Clothing comfort: A key parameter in clothing

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Abstract: The basic requirement of clothing is that it must not cause discomfort for the wearer. Modern consumers are interested in clothing that not only looks good, but also feel good. It has been identified, by both natural and synthetic fiber markers, that consumers are increasingly involving more than their visual sense and are allowing touch, smell, intuition and emotion to influence their decisions. As a result, greater importance being attributed to the shopping and wearing experience interest is growing in better feeling fabrics. Comfort is being reinforced as a key parameter in clothing. Good health is treasure. The textiles are making human life, a natural healthy life and making them comfortable.

Comfort has been identified by major fiber marketers as one of the key attributes for consumer’s desirability on apparel products in all markets. Comfort as a pleasant state of physiological, psychological and physical harmony between a human being and the environment. Physiological comfort is related to the human body’s ability to maintain life, psychological comfort to the mind’s ability to keep it functioning satisfactorily with external help and physical comfort to the effect of the external environment on the body.

Introduction

The psychological and physiological states have a number of aspects.

- Thermo physiological comfort – Attainment of a comfortable thermal and wetness state. It involves transport of heat and moisture through a fabric.
- Sensorial comfort – The elicitation of various neutral sensations when a textile comes into contact with skin.
- Body movement comfort – Ability of a textile to allow freedom of movement, reduced burden and body shaping, as required.
- Aesthetic appeal – Subjective perception of clothing to the eye, hand, ear, and nose which contributes to the overall well being of the wearer.

In all these definitions, there are a number of essential components:

- Comfort is related to subjective perception of various sensations.
- Comfort involves many aspects of human senses, such as visual (aesthetic comfort), thermal (cold and warm), pain (prickle and itch), and touch (smooth, rough, soft and stiff).
- The subjective perceptions involve psychological processes in which all relevant sensory perceptions are formulated, weighed, combined, and evaluated against past experiences and present desires to form an overall assessment of comfort status.
- Body clothing interactions (both thermal and mechanical) play important roles in determining the comfort state of the wearer.
- External environments (physical, social and cultural) have great impact on the comfort status of the wearer.

This suggests that comfort is multidimensional and complex. Subjective perception of comfort involves complicated processes in which a large number of stimuli from clothing external environments communicate to the brain through multi channels of sensory responses to form subjective perceptions.

Thermal comfort

Heat Balance

The human body tries to maintain a constant core temperature of about 37°C. The actual value varies slightly from person to person but the temperature of any one person is maintained within narrow limits. In most climates, body temperature is above that of the external environment so that there has to be an internal source of heat in order to maintain the temperature difference. The required heat comes from the body’s metabolism that is necessary burning of calories to provide power to the muscles and other internal functions. However, the body must be kept in thermal balance. The metabolic heat generated together with the heat received from external sources must be matched by the loss from the body of an equivalent amount of heat. If the heat gain and the heat loss are not in balance then the body temperature will either rise or fall leading to a serious threat to life.

The efficiency of the human organism is such that of the energy taken in as food only 15-30% is converted into useful work with the remaining 70-85% of the energy being wasted as heat. Any level of physical activity above the needed to maintain body temperature will result in an excess of heat energy, which must be dissipated, otherwise the body temperature will rise. A lower level of physical activity will lead to a fall in body temperature if the available heat is not conserved by increased insulation.

The approximate energy costs, which are associated with human activity, are shown in Table and range from a minimum value of about 70W when sleeping to an absolute maximum of about 500W (corresponding to hard physical work) can be kept up for a number of hours. If a person is comfortable (i.e. in heat balance) at rest then a burst of hard exercise will mean that there is a large amount of excess heat and also perspiration to be dissipated. On the other hand if the person is in heat balance during strenuous exercise then he or she will feel cold when resting owing to the large reduction of heat generation.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Energy cost (Watts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleeping</td>
<td>70</td>
</tr>
<tr>
<td>Resting</td>
<td>90</td>
</tr>
<tr>
<td>Walking 1.6 km/h (1 mph)</td>
<td>140-175</td>
</tr>
<tr>
<td>Walking 4.8 km/h (3 mph)</td>
<td>280-350</td>
</tr>
<tr>
<td>Cycling 16 km/h (10 mph)</td>
<td>420-490</td>
</tr>
<tr>
<td>Hard physical work</td>
<td>445-545</td>
</tr>
<tr>
<td>Running physical work</td>
<td>700-770</td>
</tr>
<tr>
<td>Sprinting</td>
<td>1400-1500</td>
</tr>
</tbody>
</table>
Heat loss

