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Oktay Pamuk
University of Ege
oktay.pamuk@ege.edu.tr
Izmir-Turkiye

CLOTHING COMFORT PROPERTIES IN TEXTILE INDUSTRY

ABSTRACT

The primary need of people to dress has changed as time passed, because different high-tech fibers, yarns, fabrics and finishing applications have completely changed. In our modern day, the most important property of all ready made garment products is comfort. Welfare and comfort properties have become decisive components to make a product appreciated and successful. The clothing comfort is divided into some groups and thermal comfort is the most important one. This paper presents the detailed explanation of clothing comfort, its sub-groups and also the instruments to measure the thermal resistance, thermal conductivity and thermal absorptiveness values of textiles.

Keywords: Comfort, Clothing Comfort, Thermal Resistance, Thermal Conductivity, Thermal Absorptiveness

TEKSTİL ENDÜSTRİSİNDE GİYİM KONFOR ÖZELLİKLERİ

ÖZET

İnsanların giyim konusundaki öncelikli tercihleri zaman geçtikçe değişmektedir. Çünkü yüksek teknoloji ürünü lifler, iplikler, kumaşlar ve bitim işlemleri tümüyle değişmektedir. Günümüzde, tüm hazır giyim ürünleri için en önemli özellik konfordur. Rahatlık ve konfor özellikleri, bir ürünün başarılı ve değerli olarak kabul edilebilmesindeki en önemli faktörler haline gelmiştir. Giyim konforu, bazı alt gruplara bölünmüştür ve bu gruplar içerisinde ısıl konfor en önemli olanıdır. Bu makale, giyim konforu konusunun detaylı açıklamasını, alt gruplarını ve ısıl konforun belirlenmesinde kullanılan ekipmanların tanıtımını sunmaktadır.

Anahtar Kelimeler: Konfor, Giyim Konforu, Isıl Direnç, Isıl İletkenlik, Isıl Soğurganlık

1. INTRODUCTION (GİRİŞ)

The term comfort is defined as "the absence of unpleaseness or discomfort" or "a neutral state compared to the more active state of pleasure" [1]. With other words, comfort is an experience that is caused by integration of impulses passed up the nerves from a variety of peripheral receptor smell, smoothness, consistency and color etc in the brain. It is a qualitive term and it is one of the most important aspects of clothing. The clothing comfort can be divided into three groups such as psychological, tactile and thermal comfort. Psychological comfort is mainly related to the latest fashion trend and acceptability in the society and bears little relation to the properties of fabrics. The tactile comfort has relationship with fabric surface and mechanical properties. The thermal comfort is related to the ability of fabric to maintain the temperature of skin through transfer of heat and perspiration generated within the human body [2]. Today numerous consumers consider thermal comfort to be one of the most significant attributes when purchasing textile and apparel products [3]

There is a general agreement that the transmission of air, heat and water vapour through a garment are probably the most important factors in clothing comfort. Comfort, as felt by the user, is a complex factor depending on the above attributes [2].

Thermal properties are among the most important features of textiles. Most of the studies hitherto carried out are devoted to measuring static thermal properties such as thermal conductivity, thermal resistance, and thermal diffusion [4]. The thermal properties of clothing materials, which relate thermal comfort of the user, involve the heat and mass transfer between a clothed body and the environment. The thermal resistance of a clothing system represents a quantitative evaluation of how good the clothing provides thermal barrier to the wearer [5]. Thermal insulation properties are determined not only by the physical parameters of fabrics but also by structural parameters such as weave and drape [4].

The human body is adapted to function within a narrow temperature range. Generally, the human body keeps its body temperature constant at 37±0.5°C under different climatic conditions. The human body converts the chemical energy of its food into work and heat. The amount of heat generated and lost varies markedly with activity and clothing levels. The heat produced is transferred from the body's skin to the environment. In a steady-state heat balance, the heat energy produced by the metabolism equals the rate of heat transferred from the body by conduction, convection, radiation, evaporation and respiration. Therefore, clothing is needed to protect the body against climatic influence and to assist its own thermal control functions under various combinations of environmental conditions and physical activities. Human thermal comfort depends on combinations of clothing, climate, and physical activity [6].

