2. REVIEW OF LITERATURE

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2.1 Eco – friendly Textiles

'Eco' is an abbreviation of ecology, which means the relationship between organisms and their habitats, or humans and their homes in the global sense. 'Eco-friendly' refers to a friendly relationship between humans and their habitats. In other words, humans taking good care of the environment in which they live, state Bajwa and Chawla (2011). The eco friendly agents not only help to effectively reduce the ill-effects associated with microbial growth on textile material, but also comply with the statutory requirements imposed by regulatory agencies, denote Joshi et al (2009). Textiles are one of the major industrial sectors where use of water, energy and polluting chemicals are very high, and due to increased health and environmental issues, people have become more environmental conscious. Eco-friendly processing trends are becoming more and more popular. Government agencies are placing more restrictions on the control of the quality of effluents. Under these circumstances, processors are looking for eco-friendly alternative chemicals for processing, as viewed by ACTI and ATIRA (2003).

Top fabric manufacturers, eco-friendly scientists, and researchers are working together to find new fabrics that are friendly to the earth, animals, and humans. From milk to spider webs, the future of green fabrics is bright, and soon we will have no reason to purchase any fabric that is not friendly with our world. However, do not wait until there is no option except for eco-friendly products and materials; do your part now to be a part of the solution instead of just another piece of the problem- views by (www.ecozeal.com). Eco textiles gain utmost important as one of the most useful resources that help promote new innovations, in an eco-friendly manner, denote Krishnaveni and Amsa Mani (2012). Many infectious diseases have been treated with herbal remedies throughout the history of mankind, says Joseph et al (2012). Recently there is lot of attraction towards natural based herbs as an antimicrobial agent because of its eco-friendly and health hazard free nature, as viewed by Rathinamoorthy et al (2011).

2.2 Natural herbs

India has about 45,000 plant species. Among them, several thousands have been claimed to possess medicinal properties. Over the past decade, substantial progress has been made in research on the natural products for the treatment of several dreaded diseases, like AIDS and CANCER. Although a significant number of studies have used known purified plant chemicals, very few screening programmers have been initiated on crude plant materials. Even so, we have barely scraped the surface in our efforts to exploit the plant world for finishes, point out Gupta and Laha (2007). Today, in order to protect the environment; the consumers have had a change in their mindset, and have turned towards eco-friendly clothing. Now, many clothing companies offer such eco-friendly clothes due to the increase in demand for Green Fabrics, as mentioned by Bajwa & Chawla (2011). Herbal remedies are safer than the corresponding pharmaceutical drugs, says Jose (2005).
The medicinal uses of plants and plant parts are an age old practice. Ancient literature indicates that therapeutic use of plants was being practiced since 5000-4000 B.C, say Kumar and Satapathy (2011). Traditional herbal medicines are an important part of the healthcare system in India, as defined by Agarwal and Varma (2012). Plants have been used in virtually all cultures as a source of food, clothes, shelter and without doubt, medicine, and have a very significant role in human civilization, state Sunaniya et al (2012). Medicinal plants are the local heritage with global importance. There is now an ever increasing interest and demand for herbs and herbal products worldwide, as referred by Kumar et al (2010). Herbal medicine, also called botanical medicine or Phytomedicine, refers to the use of seeds, berries, roots, leaves, bark, or flowers of any plant for medicinal purposes, view Chhetri et al (2010). Many efforts have been made to discover new antimicrobial compounds from various kinds of sources such as micro-organisms, animals and plants. One such resource is folk medicine. Systematic screening of these may result in the discovery of novel effective compounds; denote Tomoko et al (2002).

### 2.2.1 Ricinus communis

There is increasing interest in adding value to textiles by using natural products. These garments carrying herbal properties will be beneficial to the human body. Castor / Pendi is an oil that contains strong insect repellent properties, maintains temperature of the skin, with easy body transpiration, as referred by Jain (2010).

**Botanical name of the herb:** Ribinus communis, **Tamil name:** Amanakku and **Common Name (English):** Castor oil plant.

It is believed that castor oil was first used as an ointment 4,000 years ago in Egypt, from where it spread to other parts of the world, including Greece and Rome, and was used as a laxative 2,500 years ago, state Jonathan et al (2010). According to istrianet.org, Egypt is currently the largest producer of castor oil in the world, but it has also been grown commercially in California and the Southern U.S.

