TEXTILE MATERIALS USED FOR UV PROTECTION

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ABSTRACT

Skin cancer has been increasing worldwide due to higher exposure to sunlight. Ultraviolet rays influence all living organisms and their metabolisms. Higher exposure to ultraviolet radiation component of sunlight results in skin damages such as sunburn, premature skin ageing and skin cancer. Modification in the construction parameters of fabrics with appropriate light absorbers and suitable finishing methods can be used as UV protection fabrics. This paper gives an insight about efficient textile clothing can be used for protecting human skin from the harmful ultraviolet radiations. The various influential clothing parameters offering resistance to penetration of ultraviolet radiations through the fabric

Key words: Textile fabrics, UV radiation, UV protection finish, UPF

1.0 INTRODUCTION

Ultraviolet radiation is the form of radiant energy emitted by the sun that has effect on the skin. Sunlight that reaches the earth is composed of 66% of infrared light, 32% visible light, and 2% ultraviolet light (UVL).

2.0 CLASSIFICATION OF UV RADIATIONS

The ultraviolet radiations are classified depending up on the wave lengths. Shorter wave lengths show more energetic radiations.

- **UVA (400 nm-320 nm)** - Helps in the formation of vitamin D by the skin but it shows some harmful effects like sunburn on human skin and cataracts in eyes

- **UVB (320 nm - 290 nm)** - It damages the structure of DNA
• **UVC (290nm -100 nm)** - These are the most dangerous radiations but it is getting filtered by the ozone layer.

Among these radiations UV-A and UB-B reaches the earth’s surface and shows hazardous effects on human beings.

![Spectrum of solar rays](image)

**Figure 1** Spectrum of solar rays

*Exposure to excessive UV radiations causes*

- Chronic skin diseases
- Malignant skin cancer
- Destroys the effectiveness of immune system
- Potential risks of eye diseases
- Damage the cornea and lens of the eye

![Effect of UV rays on DNA](image)

**Figure 2** Effect of UV rays on DNA

We can protect ourselves from UV radiations by using sunscreen lotions with good SPF, by using sun glasses and by wearing UV protective clothing.
3.0 ROLE OF FABRIC IN UV PROTECTION

Clothing with alteration in some construction parameters with light absorbers and finishes helps to provide protection from the harmful effects of ultraviolet radiations. The protection extended by the textile materials are denoted by Ultraviolet Protection Factor (UPF).

3.1 Effect of parameters on UPF

3.1.1 Nature of fibre

UPF is strongly dependent on the chemical structure of the fibres. Natural fibres like cotton, silk, and wool have lower degree UVR absorption than synthetics such as PET (because of the presence of conjugated aromatic polymer systems). Cotton fabric in a grey state provides a higher UPF than in bleached state because of the presence of pectin’s and waxes in it. Protein fibres also have mixed effects in allowing UV radiation.

3.1.2 Fabric construction factors

Fabric construction factors are the most important determinant of UV radiation which includes weave and weave density, cover factor, porosity, weight and thickness. All the factors are interrelated and influence each other.

3.1.4 Effect of weave and weave density

- Closer the fabric’s weave, higher the UV radiation protection
- Tightly woven, light-weight fabrics such as linen, cotton provides sufficient UV protection.
- Satin weave has good protection than twill and plain weaves because in satin weave it is possible to achieve higher warp/weft density so UV radiation has less free space to pass through than in twill or plain weaves.