2. RESEARCH SIGNIFICANCE (ÇALIŞMANIN ÖNEMİ)

With developing technology, the main aim of the researches in the textile and apparel industry is to improve the life quality of the people. For this aim, the properties of the clothes which can be introduced as the second skin of the people are getting better. If the clothing properties are not to be fitted for the people, this situation can directly affect the people's daily life. In our modern day, especially with the long working hours and also with the stress conditions, the manufacturers are interested in to reduce the discomfort properties of clothes. In addition to this, the companies are attaching importance to this subject for the new market

opportunities and also for producing new and different products. The main aim of this paper is to present the detailed explanation of clothing comfort, the sub-groups of comfort and also the main instruments to measure the thermal resistance, thermal conductivity and thermal absorptiveness values of textiles.

3. PHYSICAL ASPECTS OF COMFORT (KONFORUN FİZİKSEL YANLARI)

In studying the physical factors determining the comfort performance of textiles, it is concluded that heat transfer between people and the environment, together with the movement of moisture for insensible heat transfer, constitutes the major comfort. Depending on the particular functional requirements of clothes, the parameters which can be evaluated for physical aspects of comfort are thermal conductivity, water-vapour resistance, air-permeability, moisture-holding ability, air resistance, abrasion resistance etc.

It is obvious that comfort involves a complex combination of properties, both subjective and physical. There is general agreement that the movements of heat, moisture and air through a fabric are the major factors governing comfort, but some of the subjective factors such as size, fit and aesthetic behavior like softness, handle and drape are obviously very important in the textile field [1].

The followings are the physical aspects of comfort:

- Thermal properties:
  - heat transmission
  - thermal protection
- Vapour-humidity transmission:
  - humidity permeability
  - influent elements in vapour permeability
- Liquid-humidity transmission:
  - water repellent capacity and water absorbance
  - humidity characteristics measurement
  - absorbent fabrics production
  - water resistant fabrics production
  - elements influencing transmission of liquids and humidity
- Air permeability
  - air permeability test
  - permeable fabrics production
  - correlation between permeability and other elements
- Size and style of items
  - esthetic comfort (subjective)
  - esthetic properties measurement
  - changes in esthetic behaviour
- Static electricity
  - electrostatic propensity measurement
  - static electricity effects
  - electrostatic laden reduction
- Noise
  - textile use to fight noise [7].

4. DEFINITIONS RELATED TO THERMAL COMFORT (ISIL KONFOR İLE İLGİLİ TANIMLAMALAR)

In this section, the general informations about the thermal comfort which is the main part of this article are given.

4.1. Thermal Resistance (Isıl Direnç) (R)

The thermal resistance of a fabric is the ratio of the temperature difference between the two faces of the fabric to the rate of flow of heat per unit area normal to the faces. It is analogous to

electrical resistance in the case of current flow through an electrical conductor [9].

4.2. Thermal Conductivity (Isıl İletkenlik) (k)

The thermal conductivity is the quantity of heat that passes in unit time through unit area of a slab of infinite extent and unit thickness when unit difference of temperature exists between its faces. For a flat material having parallel faces, **R=d/k** where d is its thickness. Thermal conductivity is the reciprocal of thermal resistance perunit thickness [9].

4.3. Thermal Absorptiveness (Isıl Soğurganlık) (b)

Thermal absorptiveness b ($Ws^{1/2}/Km^2$) is the heat flow q (W/m^2) which passes between the human skin and the contacting textile fabric. The human skin is considered of infinite thermal capacity and temperature, and the contacting textile fabric is idealised as a semi-finite body of finite thermal capacity and temperature when the time of thermal contact between human skin and a fabric is short. This property, which is known as the 'warm-cool feeling', is included in the overall assessment of the handle of the textile materials with their low-stress mechanical properties, thus it contributes to the fabric handle [10].

5. THE EQUIPMENTS USED TO MEASURE THE CLOTHING COMFORT (GİYİM KONFORUNU ÖLÇMEDE KULLANILAN EKİPMANLAR)

5.1. Thermo-Labo (Termolab)

The first instrument, which was able to evaluate the warm-cool feeling of fabrics objectively, was developed by YONEDA and KAWABATA in 1983. They have introduced the maximum level of the contact heat flow q_{max} [W/m^2] as a measure of this transient thermal characteristic. Their instrument, called THERMO-LABO, was commercialised. The instrument consists of several blocks, which are manually operated. The q_{max} parameter then depends on the composition and surface structure of the fabric, but also on the temperature gradient t_1-t_2 between the tested fabric and the pre-heated block of the THERMO-LABO instrument [8].

