EFFECT OF MOISTURE TRANSMISSION AND ABSORPTION THROUGH SINGLE JERSEY KNITTED FABRIC

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ABSTRACT

Garment physiology & environmental behavior, comfort &lifestyles have become the components of modern fabric creations. garments that light up garments against stress, garment with ultraviolet ray blockers ,garments with air conditioning gall this is not science, fiction, but a reality .The terms comfort clothing what we really mean is the comfort the wearer on use of certain clothing of textile items. The most imp. Property of any apparel is comfort. It is a qualitative term & it is i.e. physiological, tactile &thermal comfort .physiological comfort is mainly related to the latest fashion trend & the acceptability & bears little relation to the properties of fabric. Moisture is in the form of sensible and insensible perspiration to be transmitted from the body to the environment in order to cool the body and reduce the degradation of the thermal insulation of the fabric caused by moisture build up. So from the point of view of comfort this paper deals with most significant property of fabric which is moisture transmission and process of liquid transmission through fabric layers

Keywords: Moisture Transmission, Mechanism of Moisture Transmission, Process Involved In Moisture Transmission, Wetting, Wicking, Methods & Material Used

I INTRODUCTION

Moisture flow through textile materials is important in diverse range of textile applications including casual wear, sportswear, and protective wear from their comfort point of view, textile processing and cleaning, composite manufacturing liquid transfer through pre-form and in many other areas

From the comfort point of view moisture transmission through textile material both in liquid and vapor firms are equally important. Liquid moisture flow through textile materials controlled by wetting and wicking

The tactile comfort has relationship with the fabric surface & mechanical properties .the thermal comfort is related to the ability of the fabric to maintain the temp. of the skin through transfer of heat and perspiration generated within the human body.(1)

Thermo physiological wear comfort concerns with the heat and moisture transport properties of clothing and the way it helps the clothing to maintain the heat balance of the body during various levels of activity. It is known that the textile fibers take up moisture from the air. The properties of absorbing moisture is a valuable feature of clothing materials. Apart from its direct utility in keeping the skin dry the absorption of moisture causes the fabric to act as a heat reservoir, protecting the body from sudden changes of external conditions .(1)

Knitted fabrics are preferred for athletic wear because heat & liquid sweat generation during athletic activities must be transported out & dissipated to the atmosphere. As it is clear from the above study that the moisture transmission and the dryness are the two equally important parameters to check the comfort level of the fabric. So, we can say that moisture transmission and dryness are two important aspects to check the comfort level in single jersey knitted fabrics. We can also use woven fabric for testing of moisture transmission and dryness of the fabric, but in this study we have used single jersey knitted fabrics. (1)

II MECHANISM OF MOISTURE TRANSMISSION STUDY

The moisture transmission behavior of a clothing assembly plays a very important role in influencing its efficiency with respect to thermo physiological body comfort. This paper is in two parts:-

Part-1 deals with the processes involved in moisture transmission and the factors at play

Part-2 is concerned with selecting the measurement techniques which are of great importance of determining fabric factors that influence fabric comfort.

The instruments and method used for testing purposes should adequately simulate the exact conditions for which fabric will be used in order to determine the effectiveness of that fabric for a particular wearing situation and environmental condition

The testing methods used and the apparatus developed for determining moisture transmission through textiles by different mechanisms are discussed in this paper. Moreover, The fabric which is in contact with the skin should be dry to the touch otherwise heat ,which flow from the body will increase and Causing unwanted loose in body heat and a clammy feeling. for a particular end use it is necessary to design fabrics with required moisture transmission properties. (1)

The chosen experiment procedure is the most important consideration to be followed during the evaluation of the moisture transmission properties of the fabric and clothing system.

Moisture and heat transfer through a fabric is measured in two conditions:

1)Steady state

2Ttransient state

Steady state experiments provide reliable heat and mass transfer data for non active case but they cannot explain heat and mass transfer mechanisms in actual wearing condition.

