Perceptive and Protective Textile Finishes

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Abstract
The conventional textile finishes help modify basic handle of the fabric and provide surface softness or stiffness, whereas the functional effect finishes not only impart intended comfort but also the performance properties such as moisture management, flame retardant, oil and water repellency, sun protection, hygiene improvement, etc. Thus the functional finishes generate value addition through perceptive and protective effects.
Keywords *- sensory perception, skin care, health care, repellence and protection*

I. Introduction

The functional finishes provide a method whereby the deficiencies in the textile can be corrected or specific properties can be introduced. Such textile substrates which are deficient in some properties or where some improved properties are desired are treated with specialty effect finishes. Thus, conferring desired effects, meeting end use expectations, ensuring sustainable ECO norms, enhancing value for money are the major considerations for such perceptive and protective finishes. The functional finishes are categorized as

1. Sensory perceptive – these impart effects which can be sensed or which have impact on the senses of human being- such as touch, smell, visual appeal and physical comfort
2. Protective and repelling – effects which can shield the textile wearer from external environment or factors

- Skin care –rejuvenating
- Health care –antimicrobial
- Aroma - fragrance
- Fire protective – flame retardant
- Sun protection – UV absorbers
- Soil free - antistatic
- Stain free- oil and water repellent
- Quick dry - moisture management
- Wrinkle free - resins

Selection criterion - depends on desired functional effect and various factors such as

i) Intended end use
ii) Desired effect - either singular or multiple properties
iii) Regulatory norms – Ecological, Toxicological, Sustainable
iv) International Brand's requirements
v) Fastness testing and evaluation methods
vi) Washing method and durability expectations

Further, the regulating authorities for environment protection, liquid effluent discharge, land fill and safeguarding human health have specified norms which the textile material is expected to maintain.

Application methods:

(i) Padding - through low liquor ratio
(ii) Spraying - with suitable equipment
(iii) Coating - to achieve effect on one side by one finish and other side by other effect finish (moisture management on inner side and water repellant on outer side)
(iv) Micro-encapsulation - active ingredient application
(v) Multilayer - by dip-dry and layer on layer application
(vi) Electro-chemical deposition

II. Skin Care

The finishes are used to generate a feel good factor by providing human skin nourishing chemicals through textile material. These chemicals provide various effects such as moisturizing during dry or low humidity conditions | weather, Antioxidants like Vitamin E to overcome wrinkle formation, anti-ageing phenomenon. Likewise various chemicals are applied as textile finishing agents which in-turn impart effects such as anti-inflammation, improved blood circulation, soothing and rejuvenating feel. The transfer and percolations of such effect chemicals into the blood through the pores of the skin benefits the wearer because of its anti-oxidant effect

- Vitamin E and F - Protects skin against premature ageing
- Aloe Vera gel – moisturizes skin

- Jojoba oil – improves softness of skin
- Avocado oil - improves comfort feel

The performance of such effect finishes are evaluated by commercial testing methods such as qualitative assessment and ratings by a panel and quantitative evaluation by mass spectroscopy and scanning electron microscopy.

III. Health Care

Anti-microbial finishes are applied to improve health, hygiene and freshness of textile material. Especially the undergarments which are in direct contact with human body have high probability of microbial growth due to warmth and sweat generated by human body. To have control over growth of the microbes the textile material is treated with specialty chemicals. Antimicrobials are defined as bactericidal – that kills bacteria and bacteria-static – that only inhibits further growth. Antimicrobial Effect finishes exhibit Effective control of undesirable microorganisms, Non toxicity to human, Non environmental pollution, Durability to washing, laundering and dry cleaning, Compatibility with other finishing agents and Simple application and evaluation. Products belonging to various chemical composition such as -Triclosan, Chitosan, Quaternary ammonium compounds, Silver halides, etc having antimicrobial mechanism are available in the global market. The most popular method of evaluation of effect of antimicrobial finish are

(i) Quantitative assessment – AATCC 100 test method – counting bacterial growth %
(ii) Qualitative assessment – AATCC 147 – parallel strip for estimating zone of inhibition

