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AN INVESTIGATION OF CLOTHING COMFORT PROPERTIES ON MARINE FISHERIES EMPLOYEES

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ABSTRACT

Bodies of the people can be damaged as a result of effects due to the working conditions of people. Employees wear clothes to avoid these effects within the working time in order to protect the habit of body from harmful impacts. The most important expected performance feature of worn clothing is to protect the employess from these impacts. Protection function of the worn clothing must fulfill during working. As well as comfort properties of clothing provided to employees, the effects of increasing business efficiency is important. Capable of breathable membranes are used in order to increase the internal comfort of protective clothing so that disposal of moisture and heat of evaporation due to moisture are provided. In this study, protection and comfort properties of the structures of produced clothes that are worn by fishers were examined. The protection feature of clothes is basically waterproofing due to the working conditions of fishers. Having air flow between the environment and body, providing the thermal isolation and moving easily can be defined as basic comfort features of these clothes. Protection and comfort features of the present clothes of fishers have been tested and obtained results are discussed.

Keywords: Breathable clothing, Protective clothing, Thermal isolation,Clothing of Fishers, Thermal Comfort.

1) Introduction

By means of developments in textile technology, the demand for high performance protective clothing increase needs both being protective and lasting fabrics and also being comfortable. In recent years, researchers have been focus on protective clothing about comfort. When protective clothing comfort is the subject, the first important point is thermal comfort (1). Thermal comfort is the state of being satisfied in terms of thermal environment (2). Even ergonomics science defines the thermal comfort in a different way, thermal comfort in clothing is determined by carrying the features of thermal insulation and capable of breathing at the working environment. Thermal charge in the positive and negative direction over people working in the uncomfort environment or in uncomfortable outfit can lead to performance degradation as a result of distraction. Comfort of clothing is also important when performing the protection of human health and safety function. Clothing that does not provide adequate comfort decreases the efficiency of fulfilling when performing the task. Since the first aim is providing high protective feature, clothing is heavy to the person, limits the possibilities to act, when adequate heat and moisture transfer can't done, efficiency of the person can be decreased (3). Many studies carried out on thermal comfort and now production of light protective and more comfortable breathable clothing with microporous and hydrophilic membranes can be done.

Especially for sports clothing and clothing for workers in public areas are uncomfortable because standart cover material which provides water proofed is air-proof. The importance of air-permeable, micro-porous, nano-additive polyurethane coatings which is produced for

waterproof and air permeability fabrics is increasing day by day. Moreover, heated or cooled protective clothing equipped with a number of units has started to produce in the category of smart textiles in order to increase thermal comfort. In the future, air permeable and smart protective type clothing need to focus because this will be important for the economy of Turkey.

Thermal insulation features of fabrics that is composed of natural and artificial staples are compared in Alambeta instrument. Results shows that artificial fabric made of tencel yarn has lower thermal conductivity and thermal absorption value than fabrics made of cotton on the other hand artificial fabric made of tencel yarn has more thermal diffusion and resistance. Also, it is observed that weaving type is important over thermal insulation features.

The sense of cold or hot when person touches to the fabric has been analysed over people who wears different types of underclothes. The results of tests on Alambeta instrument has introduced that thermal absorption feature is affected from fabric structure formation and finishing operations. The higher the thermal resistance of underwear, the hotter sense with outer wear person felt (5).

Thermal features of textile material which composed of single and multiple layer has been tested on Alambeta instrument and relationship between thermal insulation features of material set and thermal insulation features of components has been researched. It is concluded that thermal insulation features of composite fabric is dependent on configuration and features of components (7).

One of the major contrasts in technical textiles is water proof materials can allow to pass the water vapor (sweat). Without this feature, waterproof clothing worn by highly active soldier, naval forces, special forces, ope field workers and sportman causes physiological problems. The results of this situations are given in Table 1 (8).

At very extreme war conditions, people can not decide the weather conditions and intensity of activities. Hence, injuries and deaths rely on excessive decrease or increase in body temperature can occur. To solve this problem, polymers and textile producers has a great effort. At the present time, there are coated or laminated water proof and water vapor permeable fabrics in the market (8).

Cold and warm climate clothing, various working clothings for those working under severe weather conditions, raincoats includes special fabrics finished products which are capable of breathing (throws the body sweat out) but water proof. They can be used for military purposes as well as sports and work areas. Providing thermal insulation of climate clotings which will be used for extreme cold, extreme hot and rainy environments, not passing the snow water to the inside from outside and taking outside the sweat that formed inside in other words providing air circulation is expected. For this purpose, three-layer breathable fabrics which is fabric on the outer part, membrane in the middle and fine tricot lining on the inner part have been developed.

Table 1. The effects of water and wether proof clothing at different conditions

Conditions	Activity	Result
Cold/Wet Weather	Medium Mobility	Uncomfortable
Cold/Wet Weather at Sweat soaked clothes	Low mobility subsequents high mobility	Hypothermia (Cold stress)
Hot/humid weather and wearing protective clothing	High mobility	Hypothermia (Heat stress)

Turkey is surrounded by seas on three sides so that fisheries is quite common sector. Working conditions in fisheries sector shows differences with seasonal weather conditions because of being open space. Workers in the fisheries sector have always continuous contact with water due to the working environments. Workers in this sector should be basically protected both against water and seasonal weather conditions. While this protection is providing, ergonomic working conditions is an important point.

2) Materials and Methods

2.1) Material

In Figure 1, clothing of the workers in the fisheries sector can be seen. When examining the structure of the produced clothing, clothing is composed of fabric layer to hold together the structure and PVC coating that is covered over this fabric layer. During the production of the clothing, a connecting method is used in order not to allow water leak at the places of assembly.