The human body is rarely in a thermal steady state, but is continuously exposed to transients in physical activity and environmental conditions.(2)

III PROCESSES INVOLVED IN MOISTURE TRANSMISSION THROUGH FABRIC

Under transient humidity conditions is an important factor which influences dynamic comfort of the wearer in practical use. Moisture may transfer through textiles material in vapor and liquid form.

The water collected in each of the bazels is measured and the mean volume calculated to the nearest milliliter(2)

Absorption:

From the weight of each specimen before and after the test ,the percentage of water retained by each specimen is calculated as follows:

$$\text{Absorption} = \frac{\text{Wt of water absorbed}}{\text{Original wt. of test specimen}} * 100$$

The mean of for results is calculated and reported .During testing the following points must be considered:

Temperature	=	18-20degree c
Ph of water	=	6-8
Rate of flow	=	62-68 ml/min/bezel

Drops of uniformly spaced and the fabrics to be conditioned for at least 24hours in a standard atmosphere.

Specimens to be weighed in air light containers.

Surplus water to be removed by six sharp shakes with arm outstretched in a horizontal position.

IV METHODOLOGY OF MOISTURE TRANSMISSION AND WETTING OF FABRIC

It is the ability of the fabric to take up a liquid. It is a term related the warmth of a fabric. If a fabric permeable to air but does not absorb water, evaporation of perspiration takes place from the skin and skin temperature falls. This is the phenomena which occurs when on fabrics are worn .If the fabrics absorbs the perspiration, however, evaporation takes place from the fabric and from the skin before chilling does not occur.(2)

Generation of metabolic sweat is a natural outcome of a person involved in strenuous activity, The absorption of the sweat by a garment and its transportation through and across the fabric where it is evaporated are claimed by some researchers to add comfort. The measurement of absorption is therefore of typical interest. A no. of test methods have been devised and many of these have been adopted as standards , but these tests give only fragmented information on the absorptive capabilities of a fabric. These are the vertical-strip and porous plate tests.

Method that measure both these parameters are qualitative. These is therefore a need to develop a test method that will quantitatively determine both absorption and wicking properties , in order to obtain much broader information about the moisture transmission.(2)

The following are the ways in which water can pass through a fabric:

1)By wetting the fabrics, followed by capillary action which brings the water to the other side

2)By the pressure of water, forcing it through the openings of the fabric.

3)By the combination of the above two sections.

The absorption desorption processes play a major role in vapour transport through hygroscopic materials.

In the presence of air flow ,the forced convection process play a significant part in carrying moisture from the skin to the atmosphere ,through the fabric layers. In the case of a windy atmospheric condition or the movement of air under clothing, corresponding to an" inner wind" due to body movement. This is known as pumping effect, The moisture transmission by convection process plays a significant part in carrying moisture from the skin to the atmosphere, through the fabric layers ,specially in the case of the highly porous textile layers.

The confirmed air layer close to the skin does not behave as passive barrier. This is place where strong convective movements takes place, due to its vertical dominant disposition and by the separation of a few centimeters between too surfaces(skin and internal fabric)with sufficient amount of pressure gradient.

V METHODS OF MEASURING LIQUID MOISTURE TRANSMISSION

Liquid moisture transmission through a textile material consists of two processes-
a)Wetting
b) Wicking
In the wetting process the fiber air interface is replaced with a fiber liquid interface and wicking starts as the liquid enters into the capillary formed by two adjacent fiber or yarn(3).

5.1 Wetting

Wetting is the ability of a liquid to maintain contact with a solid surface, resulting from intermolecular interactions when the two are brought together. The degree of wetting is determined by a force balance between adhesive and cohesive forces.(3)

Wetting is important in the bonding or adherence of two materials. Wetting and surface forces that control wetting are also responsible for other related effects, including so called capillary effects.(3)

Wetting Depends On The Following Factors:

Wetting is primarily depending on the solid surface and the properties of a solid material as well as the liquid use. Therefore by manipulating the properties of surfaces one can optimize the function or performance of a solid surface or the material for the purpose of interest. Likewise, if modifying the liquid of interest to achieve the desired wetting conditions.