Cover factor

- Cover factor is defined as the percentage area occupied by warp and weft yarns in a given fabric area.
- Woven fabrics usually have a higher cover factor than knits due to the type of construction
- Closer the thread set higher is the UPF
Porosity, Weight and Thickness

- The UPF increases with increase in fabric density and thickness
- Fabrics with the maximum number of yarns in warp and weft give high UPF
- Porosity depends up the fabric construction and fabric weight closer the weave or knitting, less is the UV transmitted

4.0. DYEING AND FINISHING

The factors which influence the UV protection ability of textile are

- The type of dye or pigment
- The absorptive groups present in the dyestuff
- Depth after dyeing
- The uniformity and additives present in the finishes

Colour and Dyes: Dyeing improves the UPF by modifying the proportion of UV light transmitted through fabrics. Fabrics with darker colours transmit less UV light than lighter colours. Increase in the concentration of dye gives darker shade of fabric which increases the UPF.
5.0 FINISHING FOR UV PROTECTION IN TEXTILES

5.1 UV ABSORBERS

UV absorbers are the organic or inorganic compounds which absorb UV radiations and protect human skin. The function of an UV absorber is to absorb UV radiations effectively throughout the UV region (280-400 nm), also be stable itself and should dissipate absorbed energy in such way that there should not be any chance of degradation or colour change in the medium it protects.

UV absorbers when absorb the UV radiation convert the electronic excitation energy into thermal energy through a fast reversible intra-molecular proton transfer reaction, functioning as radical scavengers and singlet oxygen quenchers.

HALS:

- All organic UV absorbers are derivates of
  a) O – hydroxyl benzophenone
  b) O – hydroxy phenyl triazine
  c) O – hydroxyl phenyl benzotriazole
- Titanium di-oxide is the of the inorganic uv absorber.

UV absorbers are available in form of colour less dyes which can be applied on the textile substrate through dyeing along with dyes. They should be compatible with dyes and may be applied in the form of normal padding, pad thermosol and pad-dry cure methods. Depending upon the type of fibre and construction about 30 – 40 gpl of UV absorbers are applied on the fabric.
5.2 NANO – FINISHING

With an enormous use of nano science and technology today, a new area has been developed in the textile finishing called as nano – finishing. Nano particles used in textiles for UV protection are zinc oxide (ZnO) and titanium di-oxide (TiO2). These inorganic materials absorb the UV radiation thus blocking the radiation from reaching the wearer’s skin.

![Diagram of Photocatalytic degradation of TiO2]

The properties which make ZnO and TiO2 as attractive choices of UV protection are:

1. They are non – toxic
2. They are compatible with human skin
3. They are chemically stable at both high temperatures and UV region
4. They are easily available.

These nano particles are applied on the fabrics using a binder resin and through padding mangle. But as only one face of the fabric is exposed to UV radiation method of spraying with compressed air or spray gun can be used for coating of these particles on fabric. Nano particles which get embedded into the fibre enhance the UV blocking property and thus protect the human skin from harmful UV radiations.

6.0 TESTING OF CLOTHES FOR UVR PROTECTION

Measurement of UPF (ultraviolet protection factor)

The clothes which are used as protective clothing for UVR should be tested to know the correct level of protection, given by UPF. To find UPF instruments like spectro radiometers, spectrophotometers and xenon lamps are used where in UPF is found by transmitting UV rays into the fabric.

Two methods VITRO method and VIVO method are available for measuring UPF. In vitro method UPF is measured in cloth by measuring the diffuse spectral transmittance where as in VIVO method UPF is measured by measuring the increase in exposure time required to sun burn. After measuring UPF’s the fabrics can be graded and care labelled in accordance with AATCC TM /83 or AS / NZS 4399.
7.0 CONCLUSION

Textile materials degrade when exposed to UV radiation causes, due to excitations in some parts of the polymer molecule and a gradual loss of integrity. UV protected woven or knitted fabrics have higher cover factor than traditional fabrics. The ultraviolet protective factor of fabric is strongly dependent on the physical and chemical structure of the fibres. Darker coloured fabrics can offer more protection than lighter coloured fabrics for the same fabric structure and dye. Protection form harmful UV rays can be by directly avoiding sun exposure. But this cannot be accepted at all the times. UVR exposure can be reduced not only by wearing sunglasses and hats but also creating awareness among people to wear UV protective clothes which do provide UVR protection for skin.

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