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RESEARCH ARTICLE

A REVIEW ON MOISTURE TRANSMISSION PROPERTIES THROUGH TEXTILE CLOTHING

Suman Bhattacharyya
Assistant Professor, Department of Textile Technology, Technological Institute of Textiles and Sciences, Bhiwani-127021.

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Abstract

Thermo-physiological comfort is one of the important aspects of clothing which enable to maintain a constant body temperature through the thermal balance of the heat generated by a person's body and to transfer it to the atmospheric environment. The thermo-physiological comfort of the clothing is mainly influenced by its moisture transmission ability and thermal resistance. This is due to the clothing comfort sensation is mainly determined by a balance process of moisture and heat exchange between the human body and the environment through the clothing system. The current paper aims to enhance the understanding of mechanism involved, various influencing parameters, current research regarding moisture transmission properties of fabric.

Introduction:-

In today's world, consumers are increasingly searching for clothing that is not only aesthetically appealing but also provides thermo-physiological comfort. Apparel plays an important role in providing psychological and physiological comfort, helping to maintain the body's physical condition, essential for survival in challenging environments and during various active sports. A number of factors governs the thermo-physiological comfort properties of fabrics like the ability to dry heat transfer, moisture transmission, air permeability, thermal absorptivity etc.The moisture transport phenomena of textile apparels are thoroughly examined in this review work.

Importance of Moisture Transport Properties:

The moisture transmission ability of a fabric, either in the form of vapour or liquid, is a crucial factor in determining the thermo-physiological comfort of a wearer in general and during active sports in particular. The moisture transport through fabric occurs in two distinct ways:

(a) Insensible perspiration (in the form of vapour) and (b) Sensible perspiration (in the form of liquid)

The insensible perspiration produced by the human body as a result of metabolic activities which helps to regulate body temperature, should pass through the fabric of clothing. If the rate of perspiration exceeds the rate at which it can escape through the fabric, moisture will condense into liquid and accumulate in the microclimate between the skin and the clothing. This can lead to an uncomfortable feeling. Further, the thermal insulation property of a fabric breaks in wet conditions. The situation worsens during active work in very cold conditions, where the accumulated moisture may freeze, potentially causing frostbite. This can lead to a reduction of core body temperature, a condition known as hypothermia, which can be fatal in extreme cases.

Corresponding Author:-Suman Bhattacharyya
Address:-Assistant Professor, Department of Textile Technology, Technological Institute of Textiles and Sciences, Bhiwani-127021.

Mechanism of moisture transmission in form of vapour:

The moisture vapour transmission property of a fabric is essentially governed by inter-yarn or inter-fibre spaces. The water vapour can easily pass through the textile material mainly through inter-yarn or inter-fibrespaces present in the clothing. Apart from this,moisture vapour can diffuse through the fibre or yarn capillaries and through absorption, transmission and desorption of water vapour by the fibres.While the diffusion through the fabric, moisture vapour has to overcome the resistance offered by different layers which include (a) the evaporating fluid layer, saturated with water vapour (b) the air layer, confined in the clothing microclimate (c) the air layer in the boundary (immediate to the outer surface of the clothing) and the ambient air layer. The moisture vapour resistance primarily depends on the air permeability of the fabric, which represents its ability to transfer perspiration from the human skin. The resistance offered by the fabric is lower than that of the external boundary layer and often much lower than the inner confined air layer between skin and fabric.The diffusion of moisture vapour through a fibrous assembly depends on the vapour pressure gradient, which causes moisture to move from areas of higher concentration to regions of lower concentration. The relationship between the flux of the diffusing vapour and the concentration gradient is described by Fick's law[1], which states that the rate of moisture flux (J_{Ax})is directly proportional to the concentration gradient (dC_A/dx) Mathematically this is represented as follows:

$$J_{Ax} = D_{AB}\frac{dCA}{dx}$$

where,

dx=equivalent air thickness;dC_A =concentration difference between two layers; and D_{AB} is the diffusion coefficient which is independent of the moisture vapour concentration within the material and changes in temperature. Pause et al [2] found that at a specific concentration gradient, the moisture vapour diffusion rate through textile materials depends on the material's porosity and the fibre's water vapour diffusivity. The diffusion coefficient for water vapour is 0.239 cm^2/s in air and about 10^{-7} cm^2/s in cotton fabric. Hence moisture diffusion through air gap is nearly instantaneous, while diffusion through the fabric is restricted by the slower movement of moisture into and out of the fibres due to the lower diffusivity of the textile material. In the context of hydrophilic fibre assembly, vapour diffusion does not completely conform to Fick's law, resulting in a two-stage diffusion process. At the initial stage diffusion takes place following Fick's Law; however, the subsequent stage, which occurs at a much slower rate, exhibits an exponential relationship between the concentration gradient and vapour flux. This diffusion phenomenon can be attributed to the swelling of the fibres.