There are four mechanisms that allow the body to lose heat to the environment in order to maintain its thermal balance. The way the heat loss is divided between the mechanisms depends on the external environment.
- Conduction
- Convection
- Radiation
- Evaporation

The requirements for heat balance vary with the climate; in hot climates the problem is one of heat dissipation whereas in cold climates it is one of heat conservation. Clothing has a large part to play in the maintenance of heat balance as it modifies the heat loss from the skin surface and at the same time has the secondary effect of altering the moisture loss from the skin surface. However, no one clothing system is suitable for all occasions a clothing system that is suitable for one climate is usually completely unsuitable for another.

The main fabric properties that are of importance for maintaining thermal comfort are:
- Insulation
- Wind proofing
- Moisture vapour permeability
- Waterproofing

Insulation

An air temperature of 28-29°C would be required for a person to be able to sit in comfort without wearing any clothes. At air temperatures lower than this, therefore, the body will lose heat without the added insulation given by clothing.

It losses by convection can be prevented, the air itself offers a very high resistance to heat conduction having a value of thermal resistance which is only slightly less than that of a vacuum. Convection losses arise because the body loses heat to the air in contact with it. This heated air is then immediately replaced with cooler air either through natural convection or through air currents. The air currents can be caused by either body movement or by external airflow such as in windy conditions. Convection losses can therefore be reduced by keeping the air surrounding the body at rest. Air tends to ‘cling’ to solid surfaces so that material with a large exposed surface area, such as a mass of fine fibres, acts as a good resister of air movement. In clothing the majority of the bulk is composed of air, for example a worsted suiting fabric is made up of 25% fibre and 75% air whereas knitted under- and quilted fabrics filled with fibre battings or down and feathers may contain 10% or less actual fibre, with the rest consisting of air.

Moisture Vapour Permeability

Perspiration is an important mechanism, which the body uses to lose heat when its temperature starts to rise. Heat is taken from the body in order to supply the latent heat needed to evaporate the moisture from the skin.

There are two forms of perspiration.
- Insensible - in this form the perspiration is transported as a vapour and it passes through the air gaps between yarns in a fabric,
- Liquid - this form occurs at higher sweating rates and it wets the clothing, which is in contact with the skin.

Waterproofing

Waterproofing is very important for the outer layer of a clothing system designed to be worn outdoors. This property is particularly important in cold weather activities for keeping the insulation of any clothing system dry. Water logging of fabrics fills up the air spaces with water and hence reduces their insulation value considerably as shown in Table. If the water penetrates to the skin it can also remove a large amount of heat by the same mechanism as that which makes perspiration effective.

The waterproofing of fabrics can readily be achieved by the use of synthetic polymer coatings, however, the uses of simple coatings bring with it the penalty of excess build-up of moisture vapour above certain levels of activity. The design of clothing for comfort and protection in adverse weather conditions is therefore a matter of compromise between the competing requirements. No one fabric or clothing item can fulfill all the requirements, the clothing system, as a whole has to be considered.

Moisture transport

In order to keep the wearer dry and comfortable, clothing that is worn during vigorous activity, such as sports clothing, has to be able to deal with the perspiration produced by such activity. There are two main properties of clothing that affect the handling of moisture. Firstly there is the ease with which clothing allows the perspiration to be evaporated from the skin surface during the activity. Secondly, after the activity has ceased, there is a need for the moisture that is contained in the clothing layer next to the unnecessarily through having a wet skin. Some workers also consider that the extent to which the wet fabric clings to the skin is also important to the comfort of a garment.

Moisture is transmitted through fabrics in two ways:
- By diffusion of water vapour through the fabric. This appears to be independent of fibre type but is governed by the fabric structure. The measurement of airflow through the fabric provides a good guide to its ability to pass water vapour in large quantities.
- By the wicking of liquid water away from the skin using the mechanism of capillary transport. The ability of a fabric to do this is dependent on the surface properties of the constituent fibres and their total surface area. The size and number of the capillary paths through the fabric are also very important but these are governed by factor such as fibre size, the yarn structure and the fabric structure. The capillary network of the fabric is dependent on the direction under consideration so that the wicking properties through the thickness of the fabric may be different from those in the plane of the fabric. Also the rate of wicking may be different along the warp (wale) direction along the weft (course) direction.
Sensory comfort