Examples of applications where solid surface wet ability plays a crucial role are body implants, contact lenses, bio-materials, fabrics, super hydrophobic surfaces, self-cleaning and non-sticky surfaces[3]

5.2 Wicking

In the absence of external forces the transport of liquids into fibrous assembly is driven by capillary forces that arise from the wetting of the fiber surfaces. If the liquid does not wet the fabrics it will not wick into the fibrous assembly. In the case of contact angle above 90°, liquid in a capillary is depressed below the surface instead of rising above it. In order for wicking process to take place spontaneously. The balance of energy has to be such that energy is gained as the liquid advances into the material.

Wicking depends upon the wettability of fiber surfaces. In contrast to diffusion of water vapor, wicking increases as moisture regain decreases because the water is not absorbed by the fibers. Whether a fabric feels wet to the touch depends not only on whether it has absorbed moisture but also on fiber properties. Garments that have become wet usually feel clammy against the skin.[4]

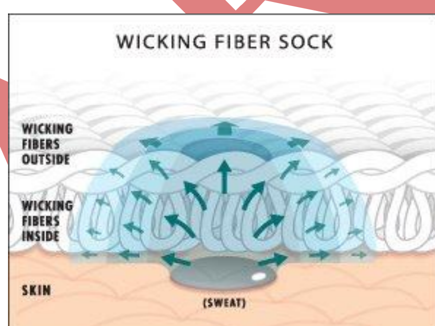


Fig: Drymax fibers vs wicking fibers

The mechanism by which moisture is transported in textiles is similar to the wicking of a liquid in capillaries. Capability action is determined by two fundamental properties of the capillary its diameter and surface energy of its inside face. The smaller the diameter or the greater the surface energy , the greater the tendency of a liquid to move up to the capillary. I n textile structures , the spaces between the fibers , the greater the ability of the fabric to wick moisture.[4]

VI THE SEVERAL FACTORS AFFECT THE MOISTURE TRANSPORT IN A FABRIC ARE

1) Fabric construction
2) Fiber type

3) Wt. of thickness of fabric

4) Effect of chemical treatment

5) Wicking behavior of knitted fabrics

VII MATERIAL AND METHODS

7.1 Material

The following materials were selected to produce the single jersey knitted fabrics for analyzing the effect of moisture transmission properties on knitted fabrics

1) Lycra as a core and cotton as sheath core yarn 30s resultant count

2) Lycra as a core and viscose as sheath core yarn

3) 100% cotton knitted fabric

The Lycra and cotton core yarn, Lycra and viscose core yarn were produced as resultant count 30s by ring frame with core yarn attachment device. The cotton yarn was produced by ordinary ring frame resultant count 30s.

The single jersey knitted fabric:-

The cotton , cotton Lycra core yarn and viscose Lycra core yarn plain knitted fabrics were produced by single jersey knitting machine. The all knitted fabrics parameters are same like GSM, wales per inch, coarse per inch, stitch length etc; and then the fabrics were bleached using sodium hypo chlorite.[5]

7.2 Testing Methods

The moisture transmission effect in core spun yarn knitted fabric (single jersey) is tested in the following ways and the results are compared with 100% cotton knitted fabrics.

1) Strip test: - A strip of the test fabric, pre conditioned at 25degree Celsius, 65% RH was suspended vertically with its lower end immersed in a reservoir of distilled water. The height reached by the water in the fabric above the water level in the reservoir was measured from the wicking height.

2) Absorbency test:- A method for assessing absorbency is sometimes used to demonstrate differences in absorbency among various fabrics. In this simple method a fabric specimen is placed in a beaker of water, and the time required for it to become completely submerged recorded [6]

7.2.1 Moisture Transmission Method

Water method

In this water method, the dish contains distilled water. In this method the assembly is weighed periodically, and the weight decreases as moisture transfer from the dish through to the fabric to the outside of the environment.