Some other test methods are also followed based on specific end use requirement

Table 1 – list of anti-bacterial test methods

Test method	**Purpose of test**
AATCC 30	Mildew and rot resistance in textile
AATCC 174	Antimicrobial activity assessment of carpets
SN 195924	Germ count method
SN 195920	Agar diffusion plate test
JIS Z 2911	Test for fungus resistance

IV. Aroma Sensual

These effect finishes provide unique benefits to the textile wearer as well as people in close proximity a feeling of comfort and well-being. In this, different aromatic chemicals and fragrances are used to impart a pleasant smell or odor and also to stimulate different moods like, relaxing | encouraging sleep etc. The Aroma imparting chemicals are volatile in nature and the fragrance is transported to and detected by the olfactory system in the upper part of the nose which in turn transmit the stimuli to the brain where it is perceived as a pleasant odor. The pleasant smell tends to elicit a variety of feelings and emotions – such as relaxation, happiness and well-being. Various essential oils like lavender, rosemary, and jasmine were used in this finish. Home textiles such as bed linens, pillow covers, bed sheets do not remain fresh due to everyday use. Also, aroma compounds infuse a feeling of well-being and freshness. Aroma fabrics have several uses fields of medicine and alternative healing. The following table gives a list of those aroma chemicals

Table 2 – list of Aroma imparting chemicals

Source	**Chemical**
Citrus	Lemon, Orange – Citronella, Decyl acetate
Floral	Phenethyl salicylate, Nonyl acetate, Anisyl acetate ,Hydroxy citronellal, Rose absolute
Fruity	Benzyl acetate, Allyl butyrate, Amyl acetate, Isobutyl isobutyrate, Allyl butyrate, Benzyl benzoate
Herbaceous	Eugenyl acetate, l-carveol,l-carvone,l-menthol
Sweet Honey Sweet Vanilla	Ethyl acetate, methyl sorbate Cinnamonaldehyde Allyl phenoxyacetate Acetanisole, Anisyl acetate

V. Fire Protection

The fire protective finishes make Textile material flame resistant. They are designed to minimize the risk of a fire starting in case of contact with a small heat sources and the fabric does not ignite or the process is delayed. When a fire starts flame, retardants reduce the flame spread and rate of fire development. The fire retardants interfere with combustion at different stages of the process like during heating, decomposition, ignition or spreading of flame.

- Increase decomposition temperature

- Decrease the amount of combustible gases
- Promote char formation
- Prevent the access of oxygen to the flame
- Increase the combustion temperature

The commonly used chemicals include BoricAcid/Borax, Tetrakis(hydroxymethyl) phosphonium Chloride (THPC) and Phosphoric Acid derivatives. Flame-retardant fibers confer high comfort and safety to textiles and are, thus, preferred for the use in garments as well as decorative fabrics and home textiles. Testing is crucial for compliance to various fire-safety laws and standards. Some of the most common test methods are Limiting Oxygen Index, Vertical and horizontal flame test, Char length measurement and Specified ASTM, JISL tests

Limiting oxygen index (LOI) is the minimum concentration of oxygen expressed as volume percent in a mixture of oxygen and nitrogen that just supports flaming combustion of a material initially at room temperature.

UL-94 vertical burning test - provides a preliminary assessment of relative flammability and dripping. It addresses such end-use characteristics as ease of ignition, burn rate, flame spread, fuel contribution, intensity of burning, and products of combustion. In the test, a bar measuring 5 x 0.5 inches is mounted vertically in a draft-free enclosure. A burner is placed beneath the sample for 10 seconds and the duration of flaming is timed. The test is repeated for five specimens. Any dripping that ignites surgical cotton placed 12 inches below the bar is noted.