Sensory comfort is concerned with how a fabric or garment feels when it is worn next to the skin. It has been found that when subjects wore various fabrics next to the skin they could not detect differences in fabric hairiness. Some of the separate factors contributing to sensory comfort which have been identified are:

- Tickle caused by fabric hairiness
- Prickle caused by coarse and therefore stiff fibres protruding from fabric surface. Matsumura et al. (15) found that the stiffness of protruding fibres given diameter the end of a long fibre is more easily deflected a fixed amount than the end of a short fibre so it appears less prickly. For fibre of a given length a larger diameter is much stiffer depending on the fourth power of the diameter and hence is more likely to prick.
- Wet cling, which is associated with seating and is caused by damp and sticky sweat residues on skin. A factor influencing cling is the actual area of fabric in contact with skin, which in turn is influenced by fabric structure.
- Warmth to touch: When a garment is first picked up or put on it is usually at a lower temperature than the skin and thus there will be a loss of heat from the body to the garment until the temperatures of the surfaces in contact equalize. The differences in cold feel between fabrics is mainly determined by their surface structure rather than by the fibre type.

For example a cotton sheet feels cool whereas a flannelette sheet, which is produced by raising the surface of a cotton fabric, feels comparatively warm. The raised surface gives a lower contact area and hence a slower rate of change of temperature. Ironing a cotton sheet has the effect of increasing the cold feel by compacting the surface structure.

Water absorption

Some textile end uses such as towels, cleaning cloths, nappies (diapers) and incontinence pads require the material to absorb water. There are two facets to the absorption of water: one is the total amount that can be absorbed regardless of time and the other is the speed of intake of the water. These two properties are not necessarily related as fabrics of similar structures but with different rates of uptake of the water. These two properties are not necessarily related as fabrics of similar structures but with different rates of uptake may ultimately hold similar amounts of water if enough time is allowed for them to reach equilibrium. Alternatively soaking the fabrics in water so that they take up their maximum load may mask any differences in rate of uptake.

Water repellency

A number of end uses, particularly those where fabric is used out of doors require the material to be more or less impermeable to rain. These include outerwear such as anoraks, capes and raincoats also industrial fabrics such as tents and tarpaulins. Broadly two main categories of resistance to water penetrations are recognized, based mainly on the treatment that has been used on the fabric.

Waterproof

A water proof fabric is one that is coated or impregnated to form a continuous barrier to the passage of water using for example rubber, polyurethane, and PVC or wax coatings. In such fabrics the gaps between the yarns are filled in by the coating which gives rise to two main drawbacks. Firstly the fabric will no longer allow water vapour to pass through it, making it uncomfortable to wear when sweating. Secondly the binding together of the yarns by the coating reduces the ability of fabric to shear and thus to mould to the body contours.

Showerproof

Showerproof fabrics are ones that have been treated in such a way as to delay the absorption and penetration of water. Showerproofing of fabrics is often achieved by coding them with a thin film of a hydrophobic compound such as a silicone. The film covers the surface of the individual fibres making them water repellent. When a fabric has been treated in this way a drop of water on the surface does not spread. The process leaves the gaps in the fabric weave untouched so keeping it quite permeable to air and water vapour. The process also leaves the handle of the fabric largely unaffected unlike fabrics with a water proof coating. However, water can penetrate the fabric if it strikes it with sufficient force as in heavy rain; alternatively, the flexing of the fabric during wear can cause the gaps in the weave to open and close so allowing the water to penetrate.

Conclusion

In modern consumer markets, companies that fail to develop new products are facing great risk. Their existing products are vulnerable to various changes in the market paces, such as changes in consumer needs and preferences, new technologies, shortened product life cycles, and increasing competition from substitutes and foreign domestic companies. Meanwhile, new product development is risky with a disturbing failing rate.

It has been estimated that major of the new products fail at launch. The common features of successful new products across a wide range of industries and concluded that the number one success factor is a unique, superior product with higher quality, new features and higher value in use.

Consumers are demanding more functions, higher quality and more added values. Fashion is no longer dictated by a handful of couture designers. Instead, consumer lifestyles are having a growing impact on the direction of fashion trends. Today consumers desire garments that enable them to be comfortable and feel good in, whatever activity they happen to be engaged upon.

They want their clothing to be natural comfortable and ‘easy care’. With these changes, development of new products to satisfy consumer needs and wants has become increasingly more difficult and more important for competing in the consumer markets.

References

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