### 2.2.1.1 Medicinal uses of *Ricinus communis*

The parts of the plant used for medicinal purposes are leaves, root, stem, fruits, the complete aerial parts, the whole plant, barks (root and stem) and flowers. However, leaves were found to be used most frequently, as referred by Sravanthi et al (2010). According to Azhari et al (2006), Castor Oil is used for temporary constipation, but is not effective for chronic constipation. It has also been used for colic and acute diarrhea due to slow digestion. Externally Castor Oil is used to treat ringworm and itching. Castor Oil can support labor and delivery. Antibacterial drugs that destroy or inhibit the growth of bacteria in concentrations that are safe for the host can be used as chemotherapeutic agents to prevent or treat bacterial infections.
In the Indian system of medicine, the leaf, root and seed oil of this plant have been used for the treatment of inflammation and liver disorders. It is reported that this plant possesses anti-diabetic and anti-fertility activities. Methanol extract of the root shows anti-inflammatory and free radical scavenging activity, as pointed out by Taur et al (2011).

In Siddha Medicinal Uses, as pointed out by www.google.com, the leaves are cut into small pieces, then fried in castor oil and used for fomentation in case of arthritis, over the swollen and painful areas. The powder of the dried seed is given in a dose of about 1 to 2 gm in rheumatism, lumbago, piles, constipation, diseases of the liver, spleen and sciatica etc.

2.2.2 *Euphorbia hirta*

The *Euphorbia hirta* has been reported to contain alkaloids, saponins, flavonoids, tannins phenolic acids and amino acids. Traditionally, it is used in treatment of gastrointestinal disorders, bronchial and respiratory diseases, kidney stones, diabetes and in conjunctivitis, as pointed out by Hore et al (2006).

**Botanical Name of the herb: Euphorbia hirta, Tamil name: Amman Paccharisi and Common Name (English): Asthma weeds**

*Euphorbia hirta* belongs to the plant family Euphorbiaceae and genus *Euphorbia*. It is a slender-stemmed, annual hairy plant with many branches from the base to top, growing up to 40 cm in height, reddish or purplish in color. The leaves are opposite, elliptic-oblong to oblong-lanceolate, acute or subacute, dark green above; pale beneath, 1-2.5 cm long, blotched with purple in the middle, and toothed at the edge. The fruits are yellow, three- celled, hairy, keeled capsules, 1-2 mm in diameter, containing three brown, four-sided, angular, wrinkled seeds, say Williamson (2002), Prajapati et al (2003), The Wealth of India (2005), and Kirtikar and Basu (2003). The Euphorbiaceae family is the sixth largest family among flowering plants. The genus *Euphorbia* of this family, alone accounts for one sixth of the whole group of flowering plants, with about 1000 species.

The Origin of *Euphorbia hirta* (Euphorbiaceae), commonly known as Dudhi it is an annual hairy plant. Abundant in waste places along the roadsides and open grasslands. It is native to India and Australia; say Rastogi and Mehrotra (2002). It is a very common annual herb. In India, new plants start appearing in the wild soon after the first showers of the monsoon and start developing very fast. No sooner than the plant grows to a few centimeters, flowering starts, says www.Ecosensorium.org.
2.2.2.1 Medicinal uses of *Euphorbia hirta*

The plant is collected, with or without roots, when it is in flower and fruit, and dried. The drug is administered in the form of liquid extracted or tincture, with lobelia or Senegal, in the treatment of coughs and asthma. It has a depressant action on the heart and respiration and relaxes the bronchioles. The leaves are eaten as a vegetable. They contain : moisture, 78.14; protein, 4.65; ether extr; 1.71; ash, 3.15%; vitamin c, 44.32 mg./100g., points out wealth of India (1952).

The tribes of western Orissa use the juice of the leaf in eye trouble and decoctions of the plant in asthma and chronic bronchial afflictions. The latex is used to remove warts, and has anti-bacterial properties. The whole plant is used for asthma by the tribes of Bastar district in Madhya Pradesh. Valaya tribes of Tamilnadu use powder of the whole plant for whooping cough: powder of the leaves and the root are used to cure bronchial asthma. Paste of the roots is applied to wounds for 3-4 days by tribes of Ranchi and Hazaribagh in Bihar. People living in Siriska National Park of Aravalli hills in Rajasthan make a paste of the leaves and apply externally for reducing pain due to scorpion sting, as viewed by www.google.com

