A Study on the Thermal Properties Of 100% Modal Fabric

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Abstract

The thermal comfort properties of fabric structures made from Modal yarns. 100% Modal is spun into yarns of identical linear density. Each of the yarns produced was converted to single jersey knitted fabrics, cross tuck fabric, cross miss fabric & twill fabric. The thermal conductivity of the fabrics was generally found to decrease with increase in the proportion of Modal fibre. The water vapour permeability and wicking of the fabrics were observed to increase with increase in Modal fibre content. Statistical analysis also indicates that the results are significant for water vapour permeability of the fabrics. Wicking test was also done which gives fabric absorbency of water that how much it takes.

Key words: Modal fabric, Water vapour permeability & Wicking.

INTRODUCTION

Knitting is a method of forming fabric from a single strand of yarn, using two needles. The resulting fabric has given more than woven fabric. It is a technique to turn thread or yarn into a piece of cloth. Knitted fabric consists of horizontal parallel courses of yarn which is different from woven cloth as said by Prakash. C (2012). The courses of threads or yarn are joined together by interlocking loops in which a short loop of one course of yarn or thread is wrapped over another course. Fabric can be formed by hand or machine knitting, but the basic principle remains exactly the same i.e. pulling a new loop through the old loop. A knitted fabric consist of forming yarns into loops, each of which is typically only released after a succeeding loop has been formed and intermeshed with it so that a secure ground loop structure is achieved by Koushik. C.V.

Modal is a wood pulp based cellulo sic fiber, made out of pure wooden chips fr om the beech tree, technically as the European Schneider Zelkova tree. While viscose rayon can be obtained from the wood pulp from a numb er of different trees, Modal uses only beec h wood thus it is essentially a variety of vis cose rayon; a generic name for modified vi scose rayon fiber that has high tenacity and high wet modulus.

Modal was first developed by Aust ria based Lenzing AG Company who trade marked the fabrics' name, but now many manufacturers make their own versions. It was initially imported from Czech Repu blic, Slovakia, Hungary and Germany; but now for Indian market, it is catered to by L en zing, Austria, which has tied up with Rajas than Textile Mills.

Thermal properties: Physical property of a solid body related to application of heat energy is defined as a thermal property. Thermal properties explain the response of a material to the application of heat. Important thermal properties are

- Heat capacity
- Thermal expansion
- Thermal conductivity
- Thermal stresses
- Air Permeability
- Water Vapour Permeability

Heat capacity: External energy required to increase temperature of a solid mass is known as the material's heat capacity, it is defined as its ability to absorb heat energy. Heat capacity is not an intrinsic property i.e. it changes with material volume/mass. Specific heat - For comparison of different materials, heat capacity has been rationalized. Specific heat is heat capacity per unit mass. It has units as J/kg-K or Cal/kg-K. With increase of heat energy, dimensional changes may occur. Hence, two heat capacities are usually defined. Heat capacity at constant pressure, Cp, is always higher than heat capacity at constant volume; Cv. Cp is only marginally higher than Cv. Heat is absorbed through different mechanisms: lattice vibrations and electronic contribution.

Thermal expansion: Increase in temperature may cause dimensional changes. Linear coefficient of thermal expansion (α) defined as the change in the dimensions of the material per unit length.

Thermal conductivity: It is ability of a material to transport heat energy through it from high temperature region to low

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temperature region. Heat energy transported through a body with thermal conductivity. It is a microstructure sensitive property and has units as W/m.K.

Thermal stresses: Stresses due to change in temperature or due to temperature gradient are termed as thermal stresses. Thermal stresses in a constrained body will be of compressive nature if it is heated, and vice versa. Engineering materials can be tailored using multi-phase constituents so that the overall material can show a zero thermal expansion coefficient. Eg.: Zerodur – a glass-ceramic material that consists of 7080% crystalline quartz, and the remaining as glassy phase. Sodium-zirconium-phosphate (NZP) have a near-zero thermal expansion coefficient.

Air Permeability: The air permeability is a very important factor in the performance of some textile materials. Especially, it is taken into consideration for clothing, parachutes sails, vacuum cleaners, fabric for air bags and industrial filter fabrics. The air permeability is mainly dependent upon the fabric's weight and construction.

Water vapour permeability: Water vapor permeability is a measure of the passage of water vapor through the material. It is also known as water vapor transmission rate (WVTR) or moisture vapor transmission rate (MVTR). It is the mass of water vapor transmitted through a unit area in a unit time under specified conditions of temperature and humidity. Breathability or also referred to as Water Vapor Permeability can be described as the ability of a fabric to allow moisture vapor to be transmitted through the material.