In this test , the water gradually moves from the moist environment through the fabric dryer environment at a rate dependent on the fabric moisture transport properties. The results of the rate of water vapor transmission are represented graphically by plotting the dish weight against time.(7)

VIII Testing Of Knitted Fabric to Check the Moisture Transmission and Dryness of the Fabric

8.1 Type of sample used for testing

Single jersey knitted fabric

NO OF SAMPLES TAKEN:

Before wash=27 Samples

After wash=27 samples

8.2 Chemical Used

Distilled water, detergent, (Brand: ezee, manufacturer, Godrej Soaps ltd. , Mumbai)

8.3 Temperature and Humidity

Temp=20°c

RH=65%

8.4 Procedure

Fabric sample preparation:-

9 fabric samples were prepared on a circular knitting machine with following specification:

8.5 Given

The fabric samples were conditioned for 48 hours in a room at 20°C &65% RH. The fabric parameters such as wales/cm, coarses/cm, measured stitch length & thickness were measured in the laboratory, following the standard procedure:

	Wales/cm	***Coarse/cm***	***Thickness (in mm)***	***Measured stitch length (in mm)***
F7 / 24	16	12	0.508	2.61
F8 / 24	16	12	0.521	2.74
F9 / 24	15.3	10.5	0.518	2.93
F0 / 24	15	9	0.505	2.85
F1/ 20	15	10	0.541	2.84
F2 / 20	15	11.3	0.555	2.60
F3/ 20	16	12.3	0.548	2.75
F4/ 20	16.3	13.3	0.565	2.60
F6/ 36	17	10	0.438	2.5

8.6 Procedure for Washing and Drying

For washing we have divided samples in two sets.

1. Before wash sample
2. After wash sample

Table 1 (detail of quality parameters of yarns)

T)	TEX TWIST FACTOR(TM)	MEASURED TEX MEAN C.V.%	TENACITY mN/Tex	Elongation %	Unevenness U%	Imperfection /1000m THIN PLACES	THICK PLACES	NEPS
)[5])	33.5 (3.5)	29.54 (1.70)	187.9	4.63	8.24	0	10	122
	36.4 (3.8)	29.03 (1.36)	151.9	4.85	8.4	0	3	160
	39.2 (4.1)	29.51 (1.77)	240.9	5.0	8.28	0	8	210
)[5])	33.5 (3.5)	24.10 (2.36)	164.2	4.37	9.08	0	22	162
	36.4 (3.8)	23.76 (2.0)	198.7	4.79	8.36	0	8	133
	39.2 (4.1)	23.74 (1.93)	201.5	4.65	8.51	0	17	152
)[5])	33.5 (3.5)	29.68 (1.78)	210.9	4.25	9.09	0	18	60
	36.4 (3.8)	29.64 (2.33)	177.3	4.14	9.12	0	15	80
	39.2 (4.1)	30.22 (1.61)	201.2	4.64	9.43	3	30	115
	33.5 (3.5)	16.36 (0.96)	145.7	3.87	9.7	0	45	65
	36.4 (3.8)	16.64 (1.35)	169.5	3.95	9.82	0	48	122
	39.2 (4.1)	16.53 (0.84)	177.4	4.1	10.25	2	57	80

Before wash

The 9 samples were tested 3 times making 27 readings, each for before wash & after wash. The before wash samples were cut into uniform sizes of 100 cm sq. by using G.S.M cutter. These samples were weighed in dry state in an electronic balance with ±0.0001 accuracy

Chemical used:- Distilled water, detergent(brand-ezee, manufactuer , godrej soaps ltd.Mumbai)