Factors affecting moisture vapour transfer:

Effect of fibre properties

Li and Holcombe [3] investigated the transfer of moisture vapour through fabrics made ofhydrophilic and hydrophobic fibres. Using multiple mathematical models,they observed that the mechanisms involved in dynamic moisture transfer in the two cases are different and hydrophilicfibres show greater mass and energy exchange with the environment than hydrophobic fibres. The moisture diffusivity of a textile material is influenced by fibre volume fraction. With the increase in fibre volume fraction, the proportion of air within the fibrous assembly decreases, this in turn reduces the total diffusivity. The moisture diffusivity through the fabric decreases with an increase in the flatness of the fibre cross-section. The polymeric structure of cotton is highly crystalline and the tightly packed crystalline structure of cotton makes cotton fibre less permeable to water vapour [4]. Prakash and Ramakrishnan [5] investigated the thermal comfort properties of fabrics made of cotton and bamboo blended yarns.They found that increase in water-vapour permeability of fabrics with the increase in bamboo fibre content in the yarn. However, due to the presence of hydrophilic groups at the Textiles polymer backbone of the cellulose polymer, cotton fibres show excellent water absorbency. Varshney et al. [6] investigated the thermos-physiological comfort of polyester fabrics with varying degrees of fibre fineness and found that moisture vapour permeability of fabrics increased with the fibre fineness.The dynamic moisture-vapour transfer through bilayer textiles composed of cotton (C) and polyester (P) in several combinations, including C/C, P/C, C/P, and P/P, was examined by Kim and Spivak [7] . According to the study, the hydrophilic fibre-containing layer's inner surface had a lower partial moisture-vapour pressure because of its high absorption of moisture vapour, whereas the hydrophobic fibre-containing inner layer had a higher partial moisture-vapour pressure because of its low absorption rate.

Effect of yarn parameters:

The yarn properties like yarn count, yarn have a significant influence in determining the moisture vapour permeability, with finer yarn and higher degree of twist water vapour permeability values increase. The combing process has the same effect on the thermal properties. Tyagi et al. [8] found that fabrics woven from compact spun yarn demonstrate significantly greater water vapour permeability than their ring yarn counterparts. This enhanced permeability is likely due to the greater compactness, reduced hairiness, and smaller diameter of the compact spun yarn. These factors contribute to a thinner fabric with larger inter-yarn spaces, which promotes easier movement of vapour. Sharma et al. [9] investigated moisture transmission through the knitted fabrics produced with 100% polyester and 80/20 polyester /cotton blended ring and vortex spun yarns and observed that with vortex spun yarn air and water vapour permeability is better than that of ring yarn counterpart. A comparative analysis with knitted fabric from conventional ring-spun, siro-spun, compact yarn has also been made by Madanet al. [10]observed that single jersey knitted fabrics made from Eli-Twist compact yarns exhibit higher air and water vapour permeability followed by fabrics from ring and siro -yarns. Further , lower air and water vapour permeability is observed for cotton knitted fabric as compared to polyester knitted fabric

Effect of fabric construction:

Greenwood, Rees and Lord [11]studied the different mechanisms by which water move through a fabric and pointed out that fabric structure plays important role in determining the water vapour permeability. Gogalla[12] studied the effect of fabric properties and of finishing treatment on moisture vapour transport and considers the changes brought about by texturing, different yarn twist, blending, different mechanical treatments and chemical finishing and opined that air permeability and moisture vapour permeability are closely related i.e. the factors affecting the air permeability also affect moisture vapour permeability in a similar fashion. Weiner [13]by using different mathematical models identified, that both the density and thickness of the fabric are critical factors that significantly influence its moisture vapour transport capability at a specified temperature.Stoffberg et al. [14] observed that the fabric thickness was negatively correlated with the water-vapour transmission rate. Fahmy [15]developed equations through multiple regression analysis to predict fabric moisture vapour transfer properties and opined that weave variations and construction factor interactions significantly impact these properties. Behra et al. [16]examined the water-vapour resistance of fabrics made from different yarn constructions, including ring, rotor, and friction-spun yarns. Their findings indicated that the ring-twill fabric exhibited the lowest water-vapour resistance, followed by friction plain, ring plain, and rotor plain fabrics. The researchers attributed the enhanced performance of the ring-twill fabric to its lower cover factor.Limeneh et al. [17] investigated the thermal comfort properties of different weave structures (i.e., plain, twill, and satin) made of 100% cotton yarns. The fabrics had the same e.p.i and p.p.i and yarn linear density. The results showed that the satin and twill structures exhibited higher water vapour permeability, water absorption rate, and air permeability than the plain structure.This result was attributed by the authors to the amount of yarn interlacements in the fabric structure. They suggested that since the satin structure has a lower number of interlacements, the length of void channels through the fabric structure where air and water vapour can travel increases. On the other hand, the plain structure had the highest number of interlacements, which caused poor moisture vapour and air transport properties through the fabric