VI. Oil and Water Repellant

The effect finishes that prevent liquids from wetting the surface and repel water, oil and release dry dirt are important in all parts of textile. Release of soil and preventing its re-deposition improves aesthetic appeal of Textiles and also imparts functional property when the garments are worn in rain. Such water-repellent fabrics permit passage of liquid water and are resistant to the penetration of water under much higher hydrostatic pressure. Water repellant finishes resist the penetration of water into the fabric but permits the passage of moisture or air. The principle is that it is coated with the repellant chemical which permits the passage of air and vapour between the interlacing in fabric. Water and the other liquid remain on the surface in small bead rather than spreading out and getting absorbed.

- Prevents oily fluids from wetting treated textiles
- Protects textiles from both dry and wet soils
- Reduces free energy at fiber surfaces
- Minimizes internal cohesive interaction of the liquid
- Exhibits low interactions with liquids and fiber interface

Various specialty chemicals including Paraffin Wax emulsion, Pyridinium compound, Steramides, Poly Siloxanes, Acrylates, Fluro-chemicals and Dendrimers are widely used as water repellants.

Table 3 – Test methods and evaluation of water and oil repellants

Test method	Description | Evaluation
AATCC 22 – Spray test	Water is sprayed on the textile. The size of the wetted pattern is compared with standard chart. Rating is assigned as 0, 50, 70, 80,90,100
AATCC 35 –Rain test	Water is sprayed on textile fabric backed by a weighted blotted paper for 5 min. Assessment is made by measuring treated fabrics resistance to water penetration
AATCC 42 – Impact penetration test	A volume of water is sprayed and the treated fabric resistance to penetration of water is measured
AATCC 118 – Oil repellence by drop test	Drops of a series of hydrocarbon oils of different surface tension are placed on the treated fabric and observe effect of wetting
AATCC 127 – Hydrostatic pressure test	Treated fabric is exposed to hydrostatic pressure till 3 points of leakage appear.
ISO 9865 – Bundesmann rain shower test	Treated fabric is mounted on a cup and exposed to artificial rain. The surface of the treated fabric is subjected to rubbing & the wetting on the surface & water penetration at the back of the fabric is assessed

VII. Antistatic Finish

Static electricity is produced or created when two non-conducting surface such as synthetic textiles rub together. The two surfaces become oppositely charged and as the rubbing continues an electrical charge is build up. The wearer of textile material can experience electric shocks and the fabric tends to cling to the body of the wearer. Anti-static finishes are chemical substances applied to reduce and eliminate static charge. It absorbs moisture from

the atmosphere and thus reducing the dryness of the fabric that causes the static charge build up. These type of finishes

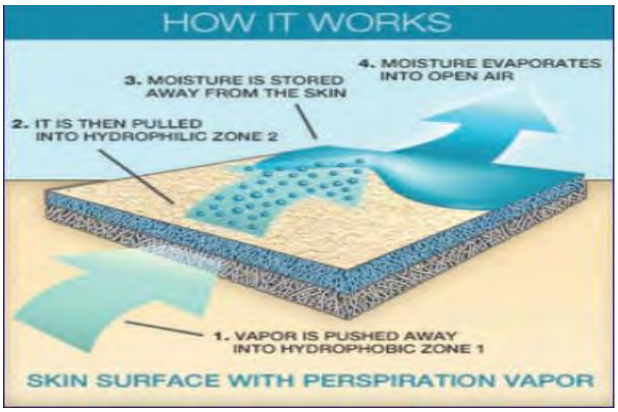
- Avoid charge creation upon rubbing
- Provide wicking effect
- Impart soft handle
- Improve fat and soil release
- Avoid impairment of whiteness

Table 4 - The commonly used evaluation methods are

Test Method	Description | Evaluation
AATCC 76: Electrical resistivity of fabrics	determines electrical surface resistivity of fabrics (ohm/square) which is calculated by determining electrical resistance offered by the antistatic finished fabric placed between two parallel plates
AATCC 115: Electrostatic clinging of fabrics	evaluates the clinging tendency of fabric to metal surface due to electric charge generation

