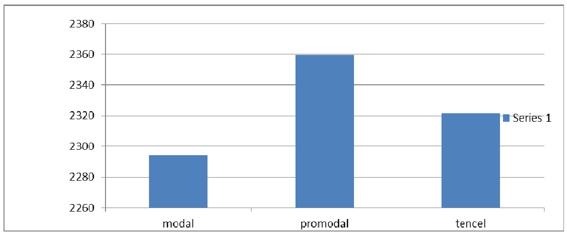
TENCEL

S.no.	Proportions	Before Weight	After Weight	Mean loss	Water Vapour Permeability
1	100/0	164.86	156.30	8.56	2297.415
2	90/10	161.31	153.40	7.91	2253.063
3	80/20	125.66	117.96	6.7	2288.544
4	70/30	140.8	134.68	6.12	2448.21



WATER VAPOR PERMEABILITY

s.no	modal	promodal	tencel
Water vapor permeability	2294.054	2259.72	2321.501



RESULTS:

- Water absorbency/wetting = Below 1 sec
- Thermal conductivity = m=0.00312, p.m=0.00327, ten=0.048200
- Water vapor permeability = m=2294.054,pm=2288.454, ten=2253.063(g/m^2 /Day)
- Washing fastness = 4-5 (5 - no change in colour, / no stainning) (4 - slight change in colour/slight stainning)
- Perspiration = 4-5
- Wick ability = m=142, p.m= 139, tencel=124
- Bursting strength = m=6 ,p.m= 5.7,ten= 5.2 Lbs
- GSM = m=100,p.m= 98, ten=100
- M-MODAL,P.M-PROMODAL,TEN-TENCEL

CHAPTER6

6.1CONCLUSIONS

TENCEL, PROMODAL, MODAL can be used effectively for the development of high performance sportswear provided that the fabric is carefully designed to maximize the contribution the TENCEL makes to the performance of the fabric.

TENCEL, PROMODAL, MODAL can serve as a permanent hydrophilic component as an alternative to hydrophilic topical treatments of polyester or expensive hydrophilic PES fibers.

- Better moisture absorption and buffering
- Equal moisture spreading
- Same drying rate
- Equal wet cling behavior
- A much better balance of water vapor permeability and thermal comfort
  A less synthetic look and touch
- Good absorbency
- Best moisture spreading
- Fastest drying rate
- Intermediate water vapor permeability index
- Good wet cling behavior

Compared to high quality 100% polyester sportswear, fabrics made using TENCEL, PROMODAL, MODAL in the outer layer give:

6.2 REFERENCE

Lenzing fibers -- Lenzing aktiengesellschaft, Austria Waterproof Breathable Active Sports Wear Fabrics –Sanjay S. Chaudhari, Rupali S. Chitins and Dr. Rekha Ram Kri

TENCEL,PROMODAL,MODAL can be used in minority blends with polyester as the outer layer of a two-layer construction to give high performance sportswear for athletic activities where sweat production is high. The fabrics produced have a non-synthetic look and touch.

TENCEL HIGH PERFORMANCE sportswearheinrich Firgo, Friedrich Suchomel, Tom burrowtencel HIGH PERFORMANCE SPORTSWEAR Heinrich Firgo, Friedrich Suchomel, Tom burrowtextile Innovation, Lenzing AG, Austria.