2.2.3 *Senna auriculata*

This plant is said to contain a cardiac glucoside (sennapicrin) and sap, leaves and bark yield anthraquinone, while the latter contains tannins. The root is used in decoctions against fevers, diabetes, diseases of the urinary system and constipation. The leaves have laxative properties. The dried flowers and flower buds are used as a substitute for tea in the case of diabetes patients. It is also believed to improve the complexion in women. The powdered seed is also applied to the eye, in case of chronic purulent conjunctivitis. In Africa the bark and seeds are said to give relief in rheumatism, eye diseases, gonorrhea, diabetes and gout. The plant has proved to have antibacterial activity in the laboratory, as denoted by Maneemegalai and Naveen (2010).

**Botanical Name of the Herbs:** *Senna auriculata*, Tamil Name: Avaram and Common name (English name): Ranawara

It occurs in the dry regions of India and Sri Lanka. It is common along the sea coast and the dry zone in Sri Lanka, in Vadodara District of Gujarat in India. *Senna auriculata* is suitable for landscaping roadways and home gardens. It tolerates drought and dry conditions, but not much cold. The flowers in racemes are also attractive, states Silva (1998)

Shrubs, 1-3 m high: branchlets pubescent or softly hairy. Leaf-reghis, 5-9 cm long, ribbed, hairy; leaflets 5-13 pairs, 0.8-2.5 X 0.3-1.5 cm, oblong or obviate-oblong, rounded-mucronate or emarginated at apex, rounded or obliquely cuneate at base, ciliate, pubescent on both surfaces or glabrous above. Petioles 1-1.5 cm long, terete, ribbed on the top, pubescent: petiolules 1-2 mm long, puberulous. Glands between all pairs of leaflets, sometimes except between the upper most pair,
subulate or fusiform: finger-shaped gland-like bodies scattered throughout the groove, identical
glands and gland-like bodies are present in the axis of leaves, produced into a serrature, ciliate,
persistent, as pointed by Singh (2001).

The fruit is a short legume, 7.5–11 cm long, 1.5 cm broad, oblong, obtuse, tipped with long
style base, flat, thin, papery, undulate crimpled, filose, pale brown. 12-20 seeds per fruit are carried
each in its separate cavity, as pointed out by Wikipedia, the free encyclopedia. A shrub with larger
bright yellow flowers, that grows wild in central provinces and in the western peninsula, is cultivated
in other parts of India. It is valuable as a tanning material, as a plant for reclothing barren tracts, and
as a green manure crop, points out wealth of India (1950).

2.2.3.1 Medicinal uses of Senna auriculata

The maximum antibacterial activity was recorded in methanolic extracts against Vibrio
cholorae and Staphylococcus aureus. Minimum activity was noted in chloroform extracts against
Pseudomonas aeruginosa, no inhibition zone was present in chloroform extracts against E.coli.
Methanolic and petroleum ether extracts showed significant antimicrobial and radical scavenging
activities and the most susceptible micro-organisms were found to be Pseudomonas aeruginosa and
Candida albicans Methanolic. The seeds are used for diabetetics. The plant is reported to exhibit

2.3 Multi functional finishes

Environmentally friendly materials were used for multi-functional finishes, point out by Chie
multidisciplinary approach as well as the merging of traditional scientific disciplines, says Gowri et al
(2010). A novel approach for imparting multi-functional properties, i.e., anti-crease, self-cleaning,
UV-protecting as well as anti-bacterial properties onto cotton fabric is described by Ibrahim and
Refaie et al (2010). It can also be used with other finishing agents for multifunctional finishes, for
example, it can be used in resin finishing of textiles to have a soft wrinkle resistant fabric, explains
fiber2fashion.com.

Nano-titanium dioxide finishing agents were prepared by sol-gel method and used for multi-
functional treatment of cotton fabrics by dip-padding technique. The results show that fabrics treated
with the finishing agent had excellent UV resistance, increased UPF, and good soaping fastness. In
addition, it had good anti-bacterial property with bacterial inactivation rate over 80%, state Hua et
al(2009). The efficacy of anti-microbial, antifungal, UV protection, stain repellency and mosquito
repellency finishes have proven to have very good sense of functional finishes on to the garments in
conjunction with a sweet fragrance, state Ramachandran and Vijayalakshmi (2012). The
effectiveness of the multifunctional finishing treatments were assessed through standardized tests
available for testing the specific functions such as anti-microbial protection, soil release and UV protection both before and after washing of the treated samples, pointed out Kathirvelu et al (2008).

