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COMPARATIVE STUDY OF THERMAL BEHAVIOUR OF SOCKS

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Abstract - ***Preserving the consistency in human health, regular physical activity is required. Athletes and sportspeople choose activewear of socks to attain comfort and functional support during a variety of activities like walking, stretching, jogging, etc. Every fabric intended for active wear must have the ability to manage moisture, as this determines how comfortable the fabric will be when used to make active wear of socks .The air and water vapour permeability of a fabric also affects how well it manages moisture. By making the best selection of fibers, yarns, fabrics, finishes, coatings, laminates etc. and also design elements of socks, high performance of socks can be developed to meet the fundamental and basic functional needs of users in terms of comfort, breathability, light weight, anti-static, and anti-odor qualities. The aim of the current study is to examine the relationship between the fabric's characteristics and its ability to conduct heat. It was found that the thermal conductivity of sock was positively proportional to yam count, GSM and thickness. No relevant work is done on the comparison of thermal properties of different types of socks. By this we can say which type of sock is preferable.***

1.INTRODUCTION

Socks are an important part of our clothing and are necessary for everyday activities to avoid the discomfort of the foot due to moisture coupling in the shoes during continuous wearing. Socks in shoes offer less air circulation than other clothing on the body, socks need to perform better in terms of comfort. The feeling of pleasure or relaxation is defined as comfort. When heat and water vapor pass through the garment, the wearer feels comfort. Thermo-physiological comfort is related to a garment's ability to transfer heat and moisture, which aids in the maintenance of the body's thermal balance at various activity levels.

Objectives:

To study the influence of wales per inch and courses per inch on the thermal comfort.

To study the influence of G.S.M on thermal comfort of socks.

To study the air permeability of socks.

To study the influence of G.S.M and course per inch and wales per inch on dry rate of socks.

1.1 Heat Transfer

Heat is the transfer of energy from a warmer object to a cooler object. It can be transferred in three ways:

By conduction
By convection
By radiation

- Conduction is one of the modes of heat transfer that takes place when the two surfaces having temperature difference, comes in contact with each other.
- Convection is the movement of heat by a fluid such as water or air. The fluid moves from one location to another, transferring heat along with it.
- Heat loss by radiation is the process by which thermal energy travels from a heated to a cold surface via electromagnetic waves.

1.2 Air Permeability

Air permeability is the measure of the ease with which air can pass through a fabric. It is an important characteristic of textiles, especially in applications such as clothing, where breathability is important for comfort.

1.3 Dry Rate

The term "dry time" in relation to fabric, it generally refers to the length of time it takes for a fabric to air dry after it has been washed or wetted. The dry time can be affected by various factors such as the type of fabric, its weight, the level of humidity, and the temperature of the surrounding environment.

2. Material and Methods

TYPES OF SOCKS	GSM	THICKNESS	YARN COUNT	LOOP LENGTH	CPI	WPI	TIGHTNESS FACTOR
	g/m^2	mm	tex	cm			√tex/l(cm)
A	248	0.95	29	0.39	24	38	13.8

B	252	0.97	31	0.46	25	35	12.10
C	260	0.97	29.5	0.50	25	38	10.8

1. Puma(A).
2. Adidas(B).
3. Decathlon(C).

2.1 Thermal transfer properties

Sensora's Alambeta testing device, Liberec, Czech Republic, is used to determine the thermal transfer properties of the fabrics in accordance with ASTM C518.

2.2 Determination of Fabric GSM

GSM of the fabrics was measured according to the ASTM D3776. A circular knife GSM cutter is used to make the samples of diameter 13 cm Five samples from each fabric were taken and weighted on the electronic balance for 0,001 decimals. Five samples were taken randomly from different places on the fabric keeping in mind that there is no same set of wale and course in the samples.

2.3 Determination of fabric thickness

The thickness of the fabric was tested according to the ASTM D1777. The samples were placed on the anvil of the thickness gauge and slowly the presser foot is lowered down till it comes in contact with the fabric, it takes 5-6 seconds to apply full pressure on the sample 3224 Determination of wales and courses per unit length.