Kothari et al. [18] established that the water vapour transfer rate of cotton fabric decreases as the cover factor and solid content increase, irrespective of the weft count. Furthermore, the swelling of cotton fibres causes a reduction in the size of the fabric's pores. leading to a diminution of the permeability of water vapour. Shobanasree et al. [19] studied the effect of elastane on lyocell-based single jersey knit structures and found that air permeability, and water-vapour transmission rate had a negative correlation with the elastane content. These relationships were attributed to the fact that the presence of elastane in the fabric structures increases the fabrics' tightness

Liquid water transfer through wicking and water absorption:

Wicking plays a vital role in facilitating quick drying and enhanced cooling in hot environments or when sensible perspiration (in liquid form) is present on the skin. Fabrics with high wickability allow moisture from the skin to disperse throughout the material, creating a dry sensation. This distribution of liquid promotes rapid evapouration over a larger surface area. Consequently, wicking is essential for ensuring comfort in clothing intended for tropical climates or active wear.

Mechanism of wicking

The transmission of moisture through textile materials in liquid form primarily results from the molecular attraction between the fibres and water at the fibre surfaces. This attraction is predominantly influenced by surface tension, effective capillary action, and pore distribution. The process of liquid transfer through a porous structure consists of two distinct stages: first, wetting, followed by wicking. The forces acting at the solid-liquid boundary under equilibrium conditions are typically expressed by the Young-Dupré equation [20]as mentioned below:

$\gamma_{sv}-\gamma_{sl}= \gamma_{lv}\cos\theta$

In this context, γ represents the tension at the interface among solids (S), liquids (L), and vapours (V), while θ denotes the contact angle between the liquid drop and the surface of the solid to be wetted. For textile materials, the fibre serves as the solid component. Wettability is evaluated based on the contact angle; a lower angle indicates greater wettability. Wettability improves as the surface tension at the solid-liquid interface decreases, but higher liquid density and viscosity can result in reduced wettability. Increased surface roughness facilitates faster water spreading, which lowers the apparent wetting angle. The chemical nature of the surface also plays a significant role; hydrophilic surfaces reduce the contact angle, enhancing wettability. Furthermore, as the roundness and diameter of fibres decrease, wettability is further improved. [21]

When a liquid wets the fibres, it effectively fills the spaces between them, generating capillary pressure. This pressure propels the liquid along the capillary, driven by the curvature of the meniscus within the narrow pores. The variations in capillary pressure throughout these pores facilitate the fluid's distribution within the material. Consequently, a liquid that fails to wet the fibres cannot wick into the yarn or fabric. This ability to maintain capillary flow is termed wickability. The volume of water wicking through a channel is directly proportional to the pressure gradient. However, research by Miller [22]reveals that this relationship is not always straightforward. He demonstrated that although larger-diameter capillaries allow for faster initial wicking, capillaries with smaller diameters can ultimately dominate over time. While larger pores can retain a greater volume of liquid, they limit the distance the liquid can travel. This behaviour aligns with the Laplace equation: as the radius of a capillary decreases, the pressure generated within increases, resulting in a more rapid flow of liquid through the capillary.