According to Molla et al (2011), the properties imparted to textiles using nanotechnology include water repellency, soil resistance, wrinkle resistance, anti-bacterial, anti-static, UV-protection, flame retardation, and improvement in dye ability.

2.4 Denim
2.4.1 Introduction

Classic Denim, a 3/1 twill based warp faced woven cotton fabric, is exclusively constructed with indigo dyed warp and un dyed grey weft keeping the warp set closer together than the weft when the former predominates on the surface to develop a blue face with white back. This gives it a substantially uniform appearance of small white flecks distributed evenly in a darker basic color, pointed by Chakraborty (2010).

With denim growing into a Fashion Icon, the cowboy work wear of yesteryear has reached the pinnacle of success. Today’s denim trend is tomorrow’s denim history. We’ve seen that technology holds the key to the fashion trends of tomorrow, says Thiry (2010). Every body loves denim. Almost everyone in the world owns at least one denim garment. Today, popular high-fashion denim garments can demand top dollar at retail. Denim is a twill weave with blue warp threads and white filling threads. Denim is designed by the weight of a yard of fabric. 14 ounce denim is heavy duty, while 10 ounce denim is for summer wear, as referred by (Understanding fabrics-A guide to understanding fabrics (2008).

Denim is so durable because only the warp yarns go through the dyeing process, the weft yarn is left natural without having to undergo any chemical process. This is the advantage of yarn dyed fabric over piece dyed. The other attraction of denim is that it is easy to take care of, it does not need starching or ironing after each wash unlike other fabric materials, denote Pujari et al, (2010).

Denim has gained much popularity such that if you look around, you will surely notice somebody wearing denim nearby. Now, more than just complementing a rugged style, denim has become suitable for any occasion. Denim is being worn irrespective of demographic differences, views Vishwakarma (2010). Jeans are the most prevalent denim garment worn all over the world by rich and poor, young and old alike.' one of the amazing things about denim is that it’s been around forever and is still growing in popularity”. Antimicrobial fabrics can foster microbial growth in one of two ways. Either passively by inhibiting the growth of micro-organisms through inherent surface structure without the use of agents – linen for example displays such characteristics, as well as lamb wool. Or actively using antimicrobial agents to either kill or inhibit the growth of any microbe present such as in treated denim fabrics, as denoted by Shirley technologies Ltd (2004).
2.4.2 History of denim

Denim began its career as the uniform of workers, miners, cowboys, carpenters, sailors and others who valued the durable cotton fabric and study construction of denim garments, say [www.google.com,Rearick (2007)]. According to Pujari et al (2010), The History of denim is given in Table-1

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1873</td>
<td>Levi Strauss made up the first jeans in San Francisco for Californian Miners, from a heavy brown canvas</td>
</tr>
<tr>
<td>1890</td>
<td>Levi Strauss produce the first jeans under the designation “sol indigo”</td>
</tr>
<tr>
<td>1940</td>
<td>Establishment of the Blue-Bell co. in Greensboro, North Carolina</td>
</tr>
<tr>
<td>1950</td>
<td>First Zipper jeans appeared in the market in 1954. Marlon Brandon and James Dean appeared in Jeans, creating a new image for denim</td>
</tr>
<tr>
<td>1960</td>
<td>Denim began its triumphal progress</td>
</tr>
<tr>
<td>1962</td>
<td>Burlington, USA, took up the production of heavy denim (14.75 ozs/sq.yd) on Sulzer Ruti Projectile Weaving Machines</td>
</tr>
<tr>
<td>1974</td>
<td>The first pre-washed jeans made their appearance</td>
</tr>
<tr>
<td>1978</td>
<td>Industry development of a new washing process for denim: stone wash</td>
</tr>
<tr>
<td>1986</td>
<td>Another Washing process won favor-chemical wash</td>
</tr>
<tr>
<td>1987</td>
<td>The first denim fabrics dyed “super blue indigo”</td>
</tr>
<tr>
<td>1990</td>
<td>Denim was evolved into the classless leisure fashion</td>
</tr>
</tbody>
</table>

2.4.3 Fashion in denim

Denim depends on the visual appeal, the hand, and the wear, says Schrott. Fashion is more and more dominated by mixed effects-new colors, new hands, and new cuts. One aspect won’t make a sufficient difference in denim sustainability. To make ordinary denim more sustainable, the total production line must be environmentally optimized, as viewed by Thiry (2007).

