Emerging Trends in Textile Industry-Exploring Ultraviolet radiation protection clothing

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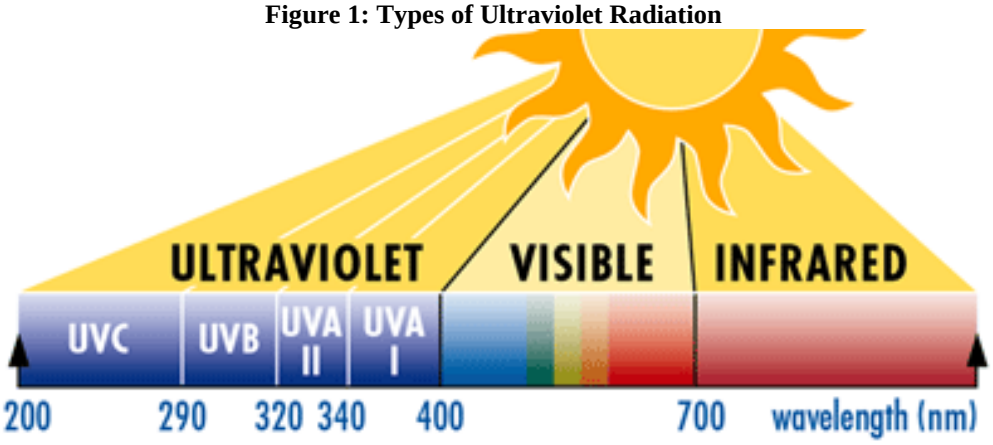
Abstract

Sunlight is the prime energy source in the world and the regular and smooth circulation of environment cycle depends on the sunlight energy. The continuous energy spectrum of sun radiation ranges from about 0.7 nm to 3000 nm. The Ozone layer in the atmosphere acts a medium to filter out the rays from sun radiation which will be harmful for the environment and human being. With the increasing greenhouse effect, the Ozone layer depletion is occurring and their filtering capacity is definitely in downward condition. As a result, the ultraviolet (UV) ray, which is harmful for human body, reached to the earth surface and its amount increased day by day. The wave length of ultraviolet radiation lies between 200-400 nm. The UV ray categorized into three types, there are UVC rays, UVB rays and UVA rays

I. Introduction

Among them UVC is highly damaging to human skin, it is effectively filtered out by the Ozone layer and as a result it cannot reach on the earth surface. But UVA and UVB can penetrate to a depth of few millimeters of the human skin. Skin cancer will be the final result and changes in central nervous system and ocular region would be happen. Skin is a very important organ of human body and acts as an effective barrier from external harmful effect. From these facts, it is highly essential to protect the skin from the severe exposure of UV rays. It is necessary to mention that, it was recognized that some sun exposure is important for health, at the very least, to maintain healthful vitamin D levels. Vitamin D deficiency is quite common and results many forms of cancer, as well as heart disease, osteoporosis, multiple sclerosis and many other conditions and diseases. Human make 90 percent of our vitamin D naturally from sunlight exposure to our skin specifically, from UV B exposure to the skin, which naturally initiates the conversion of cholesterol in the skin to vitamin D. It is a bad news, that at present more than 1 billion people worldwide vitamin D deficient. So, human being need sunlight exposure in mild level to maintain the vitamin D levels but it is also compulsory to protect the human body from severe exposure under sunlight, especially from UV B.

Figure 1: Types of Ultraviolet Radiation



II. Ultraviolet Protective Factor

Ultraviolet Protection Factor is a rating system used for apparel. It indicates how effectively fabrics shield skin from ultraviolet (UV) rays. The higher the UPF number, the greater degree of UV protection a garment offers. UPF is similar to SPF (Sun Protection Factor), the rating system used for sunscreen products. UPF gauges a fabric's effectiveness against both ultraviolet A (UVA) and UVB light. An SPF number pertains only to a sunscreen's effectiveness against UVB rays, the sunburn-causing segment of the ultraviolet spectrum.**UVA (320-400 nanometers)** Causes premature skin aging, wrinkling and potentially skin cancer. Penetrates skin more deeply than UVB rays. Can impact skin during any hour of daylight. Can penetrate clouds and untreated glass.**UVB (290-320 nm)**Causes sunburn; also contributes to premature skin aging and potentially to skin cancer. Causes most impact between 10am and 4pm. Can penetrate clouds, but not glass. **UVC (200-290 nm):** Deadly to humans. Fortunately, it is absorbed by atmospheric gases before it reaches the earth's surface. Table 1 shows various UPF Range and their corresponding UPF Rating with protection category.