Hang and Gupta [23]examined the wetting behaviour of cellulosic fibres and found that the wetting force increases linearly with perimeter for the receding liquid front, although this relationship does not hold for the advancing liquid front. The wetting index during the receding phase is primarily determined by the chemical composition of the fibres, whereas the index during the advancing phase is additionally influenced by physical and morphological factors such as molecular orientation, crystallinity, roughness, and surface texture. The cosines of the advancing angles were observed to be 0.93 for trilobal rayon, 0.83 for cotton, and 0.537 for regular rayon, reflecting the fibres' relative capacity to attract and absorb fluid through capillary action. Factors such as surface contamination and molecular structure significantly contribute to wetting hysteresis [24]. The hysteresis exhibited in these fibres can be attributed to variations in chemical purity, cross-sectional morphology, and molecular orientation. Trilobal rayon fibres possess a smoother and more uniform surface compared to regular rayon, which accounts for the differences in hysteresis values. Furthermore, surface roughness promotes more rapid liquid spreading [25]. Alkaline hydrolysis results in pitting on the surfaces of polyester fibres, thereby enhancing their wettability, as indicated by contact angle measurements [26].

Factors influencing wicking behaviour

Effect of fibres, yarn and fabric parameters :

Fibres with the highest moisture absorption demonstrate the smallest contact angles. Alkaline purification has the most significant effect on the wettability of regenerated cellulose fibres. In contrast, the influence of alkaline purification on Lyocell and Modal fibres is less pronounced compared to viscose fibres, with no significant reduction in contact angles observed. This may be due to the higher degree of crystallinity and greater molecular orientation found in Modal and Lyocell fibres. The arrangement of fibres within an assembly affects the size and geometry of the spaces between them, subsequently influencing the wicking rate. As the non-circularity of the fibres increases, the specific surface area also enlarges, thereby enhancing the capillary walls that draw in liquid. The tortuosity of the pores plays a crucial role in the wicking process, as it depends on both the alignment of the fibres and irregularities in their diameter or shape along the pores. An increase in pore tortuosity typically results in reduced wickability. Natural fibres spun into yarns usually feature highly irregular capillaries due to various factors such as fibre roughness, cross-sectional shape, and limited length, all of which impede the flow of liquid along the length of the yarn.To increase the fabric's overall wicking ability, cotton fibre is typically combined with other fibres, such as moisture-wicking fibres [27, 28]. The thermo-physiological comfort of polyester textiles with diverse cross-sections (i.e., circular, triangular, four-channel propeller, and tetrakelion) and variable degrees of fibre fineness was examined by Varshney et al. [6]. The study discovered that while the wicking rate of textiles with round cross-sections was lower than that of the other three types of cross-sections showing retreating or outward sharp angles, the heat resistance and air permeability of fabrics rose with the fineness of the fibres. Coolmax and Octa are two examples of commercial goods that intentionally change the cross-section of polyester fibres to produce capillary wicking channels along the fibre[29].

Yarn characteristics such as structure, count, twist, the number of fibres, fibre configuration, finishes, and surfactants all play a role in determining how well yarn wicks water. According to Lord [30], open-end yarn wicks water faster and more consistently than ring yarn, although both types can lift a similar volume of water for a given yarn count. Open-end yarn performs best with a twist multiplier of 4.0, but variations in the twist multiplier do not have a significant impact on wicking height. Sengupta and Murthy [31] observed that open-end spun yarn wicks water more quickly than ring spun yarn at the same vertical wicking height. The wicking time for ring spun yarn increases sharply with greater twist, while the increase for open-end spun yarn is more gradual. Overnight wicking studies also confirm that open-end yarn consistently wicks more water than ring spun yarn for the same twist. Chattopadhyay and Chauhan [32] examined the wicking behaviour of ring and compact spun yarns. Their findings revealed that water rises quickly at first but then slows down over time. In the initial minute, it was difficult to distinguish between the various yarn types. They found that ring yarn exhibited higher wicking heights compared to compact yarn. Furthermore, in both cases, coarser yarn wicked water faster than finer yarn.Ansari and Krish [33]also reportedthat similar wicking behaviour of polyester spun yarns produced with varying twist levels. It was observed that the wicking rate decreases with increase of twist factor due to reduction of capillary size. Twisted filament yarn shows a lower wicking rate than a yarn without twist. They opined that in capillary penetration of liquids, tortuosity affects wicking. Twists in the yarns influence the size of inter- fibre capillaries as a result of helical path of the fibres in the yarns. Minor et al. [34] observed similar finding s on nylon filament yarn for different twist levels. Ito and Muraoka [35] reported that water transport (measured by capacitance method) is suppressed as the number of fibres decreases. From the results obtained for rayon, nylon and polyester fibres they found that when the number of fibres is greater than ten, the liquid water moves along even untwisted fibres. But when the number of fibres was reduced to three wicking did not always occur. These results indicate that the mechanism of water transport for isolated fibres differs from water sorption in a fibre bundle or assembled fibres where capillary space exits. Hollies et al. [36]reported that difference in yarn surface roughness give rise to difference in wicking of yarns and fabric made from the yarns. Wool fibre forms rough yarns of high apparent contact angle because of natural crimp and more random distribution of fibres in the yarn, whereas the yarns of synthetic fibre are compact, well aligned and hence smooth in terms of contact angle. This type of behaviour is in agreement with evidence from the wicking and structural properties of different blended fabrics as observed by Bogati et al. [37] Sengupta and Patel[38]opined that speed of water in the capillaries of the yarn is reduced by presence of randomly arranged fibre in the yarn .They observed that both wicking height and wickability of fabrics made from wrapped rotor yarn was lower compared to normal fabric. This could be because of higher packing density of wrapped structured yarn , which in turn provides less space in core to travel water .Increase in yarn roughness due to random arrangement of fibres gives rise to a decrease in the rate of water transport, and this is seen to depend on two factors directly related water transfer by a capillary process:

i) the effective advancing contact angle of water on the yarn is increased as the roughness increased;

ii) the continuity of capillaries formed by the fibres of the yarn is seen to decrease as the fibre arrangement becomes more random.

The measurement of water transport in yarns is thus seen to be a sensitive measurement of the properties of the fibre arrangement and yarn roughness in textile assemblies.

The wicking behaviour of fabric is significantly influenced by several factors, including the size, shape, alignment, and distribution of fibres, as well as the combinations of these fibres and the structure of the yarn. Hsieh et al. [39]noted that fibrous structures irrespective of woven, non-woven, or knitted exhibit a variation in pore sizes across any planar direction. The rate at which liquid is wicked and transported through a fabric relies heavily on the size of these pores and their distribution. According to the capillary principle, smaller pores are filled first and are primarily responsible for the movement of the liquid front. After the smaller pores are completely filled, the liquid progresses into the larger pores. he advancement of liquid within smaller pores occurs at a faster rate due to increased capillary pressure; however, the amount of liquid retained in such pores is comparatively low. Conversely, larger pores can retain a more substantial liquid mass, but the height of liquid advancement is restricted. The size and shape of the fibres, as well as their alignment, affect the geometric configuration and topology of the inter-fibre spaces or pores, which act as channels that vary considerably in shape and size and may or may not be interconnected. Moreover, the arrangement of fibres within the fabric alters the size and geometry of the capillary spaces between them, subsequently impacting the wicking rate. The flow in these capillary spaces can be halted if geometric irregularities allow the liquid meniscus to reach an edge and flatten [40].Therefore, rapid liquid spreading in fibrous materials is best facilitated by small, uniformly distributed, and interconnected pores, while high liquid retention is achievable through a greater number of larger pores or an increased total pore volume. Sengupta and Patel [38] indicated that a mere comparison of the height of wicked water does not yield a realistic assessment of mass transfer rates unless the fabrics maintain similar structural and thickness characteristics. A fabric that exhibits greater water height may not necessarily absorb a large mass of water. Thus, both the height of the water wicked and wickability should be measured. Their research concluded that in both ring and rotor-spun yarn fabrics, an increase in cotton content correlates with heightened water height and wickability, attributed to the hydrophilic properties of cotton fibres and the reduction in yarn packing density as cotton content increases. Although rotor yarn fabrics demonstrate higher wicking heights, they exhibit lower wickability in comparison to ring yarn fabrics. This discrepancy can be traced back to the random arrangement of fibres, which diminishes the speed of water within the capillaries. The greater disorientation of fibres prevalent in rotor yarn results in reduced wickability. Furthermore, fabrics composed of wrapped rotor yarns display both lower wicking heights and wickability attributed to the enhanced packing density of this structure. Chattopadhyay and Chauhan [32] have identified that ring yarn fabrics wick water more rapidly than compact yarn fabrics, attributing this phenomenon to the lower packing density observed in ring-spun yarn, which facilitates larger capillary sizes and improved connectivity among capillaries within the yarn structure. Fabrics woven from coarser yarns exhibit superior wicking capabilities compared to those made from finer yarns, with the wicking behaviour of the fabric reflecting the characteristics of the yarn. Das et al.[41] conducted a study examining the wicking behaviour of plain fabrics incorporating various yarn types. Their findings revealed that twist less hollow fibre assemblies demonstrated the highest wicking performance in the weft direction due to the parallel orientation of fibres, which creates smaller pores and channels that facilitate greater water absorption through capillary action. Overall, the results regarding moisture transfer properties indicated that the ring-twill fabric possesses the highest wicking rate, influenced by yarn structure and fabric porosity, where an increase in porosity corresponds with enhanced wicking performance.