2.5 Indigo dye

2.5.1 Introduction

Indigo is one of the oldest dyes used by mankind. The current consumption of the dye is enormous due to the popularity of blue jeans, which are dyed with indigo, as pointed by Roessler and Jin (2003). The reduction of indigo to leuco-indigo represents an important type of industrial process which is operated worldwide on a considerable scale, says Roessler and Crettenand (2004).

Blue is the typical of all colors to denim or jeans. From day one, this blue color for denim is developed from indigo dye. Indigo powder is a dark blue crystalline compound which is insoluble in water. The chemical formula of the compound is $\text{C}_{16}\text{H}_{10}\text{N}_{2}\text{O}_{2}$. It is insoluble in water, as well as ether.
or alcohol, but soluble in nitrobenzene, concentrated sulfuric acid or chloroform, as pointed out by http://www.denimhelp.com/indigo-dye/.

2.5.2 Global influence on denim market

The Global market of denim products is worth an estimated US $54 billion at retail in 2011, with demand growing steadily at 5-6 %, although growth in flat in mature markets such as the US, Europe as well as Korea and Japan, with the rest of Asia is responsible for much of the increasing demand, as pointed by Wilson(2011).

2.5.3 Ozone fading in denim finishing

With finishes a hot concept, garment manufacturers and finishing units are innovating and experimenting with new techniques to get catchy finishes. Ozone fading in denims provides an interesting look to the garment. However, the procedure and methods to be adopted need to be carefully understood. One of the key noxious by-products of urban photochemistry is ozone and this can reach dangerously high levels of 0.5 ppm. In the presence of UV light, there is an interaction between the hydrocarbons, oxides of nitrogen and oxygen that causes release of ozone (in addition to other compounds). The release is during the day time due to the presence of sunlight, as stated by www.fiber2fashion.com

2.6 Blends

Blending is one of the methods to create novel combinations in many ways. Blending also provides a fabric which has different aesthetic properties and can be put in to different kinds of new uses, thus opening the way for product diversification, pointed by Jain (2010).

Blended Fabrics are made up of blended yarns. Blended yarns contain fibers of different composition in fixed proportions. Thus a blended fabric may be made of polyester/cotton in 67:33 ratios in both warp and weft. One of the most popular fabrics is formed by blending 10 percent Lycra with 90 percent cotton. This combination results in a soft, absorbent material with just the correct amount of stretch for manufacturing ladies’ panties, sleepwear and undershirts. This blend is also popular in the T-shirt industry because the Lycra prevents the cotton from shrinking to some extent, helps shirts maintain their original shape, and also alleviates the wrinkled appearance of all-cotton T-shirts, as viewed by e.How.com.

2.6.1 Uses of Blends

Lycra often is blended with other fibers, such as cotton, nylon and polyester to give a garment an additional level of comfort. Only a small percentage of Lycra is used- 3 to 10 percent depending on the item and its use. The practice is so common that most people have Lycra- (or spandex) blended garment in their closet, in the form of jeans, a hooded pullover, or a sweater says http://www.ehow.com/about_5433959_properties-lycra-fabric
2.7 Cotton

The most preferred yarn for making Denim is cotton yarn. However these days, besides the standard combination of cotton and spandex, linen and tencel are more often added. Because of the differing nature of different materials, these fibers may require special treatments during the weaving, finishing and washing processes. Cost is also an important factor when it comes to fiber selection says www.adsale.ATA.com.

2.7.1 History of cotton

Cotton is the oldest fiber used for textile purpose. India was the centre of world’s cotton industry as well as a variety of fine fabrics till 1600A.D. The date of origin of cotton is unknown. China and Japan introduced cotton from India, only in 800 A.D; but extensive cultivation was started from 1300 A.D, says Mishra (2008). The most useful of vegetable fibers, cotton grows in the seed pods of a genus of plant named gossypium, belonging to the mallow family (malvaceae) as referred by Murphy (2003).

Cotton was first cultivated in the old world 7,000 years ago (5th millennium BC), by the inhabitants western Pakistan. For example, at the site of Mehrgarh, early cotton thread has been preserved in copper beads of, says Moulherat et al (2002). Cotton was already being used in weaving, according to Saraf et al (2005). Cotton had its patriotic associations too, for it was spun on the “Chakra” by the father of our nation, as denoted by Steven et al (2007).