5.2. Togmeter (Togmetre)

Togmeter is used to determine thermal resistance of textiles. Tog is a measure of thermal resistance, commonly used in the textile industry. The Shirley Institute in Britain developed the tog as an easy to follow scale instead of the SI unit of m^2K/W. Launched in the 1960s, the Shirley Togmeter is the standard apparatus for rating thermal resistance, commonly known as the Tog Test. 10 tog is 1 m^2K/W. Another unit of thermal resistance is the clo, equal to 1.55 togs [9]. In this machine, a sample of the fabric to be tested is placed over a heated plate. The test machine is called a guarded hotplate and is encased in a fan assisted cabinet. The fan ensures enough air movement to prevent heat build up around the sample and also isolates the test sample from external influences. A disc shaped sample 330 mm in diameter is heated by means of a metal plate and the temperature on both sides is recorded using thermocouples. The test takes approximately two hours including warm up time. The thermal resistance is calculated based on the surface area of the plate and the difference in temperature between the inside and outside surfaces.

Figure 1. Shirley Togmeter
(Şekil 1. Shirley Togmeter)

5.3. Alambeta (Alambeta)

Another well-known instrument for measuring thermal resistance, thermal conductivity and thermal absorptiveness is Alambeta. Lubos Hes developed this instrument in the Czech Republic. A simplified sketch of the Alambeta is shown in Figure 2.

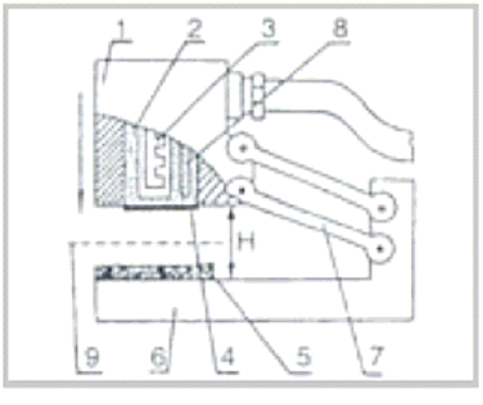

Figure 2. The sketch of Alambeta instrument [10]
(Şekil 2. Alambeta cihazının krokisi) [10]
1)Measuring Head, 2)Copper Block, 3)Electric Heater,
4)Heat Flow Sensor, 5)Measured Sample, 6)Instrument Base,
7)Head Lifting Mechanism, 8)Resistance Thermometer,
9)Wetted Textile Interface Simulating Sweat Discharge [10].

The measuring head (1) contains a copper block (2), which is heated to 32°C, simulating human skin temperature by means of an electrical heater (3). The temperature is controlled by a thermometer (8) connected to the regulator. The lower part of the heated block is equipped with a direct heat flow sensor (4). The sensor measures the thermal drop between the surfaces of a very thin non-metallic plate using a multiple differential micro-thermocouple. This sensor is 0.2 mm thick, and on contact with a subject of a different temperature, reaches the maximum heat flow qmax in 0.2 seconds. Thus, it simulates the human skin, which is approximately 0.5 mm thick and whose neutron ends; located in the middle, also take 0.1-0.3 second to reach qmax as the heat begins to flow through the contact subject. Before the measurement, the head is kept at a height H above the base plate (6) covered by the sample (5). The mechanism (7) ensures the correct movement of the measuring head. The pressure of the head onto the fabric can be adjusted within the range of 100 to 1000 Pa and substantially affects the results. It has been determined that the level of thermal absorptiveness depends on the contact pressure alone,

which also corresponds to the real situation. The test starts by placing the head on the sample. The heat starts to flow through the sample; then the surface temperature of the sample suddenly changes, and the instrument's computer registers the heat flow course. This procedure is similar to putting a finger on a fabric to be selected. Simultaneously the sample thickness is measured [10].

6. RESULT (SONUÇ)

The comfort of clothing means a comfortable wear that a characteristic human body can feel on the condition that energy exchange between human body and environment reaches a state of equilibrium while wearing clothing in different climatic environments [11]. Comfort is becoming a more importance tool for the textile and apparel industry because of the changing needs of the people. There are lots of clothing comfort properties of textiles such as heat transfer, thermal protection, air permeability, moisture permeability, water absorption, water repellence, size, fit and etc. With developing technology, the textile and apparel companies are more interested in the field of clothing comfort by using high-tech fibers and fabrics. It is obvious that the state of comfort can only be achieved when the most complex interactions between a range of physiological, psychological and physical factors have taken place in a satisfactory manner.

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