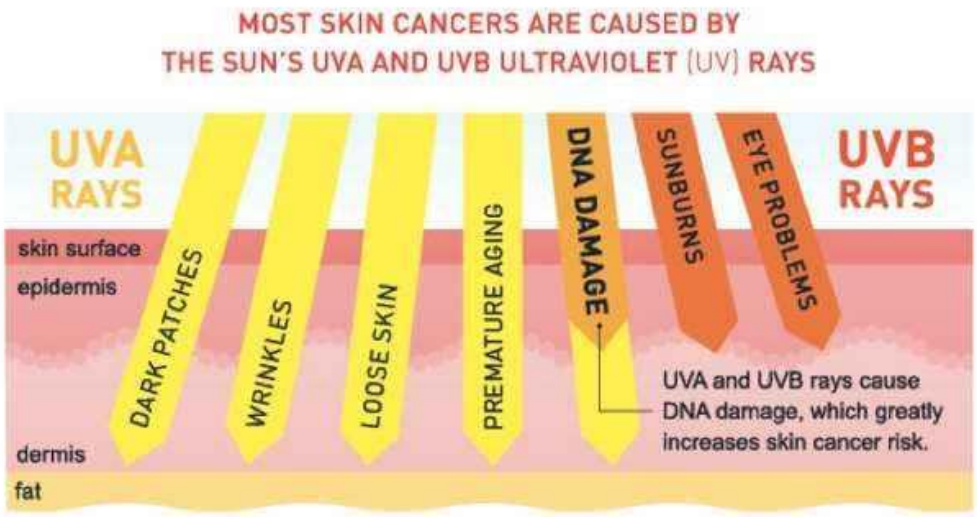
Table 1: Ultraviolet Protective Factor Rating

UPF Range	Protection Category	Effective UV-R Transmission (%)	UPF Rating
15-24	Good	6.7-4.2	15, 20

25-39	Very Good	4.1-2.6	25, 30, 35
40-50, 50+	Excellent	Less than 2.5	40, 45, 50, 50+

While no doubt true in some cases, many newer T-shirts are treated with "optical brightening agents." These OBAs, appearance-enhancers for white fabrics, also boost disruption of UV radiation. Most common household detergents also include OBAs, so repeated launderings will increase the fabric's accumulation of brighteners and thus increase its UV-protective ability. Some experts estimate that such shirts may offer a UPF of nearly 15. Fair-skinned individuals (Types I and II) commonly embrace UPF-rated clothing as an effective method for shielding their sun-sensitive skin. Yet people with any skin type can benefit from having their skin covered with UV-protective clothing to guard against the less-obvious risks (aging and skin cancer) associated with UV rays. Children also can benefit from UV-protective clothing. The Centers for Disease Control and Prevention (CDC) reports that just a few serious sunburns can increase a child's risk for developing skin cancer later in life. Clothing is a reliable form of sun protection for children, particularly for those who are not fond of sunscreen lotions. UV-protective clothing also makes sense for outdoor-oriented people of any skin type who plan to explore areas with increased UV intensity, such as high elevations, equatorial regions, or areas in close proximity to reflective surfaces (water, sand, snowfields). An overall UV protection strategy includes the use of sunscreen, wearing UV-protective clothing and limiting the amount of time you expose yourself to UV radiation. UPF-rated clothing can optimize any person's protection against UV transmission. Children, who sometimes find sunscreen unappealing and resist its use, may accept the use of UPF-rated clothing more cheerfully. This can help minimize the accumulation of sun exposure during childhood years, which medical experts have linked to an increased risk of developing skin cancer later in life. The National Cancer Institute reports "studies have consistently shown that increased cumulative sun exposure is a risk factor for nonmelanoma skin cancer." UPF-rated clothing originated in Australia. Due to its proximity to the equator, Australia experiences some of the world's most intense UV exposure. Other factors make Australians highly vulnerable to UV light: A generally clear atmosphere in the southern hemisphere; depleted ozone over Antarctica; a close pass to the sun during the earth's orbit in January, the height of Australia's summer. As the earth tilts at that time of year, sunlight coming through the Antarctica's ozone hole lands on Australia.

Figure 2: effect of ultraviolet radiation on human skin



Where, *MED* is the minimal erythemal dose or quantity of radiant energy needed to produce the first detectable reddening of skin after 22 ± 2 hours of continuous exposure. In order to avoid the harmful effects of UV rays, there are few basic defenses that everyone should keep in mind, Avoid peak hours of sunlight, use Sunscreen, Clothing construction and Chemical treatment of fabric. Among the above four defenses, the last two options are discussed in this assignment. Because clothing construction and chemical treatment of fabric are directly related to Textile Engineering work.