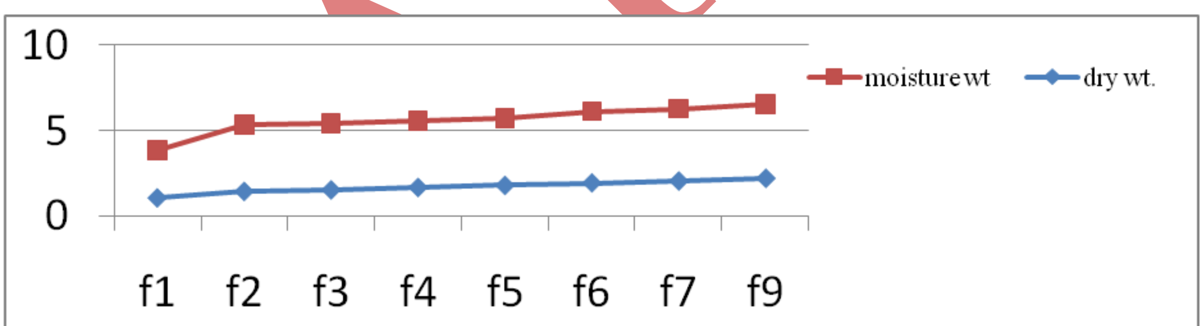
After wash

In this process we have taken 27 samples and immersed in ezee solution in a bucket and left the samples to be wet completely for 12 hours. After the complete process of wetting samples were weighed in wet state in an electronic balance with ±0.0001 accuracy. After weighing the samples were hanged to remove the loose water. Samples took 7-8hours for the removal of loose water at that time we have again weighed the samples. Then we had left the samples to get dry in standard atmospheric conditions in a room. After drying these samples were again weighed to check its dryness.

Table 2(specifications of circular knitting machine)

SPECIFICATION	***SINGLE JERSEY***	***INTERLOCK***
MAKE	STM Knitting Machine Manufacturers, Ludhiana	STM Knitting Machine Manufacturers, Ludhiana
Number of feeders	48	48
Diameter of machine	24 inch	24 inch
GUAGE OF MACHINE	16, 20 & 24	24
RPM of machine	2 – 40, step less	2 – 40, step less
Positive Feed Device	Yes	Yes
Type of creel	Side creel	Side creel
Adjustment for stitch length	Yes	Yes, both in dial and cylinder
Fabric take-down system	Adjustable belt & pulley type	Adjustable belt & pulley type
Number of needles	1192, 1524 & 1800	3678

IX GRAPH SHOWING RELATION B/W FABRIC SAMPLES AND WEIGHT



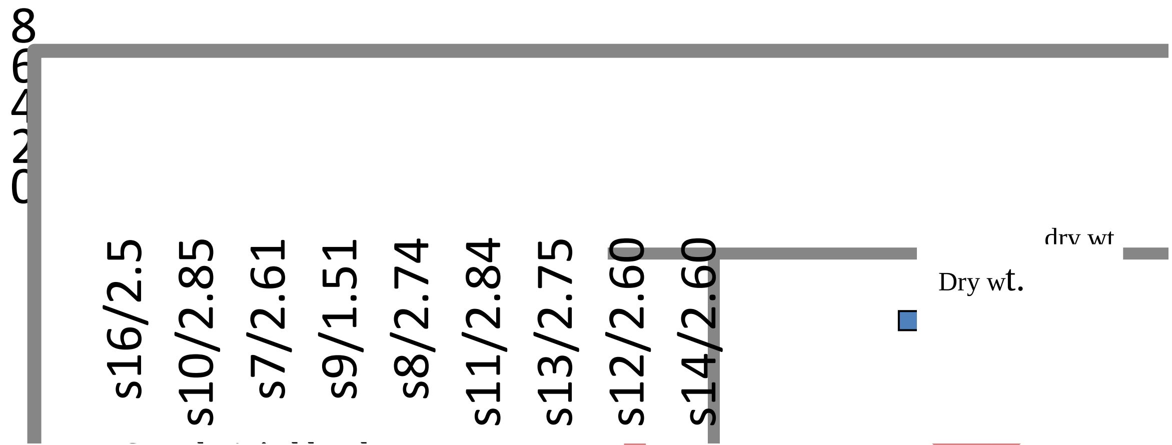
9.1 RESULT

Here we have shown the graph for samples and their moisture weight and dry weight.