2.4 Determination of wales and courses per unit length

Wales and courses per unit length of fabrics were measured according to the ASTM D8007-15. Pick glass is the apparatus used to count the wale and courses per unit length. For counting the wales, the pick glass is placed along the width of the fabric and the number of wales is counted per inches with the help of a pointer. For counting the courses, the pick glass was placed along the length of the fabric and courses per inch are counted with help of a pointer.

2.5 Air Permeability Tester

Air permeability is usually measured in terms of the volume of air that can pass through a unit area of fabric per unit time. The standard unit of measurement for air permeability is cubic feet per minute per square foot (CFM/ft2) or litres per second per square meter (L/s/m2).

There are different methods for measuring air permeability, but one of the most commonly used is the ASTM D737 test method. This involves placing a fabric sample in a special apparatus, known as a permeability tester, and measuring the volume of air that passes through it under a specified pressure differential.

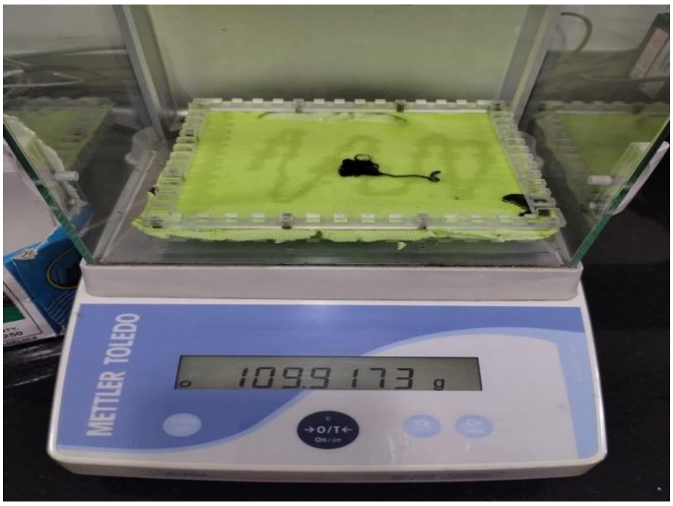
The air permeability of a fabric can be influenced by factors such as its thickness, porosity, and surface roughness. Finishing treatments, such as water repellent or water-resistant coatings, can also affect the air permeability of a fabric.

The appropriate level of air permeability for a particular application depends on factors such as the intended use of the garment or textile product, the environmental conditions in which it will be used, and the preferences of the end-user.

2.6 Dry Rate Tester

A dry rate tester is an instrument used to measure the rate of drying of a coating or paint. It is an important tool in the quality control of coatings and paints, as the drying time of a coating affects its final appearance and performance.

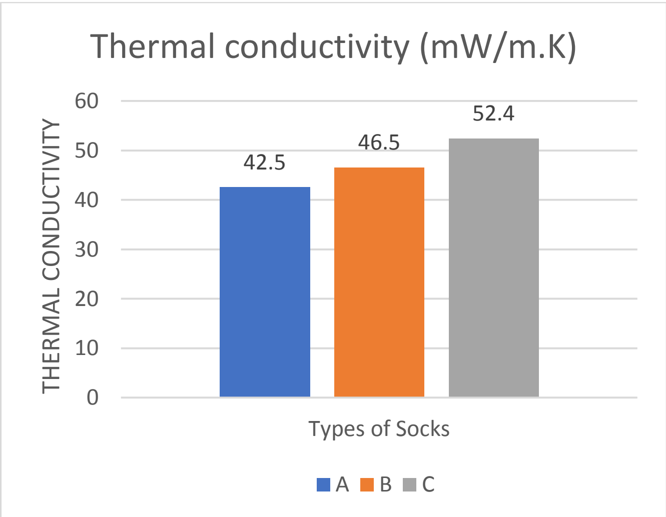
The dry rate tester usually consists of a metal plate coated with the material being tested. The plate is then placed in a controlled environment with specific temperature, humidity, and airflow conditions. The instrument measures the rate of evaporation of solvents or water from the coating and records the time required for the coating to reach a particular level of dryness.



3. Results and Discussion

3.1 Thermal conductivity

Thermal conductivity is the ability of a material to conduct heat. It is the property that describes how easily heat flows through a material. The higher the thermal conductivity of a material, the better it is at conducting heat.