2.7.2 Properties of Cotton

Cotton is soft, comfortable and wrinkles easily, it absorbs perspiration quickly. It has good color retention and is good to print on. Cotton is also strong and durable. It is versatile, and easy to print on. It performs well. It wrinkles easily, it is easy to care for, easy to wash and it is a natural resource that is fully renewable, points out cotton organic nature news.com and www.nanok-kids-clothing.

Cotton is hypoallergenic and doesn't cause allergies or irritate the skin, as it is a natural product, and therefore doesn't contain any chemicals as pointed out by www.ehow.com.

2.7.3 Uses of cotton

Denim, a type of durable cloth, is made mostly of cotton. (www.google.com) Terry cloth is used to manufacture absorbent bath towels and robes. Denim is used to make blue jeans. Chambray is popularly used in the manufacture of blue work shirts, socks, underwear, T-shirts, bed sheets, crochet and knitting, as viewed by Rastogi (2006).
2.8 Polyester

2.8.1 History of Polyester

Polyester is a term often defined as “long-chain polymers chemically composed of at least 85% by weight of an ester and a dihydric alcohol and a terephthalic acid”. In other words, it means the linking of several esters within the fibers. Reaction of alcohol with carboxylic acid results in the formation of esters. Polyester also refers to the various polymers in which the backbones are formed by the “etherification condensation of poly functional alcohols and acids”. The first commercial production of polyester fiber in the United States was in 1953 by E.I DuPont Nemours and Company, Inc. Polyester is the most used man-made fiber in the U.S, according to Jefferson (2005).

Polyester began as a group of polymers in W.H. Caruthers' laboratory. Caruthers was working for DuPont at the time when he discovered that alcohols and carboxylic acids could be successfully combined to form fibers. Polyester was put on the back burner, however, once Caruthers discovered nylon. A group of British scientists--J.R. Whinfield, J.T. Dickson, W.K. Birtwhistle, and C.G. Ritchie--took up Caruthers' work in 1939. In 1941 they created the first polyester fiber called Terylene. In 1946 DuPont bought all legal rights from the Brits and came up with another polyester fiber which they named Dacron. Polyester was first introduced to the American public in 1951. It was advertised as a miracle fiber that could be worn for 68 days straight without ironing and still look presentable. In 1958 another polyester fiber called Kodel was developed by Eastman Chemical Products, Inc. The polyester market kept expanding. Since it was such an inexpensive and durable fiber, many small textile mills emerged all over the country; many were located in old gas stations, to produce cheap polyester apparel items as pointed out by www.google.com.

2.8.2 Properties of Polyester

The following are the properties of polyester points out http:www.answers.com/topic/polyester. Polyester fabrics and fibers are extremely strong. Polyester is very durable: resistant to most chemicals, stretching and shrinking, wrinkle resistant, mildew and abrasion resistant too. It is hydrophobic in nature and quick drying. It can be used for insulation by manufacturing hollow fibers. Polyester retains its shape and hence is good for making outdoor clothing for harsh climates. It is easily washed and dried.

2.8.3 Uses of Polyester

Polyester is used in the manufacture of many products, including clothing, home furnishing, industrial fabrics, computer and recording tapes, electrical insulation, PET bottles and polyester suits says http:www.answers.com/topic/polyester.
2.9 Poly Lycra

Lycra in jeans, The 1990s saw some changes such as denim with an added percentage of Lycra to enhance fit and comfort. “Spandex” is a generic name and not derived from the chemical name of the fiber, which most manufactured fibers are, but an extension of the word expands.” Spandex” is the preferred name in North America; elsewhere it is referred to as “elastane”. Spandex is an interesting material. It is stretchy, durable, and therefore, preferred by factory workers and other blue–collar types. It wears like a second skin, and even the smallest bit of clothing caught by a machine could be fatal says by Rastogi (2006).

It is a polyurethane-polyurea copolymer that was co-invented in 1959 by chemists C. L. Sandquist and Joseph shivers. The name “spandex” is an anagram of the word “expands”; in many European countries, it is referred to as “elastane”, and is known in Britain mainly as Lycra. To give cotton pants some stretch, the cotton yarn maybe blended with Lycra. Cotton/lycra pants are made from a cotton/lycra thread, usually with 90 percent cotton/10 percent Lycra ratio. Cotton/lycra is a medium-weight fabric, woven densely, is referred from. www.wikipedia.com.