Wicking: Moisture transfer properties and drying rate of fabrics are two major factors affecting the physiological comfort of garments. Moisture transfer and quick dry behavior of textiles depend mainly on the capillary capability and moisture absorbency of their fibers. These characteristics are especially important in sport garments next to the skin or in hot climates. In these situations, it is critical that textiles are able to absorb large amounts of perspiration, draw moisture to the outer surface and keep the body dry. Therefore, in order to optimize these functionalities in sport clothing, and to support moisture management claims, it is necessary to determine the wicking behavior and quick drying capability of functional fabrics.

METHODOLOGY

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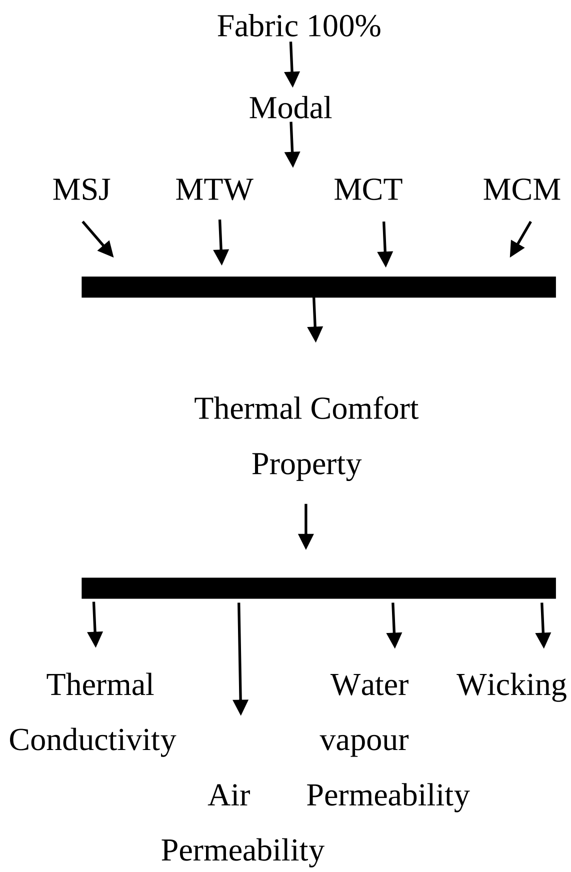
FLOW CHART



MSJ -Modal Single Jersey

MTW - Modal Twill

MCT - Modal Cross Tuck

MCM - Modal Cross Miss

Fabric Production

(Production of Weft Knitted Fabric with 0.30cm Loop Length)

The following stitch combination of fabrics are produced for our study

- Knit Stitch – Single Jersey
- Knit and Tuck – Cross Tuck
- Knit and Miss – Cross Miss
- Knit, Tuck & Miss – Knitted Twill

Single Jersey

Jersey fabric is a type of knit textile made from cotton or a cotton and synthetic blend. Some common uses for jersey fabric include t-shirts and winter bedding. The fabric is warm, flexible, stretchy, and very insulating, making it a popular choice for the layer worn closest to the body. Jersey also tends to be soft, making it very comfortable.

Tuck and miss stitch

Apart from the knitted loop stitch the two most commonly produced stitches are the tuck stitch and the miss stitch (float stitch).

Tuck

A tuck stich is composed of a held loop, one or more tuck loops and knitted loops. It is produced when a needle holding its loop also receives the new loop. The tuck loop assumes an inverted U-shaped configuration.

Miss

A miss stitch or float stich is composed of a held loop, one of more float loops and knitted loops. It is produced when a needle holding its old loop fails to receive the new yarn that passes, as a float loop to the back of the needle, and to the reverse side of the resultant stitch.

Twill

Twill is a type of textile weave with a pattern of diagonal parallel ribs (in contrast with a satin and plain weave). This is done by passing the weftthread over one or more warp threads then under two or more warp threads and so on, with a "step," or offset, between rows to create the characteristic diagonal pattern.[1] Because of this structure, twill generally drapes well.

THERMAL PROPRERTIES OF MODAL FABRIC IN WATER VAPOUR PERMEABILITY & WICKING TEST ARE DISSCUSSED BELOW.

