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COMFORT PROPERTIES OF DEFENSE PROTECTIVE CLOTHINGS

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Abstract. *The term comfurr is a subjective concept which is only recognized by the person experiencing. In recent years attempts have been made by several workers to connect comfort with cloting. The type of clotings used by Defence Forces is having a wide range at end – uses starting from parade garments suitable for both summer and winter combat uniforms, fatiguer for exercises, protective clothing like overalls, flying clothing, clothing for high altitude areas and exterme cold climates suits for protection against nuclear, biological and chemical warfare. Although the functional requiriments for clothingitems are paranouits interest, comfort, aspects of the same can not be ignored while selecting the basic materials for such clothing or while desening the same for a particular end – use. Because it must be understood that the combat efficiency of the troops will much depend on the comfort and case of donning a particular garment.*

INTRODUCTION

1. GENERAL ASPECTS OF COMFORT

The term comfort is defined as "the absence of unpleaseness or discomfort" or "a neutral state compared to the more active state of pleasure". There is general agreement that the movement of heat and water vapour through a garment are probably the most important factors in clothing comfort. A survey on recent literature availlable on the subject of comfort reveals that there is general agreement on the fact that a satisfactory thermal equilibrium is identified as the most important single criterium comfort. Secondary, it is obvious that the state of comfort can only be achieved when the most

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complex interactions between a range of physiological, psychological and physical factors have taken place in a satisfactory manner.

1.1. Physiological and psychological aspects of comfort

There are generally subiective comfort factors. The physiological effects of climatic variables, e. g. temperature, relative humidity and air movement on a body situated in the particular condicions are studied. The other factors studied are the effecet of clothing factors, particularry fabric geometry, pore volume and enclosed air content on physiological as wel as physical parameters.

It is considered that a studz can be made bz framing a suitable questionnaire for the users particularlz in Defence sector for their reaction of comfort factors like weght, beathability, fit etc based on field trials or practical performance tests on garments suitable for warious and uses (like protective clothings for exterme climatic, conditions, for jungle and desert conditions, for industrial apparels etc.)

2. PHYSICAL ASPECTS OF COMFORT

In studying the physical factors determining the comfort performance of textiles, it is concluded that heat transfer between man and his environment, together with the movement of moisture for insensible heat transfer, constitutes the major comfort - maintaining mechanism. Depending on the particular functional requirements of garments, the parameters which can be evaluated for physical aspects of comfort are conductivity, water-vapour resistance, air-permeability, moisture-holding ability, wind 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 behaviour like softness, handle and drape are obviously very important in the textile field.

2.1. Thermal properties and comfort

The fact that the body temperature is the most critical factor in deciding comfort means that we must examine more closely the mechanisms by which textile fabrics assist or hinder the maintenance of a uniform temperature in the body that they enclose. Heat is gained by the body from the sun (directly or indirectly), by internal metabolism, by physical exercise, or by involuntary contractions of skeletal muscles in shivering. Heat loss, by conduction, convection or radiation, depends partly on the temperature gradient between skin and environment, and varying the skin temperature modifies this gradient. Body flow near the body surface and evaporation from it control the skin temperature, and one function of clothing is the support of these processes. Excessive heat may be dissipated rapidly by vaporization of body water, the body being used, as a source of latent heat for the purpose and clothing systems that hinder free evaporation to any appreciable extent will thus be uncomfortable. On the other hand, undesirable heat loss can be prevented by increasing the thermal resistance of the barrier between the body and

its environment, and a fabric will again result in discomfort for the wearer.

The ambient air temperature is the dominant influence in determining the skin temperature and that at low temperature, clothing is essential for the regulatory process because the body does not have the ability to continue compensating for heat loss under these conditions. In addition to prevent undue heat loss, the winter clothing must also allow the escape of surplus heat or moisture when this is necessary.

2.1.1. Heat transfer

The resistance that a fabric offers to the movement of beat through it is of critical importance to its thermal comfort. In studying the thermal insulating properties of garments during wear, it is reported that the total thermal resistance to transfer of heat from the body to the surrounding air is the sum of three parameters:

(I) the thermal resistance to transfer of heat from the surface of the material,
(II) the thermal resistance of the clothing material, and
(III) the thermal resistance of the air interlayer.

It is obvious that heat transfer through a fabric is a complex phenomenon affected by many factors. The three major factors in normal fabrics appear to be thickness, enclosed still air and external air movement.

It is also reported by many authors that entrapped air is the most significant factor in determining thermal insulation. There are "microlayers" (those between contacting surfaces of the materials) and "macrolayers" (between non-contacting surface) of air enclosed within an assembly, and an increase of either of these can increase thermal insulation.

The above concepts are significant from the point of view of Thermal Protection, since one of the major functions of clothing is to protect the wearer against extremes of environmental temperature, i.e. from excessive ambient heat as well as cold.

2.2. Thermal protection

One of the major functions of clothing is to protect the wearer against extremes of environmental temperature and this aspect, from the standpoint of excessive ambient heat as well as cold, has been explored in several recent papers. The fundamental aspects of the development of materials for clothing to provide protection against either heat or cold are fibre selection, blend ratios and weave structure.

Apart from the incorporation of flame-resistant fibres or finishes, the main approach in providing heat protection appears to make use of energy reflecting surfaces as a part of the garment. Most types of heat-protective clothing are impervious to water, which makes them uncomfortable to wear. To overcome the problem, the use of various organic coatings are reported. Another optimum solution is by aluminising an open-mesh structure. The concept has assured great significance in military clothing applications all over the world.