Fig. 1: Clothing worn by fishers for protection

2.2) Test Method

2.2.1 Alambeta Instrument and Working Principle

Alambeta instrument was developed for measurement of thermal absorption by Lubos Hes at the Czech Republic. The photograph of this instrument and simply drawn parts are shown in Figure 2. Instrument is composed of measuring head and a base to place the sample. When the measurement start, heat flow sensor that is consisted in measuring head will drop down and it touches to the sample that is placed planar to the lower plate. At the same time surface temperature of the sample suddenly change and instrument computer record the heat flow values. Concurrently, one photoelectric sensor measures sample thickness. This procedure resembles the process of touching to the fabric of the human finger at the room temperature (12).

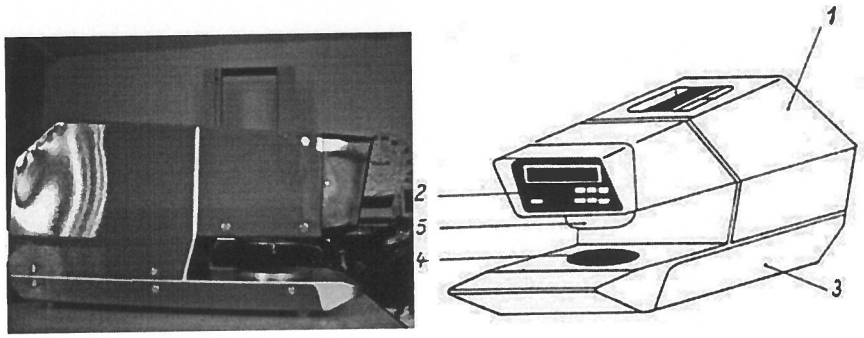

Fig. 2: Alambeta Instrument (1) control and evaluation unit; (2) control panel with display; (3) frame and housing unit; (4) measuring plate; (5) measuring head.

2.2.2. Test Conditions of Alambeta Instrument

Samples are taken from front and rear of the fabric and membranes that composes the protective clothing and then results are taken by testing in the Alambeta instrument. Evaluation was made of the obtained results.

2.2.3. Thermal Insulation Parameters (Alambeta Outcomes)

Thermal insulation parameters that is measured in Alambeta instrument are listed below:

a) coefficient of thermal conductivity (k)
b) coefficient of thermal diffusion (a)
c) coefficient of thermal absorption (b)
d) coefficient of thermal resistance (r)
e) Material thickness (h)
f) Maximum and steady heat flow rate density(p)
g) Steady heat flow density (qs)

2.2.3.1. Thermal Conductivity

Thermal conductivity or heat conductivity is transter of the heat quantity from unit of material thickness to the unit of surface area when heat transfer is dependent on temperature difference and continuous regime conditions (steady state conditions). Coefficient of thermal conductivity is calculated by the following equation (7).

$$k = \frac{Q}{A \cdot \frac{\Delta t}{h}} \quad , \mathrm{Wm^{-1}K^{-1}}$$

Here,
k : coefficient of thermal conductivity,
tΔ: Temperature difference,
Q : Heat transfer,
A : Area,
h : Material thickness (mm)

2.2.3.2. Thermal Diffusion

Thermal diffusion is about the ability of passing air flow temperature inside the fabric structure. Thermal diffusion of the textile materials is the ability of temporal thermal textiles. Coefficient of thermal diffusion for homogeneous materials is calculated by the following equation (7).

$$a = \frac{k}{\rho.c}, \ m^2s^{-1}$$

Here,
a : coefficient of thermal diffusion (thermal diffusivity coefficient),
ρ: fabric density,
k : coefficient of thermal conductivity,
c : specific heat capacity.

2.2.3.3. Thermal Absorption

Because of Thermal absorption being a property of surface, it can vary due to the textile finishing processes. This parameter helps to evaluate the characteristics of the fabric in terms of feeling cold or hot when human skin briefly touches any object such as textile material. Materials with low thermal absorption gives the feeling of hot, while high-value ones give the feeling of cold. The thermal absorption is a temporary parameter which is not related to temperature difference between fabric and skin nor the measurement time. It is not a technical parameter but a real textile characteristic. The validity of the thermal absorption confirmed in many tests which is done by Alambeta instrument comparing the measured values of subjective sensation of approximately 100 by the results (5). The thermal absorption coefficient for homogeneous material explained in the following equation (7).

$$b = \sqrt{k.\rho.c} \ , \ Wm^{-2}s^{1/2}K^{-1}$$

Here,
b : coefficient of thermal absorption,
ρ: fabric density,
k : coefficient of thermal conductivity,
c : specific heat capacity of the fabric.

2.2.3.4. Thermal Resistance

Thermal resistance defines the temperature difference corresponding to the unit area of the material at the unit heat energy flow per unit time on the unit material thickness. This parameter is proportional to the thickness of the material and calculated using the formula below.

$$r = \frac{h}{k} \ , \ m^2KW^{-1}$$

Here,
r : Thermal resistance,
h : thickness of the material,
k : coefficient of thermal conductivity.

3) Results and Discussion

The clothes which workers in fishing market used are done comfort tests using Alambeta instrument. Numeric test results couldn't get, because the fabrics tested on instrument don't allow the passage of air. As a result of this situation encountered, it can be said that clothes which fishermen use to work have not a good quality in terms of thermal comfort and clothing. When we examine the fabrics which are used to produce the clothes of the fishermen, we see that their thermal insulating is too bad. Because of these features of clothes, workers wear extra clothes which makes working condition uncomfortable, to enable their protective features. In the light of these results obtained, determination is made that the protective clothes which workers in fishing sector wear need to be improved.

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