Water Vapour Permeability Test

Water vapour permeability of fabric samples was determined using an SDL Atlas instrument (M261, USA) according to ISO 14596. A test specimen was sealed over the open mouth of a test dish which contains water, and the assembly was placed in a controlled atmosphere. After establishing equilibrium water vapour pressure gradient across the sample, successive weightings of the assembled dish were made and the water vapour permeation through the specimen was determined. The water vapour permeability (WVP) in g/m²/day was calculated by the equation;

$WWWWWW=24\times MM\ AA\times tt$

where M is the loss in mass of the assembly over the time period t (in g), t is the time between successive weighing of the assembly in hours, A is the area of exposed test specimen (equal to the internal area of the test dish (in m²).

Wicking Test

Wicking behaviour of fabric samples was determined according to DIN

53924. Ten specimens were cut along the warp and weft directions respectively to dimensions of 200 mm × 25 mm and suspended in a reservoir of 1% K2CrO4 with their bottom ends at a depth of 30 mm into the water. The height of the solution raised was measured and recorded in terms of mm after 60 seconds.

Moisture transfer properties and drying rate of fabrics are two major factors affecting the physiological comfort of garments. Moisture transfer and quick dry behaviour of textiles depend mainly on the capillary capability and moisture absorbency of their fibbers. These characteristics are especially important in sport garments next to the skin or in hot climates. In these situations, it is critical that textiles are able to absorb large amounts of perspiration, draw moisture to the outer surface and keep the body dry. Therefore, in order to optimize these functionalities in sport clothing, and to support moisture management claims, it is necessary to determine the wicking behaviour and quick drying capability of functional fabrics.

RESULTS AND DISCUSSION

In this study, the results on the thermal comfort properties of , water vapour permeability and wicking test has been seen and discussed.

The result of the study discussed below

Water Vapour Permeability Test

The bi-layer knitted structures of fabrics had higher water vapour transport than the other fabrics because their thickness and weight were lower than for the others fabrics. This is because, in a steady state, moisture vapour transport through fabrics is controlled by the diffusion process, which is influenced by the fabric structure.

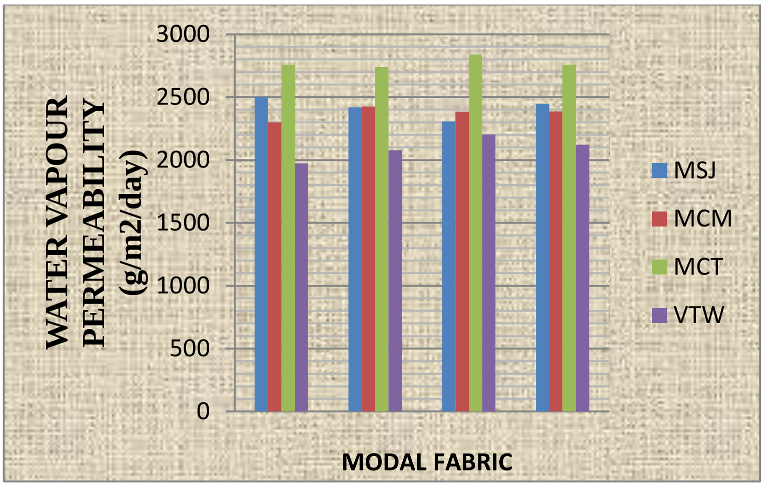
Water Vapour Permeability of Modal fabric

Water Vapour permeability of Modal fabric.

WVP (g/m2/day)	MSJ	MCM	MCT	MTW
1	2501.432	2300.371	2758.672	2268.269
2	2418.642	2424.556	2740.931	2299.949
3	2306.285	2383.161	2838.505	2084.527

4	2448.210	2389.075	2758.672	2306.285

Water Vapour permeability of Modal fabric.

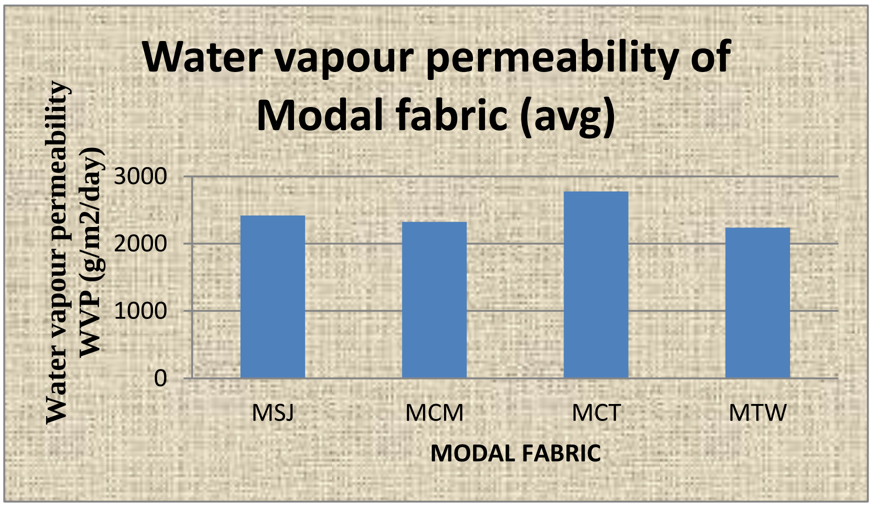


From the above Table & Figure it is clear that the fabric of Modal from the four structures in the test of the Water Vapour permeability of Modal Cross Tuck gives good result compared to single jersey, cross miss & twill