III. Chemical Treatment of Fabric

The application of nano particles (nanometer particles are those superfine particles with sizing range around 1-100 nm) to textile materials has been the object of several studies, aimed at producing finished fabrics with different functional performances. For example, nano-Ag has been used for imparting antibacterial properties, nano-TiO_2 for UV blocking and self cleaning properties and ZnO nano particles for antibacterial and UV blocking properties. Among them nano TiO_2 and nano ZnO are effective against UV rays. Titanium dioxide and Zinc oxide reside on the surface of the fabric and shows strong UV-absorbing capability and UVA and UVB could be effectively shielded while visible light could freely penetrate through. These ingredients are safe and non toxic and chemically stable under exposure to high temperature. Nano particles can provide high durability for treated fabrics as they possess large surface area and high surface energy that ensure better affinity for fabrics and lead to an increase in durability of the desired textile functions. In order to increase the wash fastness, nano particles

can be applied by dipping the fabrics in a solution containing a specific binder. UPF rating of very good to excellent can be achieved by using nano particles.

IV. Clothing Construction

Most of our clothing is dyed attractive or functional colours. Many dyes absorb UV, which helps reduce exposure. Darker colours tend to absorb more UV than lighter colours, including whites and pastels, but bright colours such as red can also substantially absorb UV rays.[3] The more vivid the colour, the greater the protection; a bright yellow shirt is more protective than a pale one. But even a pale fabric can offer good protection if the weave, material, weight, etc. are effective at keeping out UV. And many white fabrics have "optical whitening agents," chemical compounds that strongly absorb UVR, especially UVA. Though loosely evaluating fabric content, colour, weight and weave by eye are helpful at sizing up UV protection, it is difficult to pinpoint just how protective a piece of clothing is simply by looking at it. Holding it up to the light helps show how much light passes through, but this isn't ideal, because the human eye sees visible light but not UV radiation. One solution is to choose garments with UPF labels. UPF, a concept originally standardized in Australia in 1996, stands for ultraviolet protection factor, which quantifies how effectively a piece of clothing shields against the sun. The label means the fabric has been tested in a laboratory and consumers can be confident about the listed level of protection. It is based on the content, weight, colour, and construction of the fabric, and indicates how much UV can penetrate the fabric.

- Weave: If a fabric is very tightly woven or knitted there are fewer "holes or spaces" for UVR to sneak through the fabric.
- Color: The dyes used in fabrics typically absorb some UV rays. Darker colors use more dye so they absorb more UV radiation and provide better protection. Un- dyed fabric does not provide much protection at all. Lighter colors reflect visible light, but UV radiation passes through the fabric to the skin. Many detergents contain brighteners that make clothing look cleaner and whiter and these act like dyes. Repeated washings can slightly increase the UV absorption of the fabric.
- Weight: The thicker and dense fabrics absorb more UV rays and provide better protection than thinner fabric against UV rays.
- Stretch: When a fabric gets stretched out, the holes between the yarns open up and the UV rays can get through to the skin.
- Wetness: The UPF of wet garment is significantly lower than that of the same garment measured in the dry state. Water in the interstices of the fabric reduces the scattering effect and therefore, increases its UV radiation permeability. Wetness may cause a 30%-50% reduction in a fabrics UPF rating.
- Construction: Dense, tight construction (either weaves or knits) minimizes the spaces between yarns, which in turn minimizes the amount of UV light that can pass through. Some tightly constructed UPF-rated garments use vents to boost air circulation and help the wearer stay cool. Thicker fabrics also help reduce UV transmission.
- Treatments: Chemicals effective at absorbing UV light may be added during processing. Specialized laundry additives, which include optical brightening agents and newly developed UV-disrupting compounds, can boost a garment's UPF rating.
- Fibre type: Polyester does an excellent job at disrupting UV light (due to hydrogen- and carbon-based benzene rings within the polymer). Nylon is good. Wool and silk are moderately effective. Cotton, rayon, flax and hemp fabrics (natural fibers composed of cellulose polymers) often score low without added treatments. However, unbleached or naturally coloured cotton performs better at interacting with UV light than bleached cotton.
- Condition: Worn or faded fabrics are less effective against UV light.
- Age: UV protection capacity decreases with increasing the service life of the garments.