3. AIR PERMEABILITY

The air permeability of a fabric can influence its comfort behaviour in several ways. In

the first case, a material that is permeable to air is also, in general, likely to be permeable to water, in either the vapour or the liquid phase. Thus, the moisture-vapour permeability and the liquid-moisture transmission are normally closely related to air permeability. In the second case, the thermal resistance of a fabric is strongly dependent on the enclosed still air, and this factor is in turn influenced by the fabric structure, as also is the air permeability. A very open cloth can inflict serious wind chill problems on the wearer in cold climates with a breeze blowing and may thus affect survival chances in extreme cases. Finally, a highly air-permeable fabric may be sheer or have as very open structure, so that aesthetic factors such as modesty, dimensional stability, drape, handle etc may result in discomfort of a psychological or physical nature in the wearer. Although air permeability in itself is merely another effect, rather than a cause, associated with such manifestations of discomfort, it can nevertheless provide a convenient and readily measured way of quantifying the likely behaviour of a fabric in these other areas.

Air permeability is normally measured on apparatus designed to force air through the test specimen in a reproducible manner, usually classified into two types. In one system, the pressure difference between the opposite faces of a test specimen is fixed, and measurement is made of the resulting air-flow thro' the material. In the other type, the rate of movement of air thro' the fabric is adjusted to a fixed value and the pressure difference that must be developed across the fabric in order to maintain this air-flow is then measured.

4. MOISTURE-VAPOUR TRANSMISSION

4.1. Moisture permeability

Another important property of a fabric, from the comfort standpoint, is the way in which it allows water to pass through it. This process can take place in both the liquid and vapour phases of water and the difference is an important one. This property is known as 'permeability of a fabric to moisture vapour'.

Moisture-vapour permeability in fabrics is achieved or lost at either the manufacturing or the finishing stage of the production process.

Although heat transmission may be critical to survival in cold weather, it is incontestable that moisture-vapour transmission is crucial to comfort in both cold and hot weather. Free movement of water to the fabric surface is essential if perspiration discomfort, causing fabric wetness with resulting freezing in winter or clamminess in summer, is to be prevented.

4.2. Factors affecting moisture- vapour permeability

The movement of water vapour through a fabric depends considerably on the micro porous nature of the material, and this movement can therefore be modified by any operation that brings about a change in this structure. The factors affecting moisture-vapour permeability are enumerated by different authors, some of which are the effect of fabric structure and properties, finishing treatments, texturising, different yarn twists, blending and mechanical treatments.

4.3. Water repellence and water absorption

In considering the movement of liquid, water through a fabric, two comfort aspects may be identified. Water from an external source, e g rain, should be prevented from reaching the body, an aim that is achieved by using a water-resistant barrier. On the other hand, water generated at the body surface as perspiration should be removed as quickly and as efficiently as possible if comfort is desired, a process that is encouraged by absorption within a body-covering. Both mechanisms are generally needed simultaneously although two requirements are diametrically opposite. In defence clothing in particular, attempts have been made to find a satisfactory compromise between the two, but with no outstanding success so far.

For waterproof and water-repellent finishes on textiles various treatments with chemical compounds are used. For achieving increased absorbency, three methods may be suggested. They are (i) physical modification of the structure (ii) chemical treatment or modification and (iii) coating techniques. Test methods for evaluating both repellence and absorbency are available.

5. SIZE AND FIT

Another important aspect of comfort, which is not strictly a textile problem but clothing one, is that of size and fit. No matter how well a fabric is engineered to have optimum values of heat, water or air transmission, any garment made from it cannot be regarded as comfortable if it does not fit properly. There are two distinct factors in determination of whether the fit of a garment is good. The first one is a subjective one, which depends on whether the wearer achieves psychological satisfaction from the garment. The other factor is a physical one and is concerned with the conditions of contact between fabric and body. A badly fitting garment can restrict cardio-vascular flow, cause skin abrasion, create unpleasant thermal or moisture conditions or induce irritation that manifest to the wearer in the form of discomfort.

In order to establish criteria for good or bad fit, it is necessary to define the size of the body area at which the fit must be made. As a result of obvious non-uniformity of the human population, such a definition cannot be established exactly and some reliance on statistical variability must be assured.

Even where a garment has been selected for optimum fit of has been made to measure, the imperfections of the tailoring process and of human body make it perfectly possible that the wearer may experience some degree of discomfort as a result of faulty fit. In addition, the original size may change because of dimensional instability during use or after washing.

Comfort of fit during stress is very important in military clothing. A procedure for comfort testing of military clothing is described by Gilling, which uses a sequence of tests from laboratory trials to troop manoeuvres in actual operation.

6. AESTHETIC COMFORT

In examining the comfort behaviour of clothing, it is necessary to include some

consideration of factors that are not readily measured by obvious physical tests and may be subjective in that two people may disagree about the level of comfort of the same garment. These aesthetic factors include such aspects as softness, handle, drape and similar properties. It may also include properties such as colour, lustre, style, fashion compatibility and other similar characteristics. The aesthetic properties are normally judged by the way in which it feels or looks, but some of them are in pressed in quantitative terms in the textile technology.

The aesthetic behaviour may be modified in fabrics by either chemical or mechanical treatment. Imparting softness, crease resistant finishes, modifications causing a change in its appearance, wrinkling, pilling and lustre of fabrics are some of the properties investigated in the recent literature.

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KARAKTERISTIKE KOMFORA KOD ZAŠTITNE ODEĆE

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