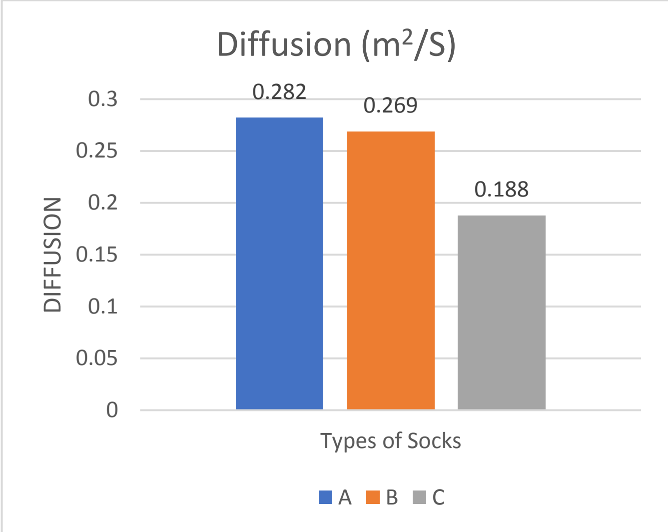


Type C sock has high thermal conductivity than A and B type socks due to higher GSM, higher course per inch and wales per inch.

3.2 Thermal Diffusion

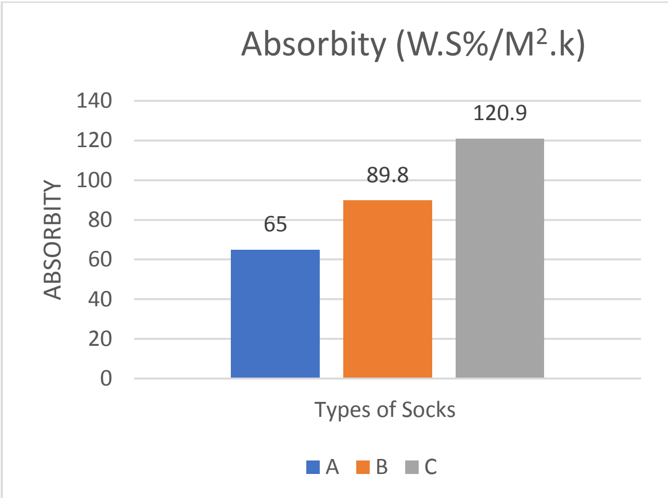
The movement of molecules, such as water vapor or gases, through the spaces between fibres or yarns in the fabric.

Type A sock has high thermal diffusion than B and C type socks due to lower GSM and lower course per inch and wales per inch.



3.3 Thermal Absorbity

Absorbency is an important property of fabrics, particularly those used for clothing and textiles. Fabrics with high absorbency can absorb and retain moisture quickly, making them suitable for use in socks, towels, diapers, and other absorbent products.



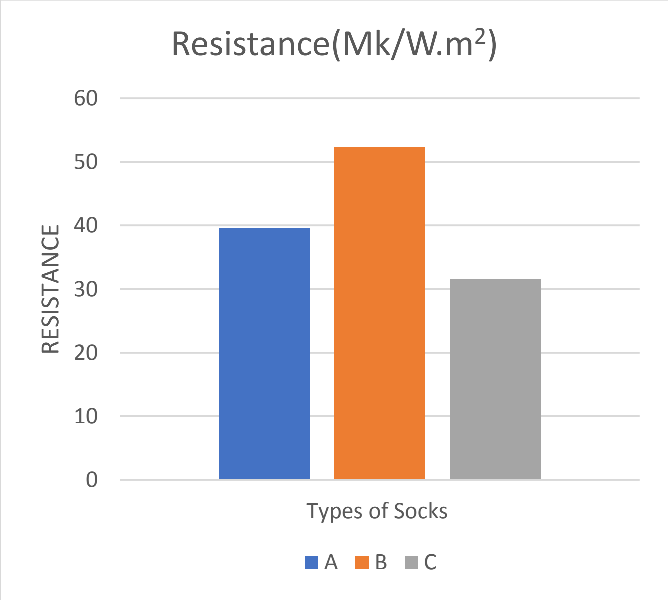
Type C sock has high thermal absorbity than A and B type socks due to higher GSM, higher course per inch and wales per inch.