Yoon and Buckley [42] observed substantial variation in wicking behaviour as the fibre composition varied in polyester/ cotton fabric sample. 100% cotton and 50/50 blend sample showed a very rapid wicking behaviour but the wicking rate sharply dropped as the polyester content increased. Cheung et al. [43]studied the wicking behaviour of polyester cotton knitted fabrics of varying blend percentage and found that overall wickability (weight of water absorbed per unit length and per unit timeincreases with increase in cotton component in the fabric . This fabric with high percentage of cotton absorbed more water than fabric with a high percentage of polyester. Further, yarn bulkiness increases with increase with increase in cotton content in the in the yarn. Hence the amount of water absorbed by fabric by wicking increased with increase in cotton content in the fabrics. Gali et al. [44] pointed out that capillary pressure and permeability are the two factors which predict the overall performance of a fabric. The capillary pressure decreases with an increase an in saturation, due to higher cross-sectional area of the absorbed water molecules to flow.

Effect of finishing:

Rhee et al. [45] studied the effect of treatment with durable press finish and laundering on vertical wicking and demand wettability of fabric. An increment in vertical wicking rate for cotton fabric after treatment with durable press finishes was attributed to the increase in total pore volume, although no noticeable changes were observed in contact angle. This indicated that there was no significant difference in fibre wettability after durable press finish. After the durable press treatments, the water uptake rate (from demand wettability test) and amounts were reduced for fabric treated with DMeDHEU and increased for one treated with DMDHEU, but the difference were significant. Anti- static finishes on the cotton reduces the surface energy of the fibre as indicated by higher values of contact angles and reduced both the wicking and water uptake rates. When the cationic surfactant is absorbed on the fabric, the hydrophilic end apparently attaches to the surface of the cotton and hydrophobic alkyl chain protrude out, resulting in a hydrophobic surface. However, the antistatic treatment significantly increased the wicking rate and amount of water uptake of the polyester fabric. D Silva et al. [46] observed a faster rate of wicking across the soil release finished polyester fibre. He argued this was due to the modification of fibre surface properties, governed by the extent of hydrophilicity imparted by the soil release finish. The wicking rate therefore faster and the amount of water wicked was much higher. Hawkyard et al. [47]found that crease resistance finish on mercerized and bleached cotton significantly improved the wettability. However, a considerable increase in wetting time is observed after treatment with softening agent. Rhee et al [45]studied the effect of durable press finish and laundering on vertical wetting rate for cotton fabric and observed that advancing contact angle of untreated cotton slightly higher than that of untreated cotton. Further, cotton treated with DMeDHEU had an even lower contact angle than untreated cotton. They found that the presence of reagent on the on the cotton causes a decrease in the dispersion force and an increase in the polar component. As the concentration of the durable press finish was increased the value of $\cos\theta$ increased slightly indicating that surface has become more hydrophilic though the difference is not so significant, a possible explanation put forward by them for increased wettability is that the durable press finishes themselves readily interact with water. Durable press finishes make the fabric less hydrophilic, since the durable –press agent are cross linked with hydroxy groups of cellulose and therefore contact angle of treated cotton should be higher than that of untreated cotton. Sengupta et al [37]further investigated the effect of chemical treatment (treatment with 5%caustic soda in presence of methanol at 60^0c for 1 hr) on 100%polyester knitted fabric and concluded that water absorbency of treated polyester fabrics increase tremendously as compare to untreated fabrics. Due to the treatment, wicking behaviour of treated fabrics is much closer to 100% untreated cotton fabrics. Hence, he concluded that for improving wicking behaviour of fabric, the method of modification of surface characteristics of fibres through chemical treatment could be more advantageous compared to method of engineering of yarn structure through mechanical means.