VIII. Moisture Management

The ability of a garment to transport moisture away from the skin is one of the key performance enhancement criteria in modern sports and active outdoor wear. This phenomenon is widely termed as moisture management. Various factors including the physio-chemical characteristic and construction of the textile material coupled with application of different type of finishing chemicals help impart this effect. Generally, the hydrophobic textiles repel moisture and the insufficient transport of moisture leads to damper feeling, restricting evaporative cooling. Whereas, the hydrophilic textiles have more moisture absorption, but at the same time retains moisture due to slower drying and leads to clinging and sagging. However, a combination of inner hydrophobic and outer hydrophilic textile can provide desired rapid transport of moisture from skin and then evaporated from the outer surface. Such finishes are used in combination to impart some additional desirable properties like antibacterial, antistatic, soil release effects. It helps controls moisture balance between the garment and skin and to keep the body temperature constant by evaporating moisture both from the skin and from outside of the textile material. The schematic mechanism of moisture management is given below



The common methods of determination and evaluation are AATCC 195, Wicking- vertical wicking test (BS 3424 or AATCC 197:2011), Water Absorbency (AATCC 79: 2000) and Air permeability

IX. Thermal Protection

The textile material which is capable of absorbing or releasing heat energy, can provide desired thermal protection under adverse climatic conditions. The chemicals which can provide such effect are called phase-change material. Such chemicals possesses ability to change their state with a certain temperature range. These materials absorb energy during the heating process as phase change takes place and release energy to the environment during a reverse cooling process. These chemical finishes have capability of melting during heat absorption and crystallizing during heat release, thus maintaining the temperature of the wearer constant under varying surrounding conditions. Certain specialty paraffin microcapsules are applied on textile substrate to achieve such Thermo-regulating and temperature controlling effect.

X. Sun Protection

The sun light consists of harmful Ultra violet radiation component (in the wavelength region of 150 to 400 nm), which on prolonged exposure can result in acceleration of skin ageing, photodermatosis (acne), erythema (skin reddening), sunburn, increased risk of melanoma (skin cancer), etc. Though the intensity of UV radiation is much less than that of visible or infrared radiation, the energy per photon is significantly higher. When radiation strikes a fiber surface, it can be reflected, absorbed, transmitted through the fiber or pass between fibers. The relative amounts of radiation reflected, absorbed or transmitted depend on many factors, including the fiber type, the fiber surface smoothness, the fabric cover factor and the presence or absence of fiber delustrants as well as dyes. Therefore, to protect human skin and other body parts from the harmful UV component of natural sunlight, the textile material needs to be finished with an effective UV absorber which absorb UV radiation and then dissipate the absorbed energy to avoid degradation of fabric and detrimental effect on human body. Sun protection factor or UV protection factor is used as a measure of how well a UV absorber will protect skin from harmful rays. When the skin normally burn after 10 minutes in the sun, finish chemicals having SPF 15 would allow to stay in the sun without burning for approximately 150 minutes (a factor of 15 times longer). For best protection, a minimum SPF of 30 + is desired. Another method of estimation of Sun protection is Erythema Damage Factor (EDF) where the chemical is applied on the skin of test animals and the extent of reddening of skin is noted after specified time duration and the effect is compared.

Storage and Disposal of functional finishes

The storage conditions of such functional finishes is generally specified by the manufacturer | supplier of these chemicals. It varies from product to product and the chemical composition | concentration. In general, most of such chemicals are recommended to be stored under cool and dry place maintaining below conditions for a shelf life of about one year.

- Relative humidity – 65 %
- Temperature - 20+/- 2^0 C

The disposal mechanism and conditions for the effect chemicals varies and depends on the specific chemical composition and is specified by the manufacturer and provided in the material safety data sheet (MSDS). This also contains information on precautions to be ascertained during handling, safety and storage of these products.

XI. Conclusion

With the growing awareness, the end users expectations in terms of desired quality of textile material is continuously evolving and to meet this challenge specialty chemicals are being developed which can impart a specific performance characteristics. The major areas for apparel clothing and home textiles are comfort, easy care, health and hygiene while at a same time such textile material also needs protection against thermal, mechanical, chemical or biological attacks. Thus, such perceptional and protective finishes is a combination of many functions.

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