3.4 Thermal Resistance

Resistance of the fabric refers to the fabric's ability to resist various external influences, such as mechanical stress, abrasion, chemicals, sunlight, and water. It is a measure of how well the fabric holds up under different conditions and is an important factor in determining its durability and lifespan.

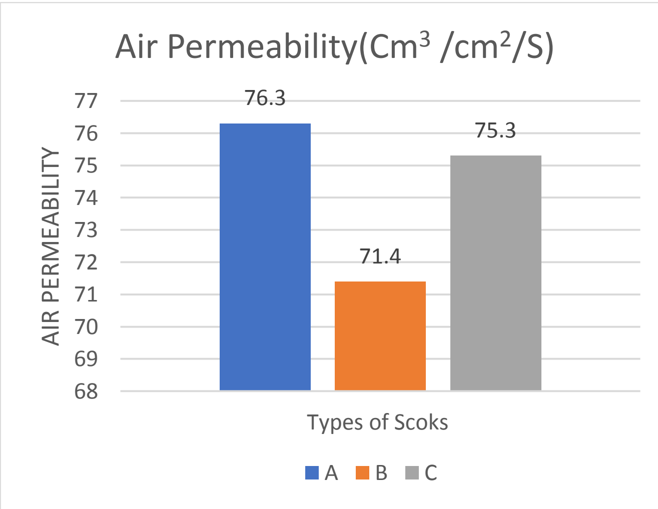
Type A socks has more thermal resistance compared with type B and C socks.

Whereas thermal resistance is directly proportional to the thickness of the fabric.



3.5 Air permeability

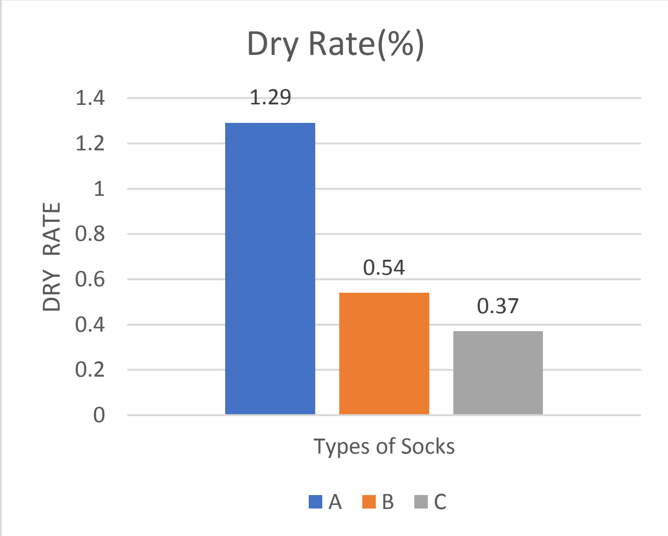
The ability of a fabric to allow air to pass through it. It is a measure of the breathability of a fabric, which is an important property for clothing and other textile applications.



Type A sock has high air permeability than B and C type socks due to lower GSM and lower thickness. Higher thickness and gsm reduces the air permeability.

3.6 Dry Rate

The speed at which a fabric dries after being wet. It is an important property for many textile applications, particularly for clothing and other products that are exposed to moisture.



Type A sock has high dry rate than B and C type socks due to lower GSM and lower thickness.

Higher thickness and gsm reduce the dry rate.

4. CONCLUSIONS

Higher G.S.M offer higher isolation, higher good thermal properties. So, increasing the G.S.M of socks will make the thermal conductivity high. Higher the course and wales per inch of socks then tightness factor increases whose effect the thermal properties. Therefore, Higher course or wales per inch will increase the thermal comforts properties of socks. Higher G.S.M and higher Wales and course per inch also increases moisture dry rate properties. Therefore, Socks clinginess, stickiness and dampness all will decrease by increasing structure tightness and G.S.M. Higher thickness and G.S.M reduces the air permeability which increases the thermal comfort properties of socks.

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