Conclusions:-

Th**e**innovations made by Textile Research and Academic Institutes along with the wealth of practical knowledge and skills gained, have contributed to tremendous advancements in textiles not only imparting aesthetic value but also in achieving desired thermos-physiological comfort characteristics. With the availability of a wide range of fibres and textile manufacturing methods, nowadays it is possible to manufacture fabrics of required moisture transmission ability. Engineering a fabric for specific end-use requires a judicious combination of fibres, selection of appropriate yarns and fabric constructional parameters together with suitable finish.This review paper gave an in-depth analysis of the moisture transmission mechanism(either in form of the vapour or liquid) through fabric , its importance and various factors which can influence the moisture transport phenomena .

References:-

1. Sachdeva, R. C., “Fundamentals of engineering heat and mass transfer”, 2nd ed., India, 2005, Publisher New Age International (P) Ltd**.**
2. Pause, Measuring the water vapour Permeability of coated fabric and laminates J. coated fabric 25(4)3 (1996) 320.
3. Li. Y, Holcombe. Lou, Z An improved simulation of coupled diffusion of moisture and heat and transfer in wool fabric. Textile Res. J. 69(10) 760-768.
4. Morton, W.; Hearle, J.S. Physical Properties of Textile Fibres; Heinemann: London, UK, 2008.
5.Prakash, C.; Ramakrishnan, G. Effect of Blend Proportion on Thermal Behaviour of Bamboo Knitted Fabrics. J. Text. Inst. **2013**, 104, 907–913
6. Varshney, R.K.; Kothari, V.K.; Dhamija, S. A Study on Thermophysiological Comfort Properties of Fabrics in Relation to Constituent Fibre Fineness and Cross-Sectional Shapes. J. Text. Inst. **2010**, 101, 495–505. 99.
7.Kim, J.O.; Spivak, S.M. Dynamic Moisture Vapor Transfer Through Textiles. Text. Res. J. **1994**, 64, 112–121.
8. Tyagi,G.K. Bhattacharya. S, Study of cotton ring and compact spun yarn fabrics, Indian J. fibre Textile Res. 35, March , (2010) 45-49.
9. Sharma et al Indian J. fibre Textile Res. March, (2016) 15-19
10. Madan et al Moisture transport behaviour of Eli-Twist knitted fabric and its comparison with fabric made from yarns spun on different spinning systems Indian J. fibre Textile Res. Vol 48, March2023, pp. 5-12
11. Green wood. K, Rees. W.H, & Lord. J Studies in Modern Fabrics, The Textile Institute, Manchester (1970).
12. Gogalla D. Textiltech , 22,(1972),696.
13 Weiner.L.I Text Chem, Col ,2,(1970),378.
14 Stoffberg, M.E.; Hunter, L.; Botha, A. The Effect of Fabric Structural Parameters and Fiber Type on the Comfort-Related Properties of Commercial Apparel Fabrics. J. Nat. Fibers **2015**, 12, 505–517
15. Fahmy S.M.A, PhD, Thesis, University of Guelph, (1974)
16.Behra, B.K., Isthaque, S.M., and Chand, S., comfort properties of fabrics woven from ring, rotor- and friction spun yarns, J. Textile Inst, 88 (3), (1997), 255-264).
17. Limeneh, D.Y.; Ayele, M.; Tesfaye, T.; Liyew, E.Z.; Tesema, A.F. Effect of Weave Structure on Comfort Property of Fabric. J. Nat. Fibers **2020**, 19, 4148–4155.
18. Kothari V.K ,Das S, Indian J. fibre Textile Res. 37, June , 151-156 (2012).
19. Shobanasree, P.C.; Prakash, C.; Kumar, M.R.; Lokesh, K.V. Effect of Elastane Plating on Physical & Thermal Comfort Properties of Lyocell Single Jersey Knit Fabric with Different Loop Length. J. Nat. Fibers **2022**, 19, 11574–11581.
20. Kissa, E., “Wetting and wicking”, Text. Res. J., 66 (10), 660-668 (1996).