The moisture weight and dry weight both increases as the stitch length of the samples decreases for 24s count. Similar trend is observed for 20s count also. However the values of both moisture and dry weights are higher for 20s count than 24s count. This is to be expected since increasing stitch length decreases the fabric weight and 20s count being coarser than 24s fabric weight are higher than with this count than 24s count.

The role of moisture in the fabric under control conditions of experiment is following the expected trend meaning that higher dry weight retains higher amount of moisture.

X GRAPH SHOWING RELATION B/W STITCH LENGTH & WEIGHT



10.1 RESULT

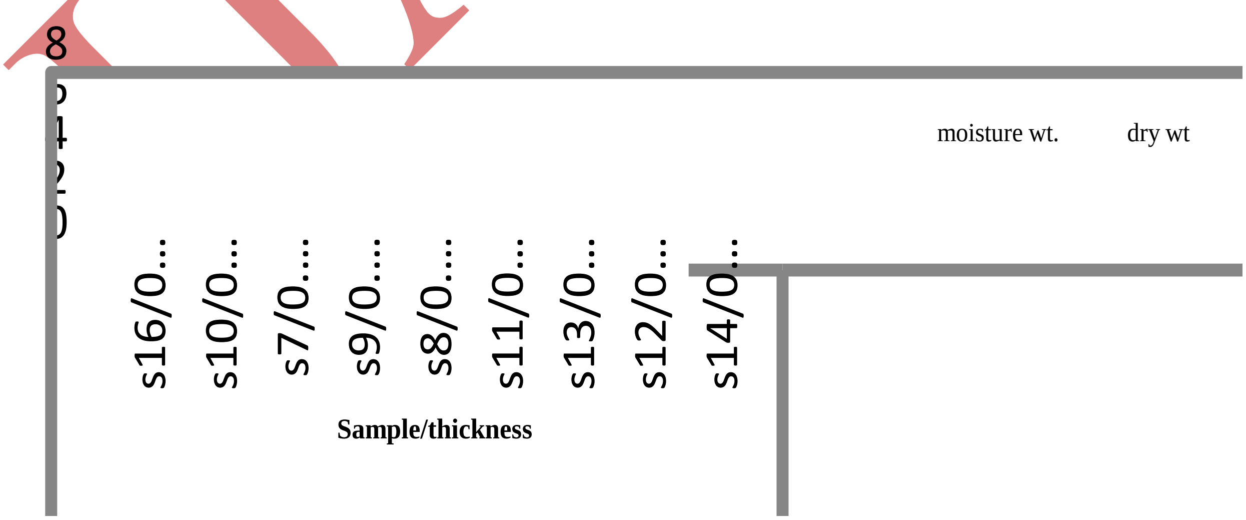
The fabric wt. in both dry and moisture wt. decreases as stitch length increases. This is obvious because lower SL means tighter fabric and more fabric wt.

The addition of moisture is in the fabric is consistent with the wt. of dry fabric sample. This indicates the dry wt. The higher the dry weight. The higher will be the moisture wt. of the fabric samples

10.2 CONCLUSION

The dry weight and moisture wt. decrease as stitch length increases, since weight of the fabric is inversely proportional to stitch length and absorption of moisture in the fabric is higher with dry weight

XI GRAPH FOR THICKNESS V/S DRY WT. & MOISTURE WEIGHT



11.1 RESULT

The graph of dry weight against fabric thickness shows a more or less consistent curve as the fabric thickness increases although to a very small extent. However, there is an abrasion with fiber thickness of 0.508mm which may be due to some error in measurement.

The graph of moisture wt. against thickness shows wt. against thickness shows a more or less increasing trend that means moisture weight increases with increase in thickness, although the graph is not exactly linear. The increment is not exactly same. This means the amount of moisture depends on some factors beside thickness which has not mean taken into consideration in this experiment.

11.2 CONCLUSION

Both the dry wt and moisture wt. of the fabric increases with thickness. The increases for dry wt. is more consistent than the moisture wt. except in one sample. Although, the general trend for moisture shows increase with thickness but the relationship is not exactly linear indicating presence of some other factors in the phenomenon of moisture absorption by fabrics.

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