Table-Water Vapour Permeability of modal fabric – Average

WVP (g/m2/day)	MSJ	MCM	MCT	MTW
Avg	2418.642	2324.291	2774.195	2239.785

Figure-Water Vapour permeability Modal fabric- avg



From the above Table & Figure it is clear that the fabric of Modal from the four structures in the test of the Water Vapour permeability of Modal Cross Tuck gives good result compared to single jersey, cross miss & twill.

Wicking

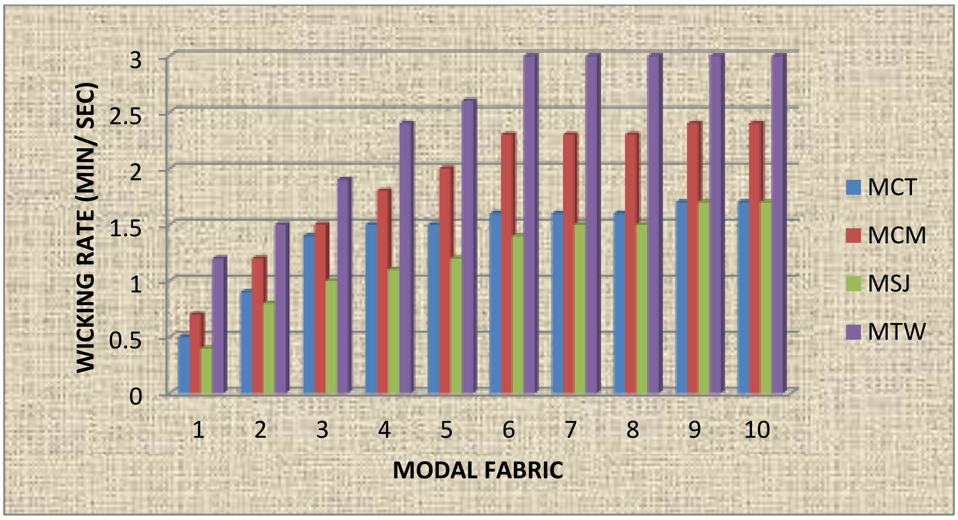
Wicking is the spontaneous flow of liquid in a porous substrate, driven by capillary forces. The capillary forces caused by wetting is wicking. The longitudinal wicking height determines the liquid transporting ability, and the faster the rate of wicking, the better the sweat transporting ability will be, hence the fabric feels more comfortable to wear.

Wicking test of Modal fabric.

Table -Wicking test of Modal fabric.

S.NO	MCT	MCM	MSJ	MTW
1	0.5	0.7	0.4	1.2
2	0.9	1.2	0.8	1.5
3	1.4	1.5	1	1.9
4	1.5	1.8	1.1	2.4
5	1.5	2	1.2	2.6
6	1.6	2.3	1.4	3
7	1.6	2.3	1.5	3
8	1.6	2.3	1.5	3
9	1.7	2.4	1.7	3
10	1.7	2.4	1.7	3

Figure- Wicking test of Modal fabric.



From the four structural variation of modal that is Modal single jersey, Modal twill, Modal cross miss and Modal cross tuck we get the result that in wicking test modal twill gives good result.

Summary & Conclusions

A "Warm – cool feeling" is a very important property, as a result of which a human can feel comfort or discomfort in various activities and environmental conditions. This feeling could be achieved by using different types of yarns. It was determined that higher air permeability is characterized for knits manufactured only from pure yarns.

The thermal comfort properties of single jersey fabrics made from yarns of 100% Modal yarns were investigated.

water vapour permeability are significantly affected by the Moisture Vapour Transport. An increase in the Modal fibre content in the fabric affects the thermal comfort properties. The wicking height of woven fabric, with longer yarn floats and less crimped yarns, is the highest. Increase in weft yarn density leads to a decrease in porosity, due to increased warp yarn crimp and therefore a decrease in wicking height.

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