21. Das. B, Das. A, Kothari V. K ,Fanguiro. R, Moisture transmission through textile Part-I Autex.R. J (2) (2007) 100-110.
22. Miller. B Critical Evaluation of upward wicking test Intl. Nonwoven J. 9, (2000)35-40.
23. Whang. H.S , Gupta B.S, Surface wetting characteristics cellulosic fibre Textile Res. J. 70,4 (2000),351-358.
24. Lunar. P, Msandell, The wetting of cellulose, J. Poly. Sc . Part C 28 , (1969),115-142.
25.Cazabat A .M, Stuart, Dynamics of wetting: Effect of surface Roughness J Phy. Chem ,90,No22,(1986),5845-5849.
26. Sanders E.M, Zeronian. S.H, An analysis of Moisture Related properties of Hydrolyzed Polyester J . App. Poly. Sci 27. No 11, (1982) 4497-4491,
27.Atasağun, H.G.; Okur, A.; Psikuta, A.; Rossi, R.M.; Annaheim, S. Determination of the Effect of Fabric Properties on the Coupled mHeat and Moisture Transport of Underwear–Shirt Fabric Combinations. Text. Res. J. **2018**, 88, 1319–1331. 112.
28.Hussain, U.; Younis, F.B.; Usman, F.; Hussain, T.; Ahmed, F. Comfort and Mechanical Properties of Polyester/Bamboo and Polyester/Cotton Blended, Knitted Fabric. J. Eng. Fibers Fabr. **2015**, 10,
29.Gulhane, S.S.; Raichurkar, P.P. Developments in Profile Filament Yarn for Enhancing Moisture Management Properties of Fabrics. Man Made Text. India **2020**, XLVIII, 88–92
30. Lord P.R A comparison of of the performance open end and ring spun yarn in terry toweling , Textile Res. J.,44, (1974)516-512.
31.Sengupta, A.K, Murthy, H.V.S Wicking in ring spun yarn vis a vis rotor spun yarn Indian Journal Text,10, No4, (1985) 155-157
32 Chattopadhyay. R, Chauhan. A Wicking behaviour of ring and compact spun yarn and fabric in one day seminar on Comfort in Textile, Dept of Textile Technology IIT Delhi, New Delhi, Oct ,16 (2004).p16
33. Ansari. Nand Kish MH The wicking of water in as measured by an Electrical Resistance Technique. J Text Inst,Part I 91 No3 (2000) 410-419.
34 Minor F.W, Schwartz E,The Migration of Liquids in Textile Assemblies Part-IIThe wicking of liquid in yarn Text.Res J64.No 112, (1994), 931-939.
35Ito.H and MuraokaY Water transport along textile fibres as Measured by Electrical Capacitance Technique. Text.Res J 1993, Electrical Capacitance Technique. Text.ResJ ,63,no7, (1993) 414-420.
36. Hollies N.R.S. Kessinger, Bogati H Water Transport mechanism In Textile materials Parti The role of yarn roughness in in capillary Type penetration Textile Res. J. 26, (1956), 829-835.
37. Bogati H Hollies N.R.S, Hintermeir J.C Some properties of serges made from Blends of Wool with Acrylic type synthetics Textile Res. J 23, (1953),536-544.
38.Sengupta, A. K., and Patel. S, A study on thermo physiological comfort properties of cotton, polyester rich polyester- cotton blended fabrics, Proceedings, 44th joint Technological Conference of ATIRS, BTRA, SITRA, and NITRA, (SITRA).
39. Hsiesh Y.L, Thomson J, Liquid wetting and retention of Fibrous assemblies Part II Water wetting and Retention properties of 100%and blended woven fabric , Text. Res J,62, No10 , (1992) 972-970.
40. Hollies N.R.S. Kaessenger , Bogati. H Water Transport mechanism In Textile materials PartI II, Capillary Type penetration, Textile Res. J.,27 No1 (1957),8-13.
41. Das. . A and Istiaque S.M, Study on comfort properties of fabrics made of specialty Yarn structure, in one day Seminar on comfort in textile IIT (Delhi), October 16 (2004), p30.
42. Yoon, H.M, and Buckley, A., improved comfort polyester part 1: transport properties and thermal comfort of polyester-cotton blended fabrics, Textile Res. J., 54, (1984), 289-298.
43.Cheng KPS and Cheung Y.K Feb Textile Asia, (1994)48-50
44. Gali. K, Jones. B, Tracy. J Experimental Techniques for parameters describing wetting and wicking in fabrics Textile Res. J., 64(2), (1994) 106-111
45. Rhee .H, Young R.A and Sarmadi A.M,The Effect of functional finishes and laundering on Textile Materials Part –II, Characterization of Liquid Flow, J.Text ,Inst',84,No3 (1993) 406-418.
46. D'Silva A.P.D. Greenwood C.A. Concurrent determination of absorption and wickability of Fabric. J. Text. Instt, , Part I, 91, No3 (2000) 383-396.
47. Hawkyard. C.J .Sing. P, A comparison of manual and automated test methods for wettability, Proceeding of the 80th,world conference of the Textile Institute , Manchester , UK, , April 16-19 (2000), P11.