V. Merits and limitations of UV radiation protection clothing

Clothing is the most basic and generally the best means of sun protection. Not all clothing is equal, however, and some of it isn't actually very good at protecting us. The sun damage done to every exposed part of your body is cumulative over your lifetime, continually adding to your risks of premature skin aging and skin cancer. So, to put it simply, the more skin you cover, the better. A long-sleeved shirt covers more skin than a T-shirt, especially if it has a high neckline or collar that shields the back of the neck; long pants cover more skin than shorts. Of course, you can have clothing over every square inch of your body, but if the sun goes right through it, it's not much use. Fabrics are made of tiny fibers woven or knitted together. Under a microscope, we can see lots of spaces between the fibers; UV can pass directly through these holes to reach the skin. The tighter the knit or weave, the smaller the holes and the less UV can get through. Twill, used to make tweeds or denim, is an example of a tightly woven fabric. Open weave fabrics provide much less protection. Fabrics can be made from many types of fibers, including cotton, wool, and nylon. Most fibers naturally absorb some UV radiation, and some have elastic threads that pull the fibers tightly together, reducing the spaces between the holes. Synthetic fibers such as polyester, lycra, nylon, and acrylic are more protective than bleached cottons, and shiny or lustrous semi-synthetic fabrics like rayon reflect more UV than do matte ones, such as linen, which tend to absorb rather than reflect UV. Buy garments that suit your purpose. You don't need a heavy work shirt for the beach, but a long-sleeved, tightly woven linen shirt can be both cool and sun-smart. If you are buying elastic garments like leggings, make sure you purchase the right size — overstretching will lower the UPF rating. Look for garments with a UPF of at least 30 so that you know you're getting effective sun protection. Choose garments that cover more skin—there's no point

in a high-UPF bikini. Instead, consider a rash guard or swim shirt. Made of lightweight, elastic materials like spandex, these athletic tops will cover your upper body without weighing you down. You can also have beach skirts or sarongs ready for when you leave the water. Wash new garments made from cotton or cotton blends two or three times at least. This can often permanently raise the UPF rating due to shrinkage of the spaces between the fibers. Select wide-brimmed hats (at least 3" in diameter) that shade your face, neck and ears. When outdoors, seek out shaded areas under awnings or trees and minimize your time in the direct sun. Be aware that UV light can bounce off surfaces such as water, snow and glass, hitting your skin twice and increasing the intensity of exposure. Use UV-filtering sunglasses and sunscreen with a sun protection factor (SPF) of at least 15 for everyday incidental exposure and 30 or higher for extended exposure. Apply sunscreen on all exposed areas — clothing can't cover everything. Remember, sun-protective clothing doesn't have to be boring: it can be light and bright and fashionable and fun. And when chosen and used correctly, it's the best form of sun protection.

Conclusion

UV radiation causes degradation of textile materials, due to excitations in some parts of the polymer molecule and a gradual loss of integrity. UV radiation is also responsible for causing many skin problems, including sunburns, age spots, wrinkles, freckles, allergic rashes and UV radiation is the major cause of skin cancer. But excessive avoiding of sunlight causes vitamin D deficiency because UVB portion converts our cholesterol into vitamin D. During selecting garments we should consider the above factors. A highly dense, weight fabric can save us from the harmful effect of UV ray.

References

[1]. G. Reinert, F. Fuso, R. Hilfiker, and E. Schmidt "UV-properties of textile fabrics and their improvement", Text. Chem. Color, vol. 29, no. 12, pp. 36-43, 1997.
[2]. Osterwalder U, Schlenker W, Rohwer H, et al. Facts and fiction on ultraviolet protection by clothing. Radiat Prot Dosimetry 2000; 91(1):255–259.
[3]. M. Ramachandran, Application of Natural Fibres in Terry Towel Manufacturing, International Journal on Textile Engineering and Processes, Vol 1, Issue 1, 2015, pp. 87-91.
[4]. Haixia Li, Hua Deng, and Jing Zhao "Performance research of polyester fabric treated by nano TiO_2 anti ultraviolet finishing", International journal of chemistry, vol. 1, no. 1. P. 57-62, 2009.
[5]. Pramod Raichurkar, Updeep Singh, Tushar Patil, M. Ramachandran, Cotton Weaving - A New Business opportunities and diversification in Cotton weaving, International Journal on Textile Engineering and Processes, Vol 1, Issue 2, April 2015, pp. 11-15.
[6]. Malvika Sharma, M. Ramachandran, Development and characterization of fibre reinforced material based on potato starch and jute fibre, International Journal of Applied Engineering Research. Vol 10, No. 11 (2015) pp. 10324-10327.
[7]. S. Kathirvelu, Louis D Souza and Bhaarathi Dhurai "UV protection finishing of textiles using ZnO nano particles", Indian journal of fiber and textile research, vol. 34, pp. 267-273, 2009.
[8]. Rakshit Agarwal, M. Ramachandran, Stanly Jones Retnam, Tensile Properties of Reinforced Plastic Material Composites with Natural Fiber and Filler Material, ARPN Journal of Engineering and Applied Sciences, Vol. 10, No. 5, 2015, pp. 2217-2220.
[9]. D. Saravanan "UV protection textile materials", Autex Res. J, vol. 7, pp. 53-62, 2007.