2.9.1 History of Poly Lycra

The first commercial production of spandex fiber in the United States was in 1959 by E.I. Du Pont de Nemours and Company, Inc. It is an electrometric manmade fiber. Spandex is used in filament form, says www.google.com

2.9.2 Properties of Poly Lycra

The following are the properties of Poly Lycra

- It is a product that can be stretched up to 600%.
- It has a high tensile strength and is available is deniers ranging from 70 to 1120.012, as pointed out by www.google.com

2.9.3 Uses of Poly Lycra

Athletic, aerobic, and exercise apparel, belts, swim wear, diapers, gloves, hosiery, leggings, ski pants, slacks, socks, under wear, foundation garments are made of poly lycra, says Whyte (2010).

2.10 Core spun Lycra

Core Spun Yarn Can is defined as a yarn consisting of a filament surrounded by staple fibers. Core spun yarn can also be manufactured with staple fibers at the core as well as at the sheath. The yarn has the strength and elongation of the central compound and exhibits most of the other characteristics of the surface staple fibers, says Chattopadhyay (1999). Core spun threads, sometimes referred “pcore” or “polycore” or “cotton core”, are made by wrapping a staple polyester
or cotton wrapper around a continuous filament bundle of polyester fibers during spinning, and then plying these yarns into a sewing thread, as denoted by Agarwal (2010).

Core spinning is one of these methods, and can be applied by the ring, Murata vortex, friction spinning, and rotor twister techniques. In core yarns, there is an electrometric filament in the core and around it, where staple fibers are located. Consequently, the resultant fabric has all the characteristics of the predominant staple fiber together with the advantages of stretch and recovery as referred by Mourad et al. (2012).

The yarn fed through the delivery rollers only is usually known as the "core", and the other component is known as the "wrapper". The core may be of continuous-filament yarn or of spun yarn. If the core is of spun yarn, the direction of its twist is usually the same as that of the complete yarn. The application of core-spun yarns in the textiles industries is limited to some extent. These yarns are used to improve the physical and mechanical properties of fabrics such as breaking strength; abrasion resistance etc., says Gharehghaji et al. (2007).

2.10.1 History of core spun Lycra
Invented in 1937 in Germany, elastane has properties not found in nature, the most important having an extraordinary elasticity. The name spandex is an anagram of the word expands and is known as elastane points out Kumar et al. (2011).

2.10.2 Properties of core spun Lycra
Fabrics containing spandex yarn have a wide application value, especially because of their increased extensibility, elasticity, and high degree of recovery, good dimensional stability, and simple care by Rahman and Ansary (2011). Core spun yarns are made for decorative purposes or, more commonly, for strengthening the wrapper for facilitating subsequent processes. When used for strengthening, the core may, after it has served its purpose, be removed by solvent or other chemical action - e.g. the removal of calcium alginate filament yarn by an alkaline scour or of a cotton yarn by carbonizing, as noted by http://www.textileglossary.com/terms/core-spun-yarn.html

According to the www.EsskayPlastics.com, core spun yarn can have a high stretch, poor quality. Specifically, these fabrics have high wash shrinkage, dimensional instability, poor recovery and high skew on the fabrics.

2.10.3 Uses of core spun Lycra
These yarns are widely used in a variety of applications, such as an industrial clothing, conveyer belt, sewing threads and tentage, says Chattopadhyay (1999).
2.11. Special finishes

Specialty finishes include antimicrobial, fragrances, flame retardants, and many others. Special functional finishes represent the next generation of the finishing industry. Many functions can be achieved through current finishing technology. And, as with all emerging technologies, continued sharing of ideas and research findings will help create more and better opportunities to enhance textiles through functional finishes, says Mwnezes and Choudhari (2007). Now, there is a good deal of demand for the fabrics having functional/specialty finishes in general protecting human being against microbes, as viewed by Klaus (2001). Due to functional textiles apparels having added values and specific end uses, say Kumar and Teli (2007). Functional textiles and clothing provide the expected traditional properties, e.g. appearance, social identification, attraction, protection against cold, easy-care, as well as some new properties and functions of thermo-conducting, deodorant, avoidance of unpleasant odors, antibacterial and antifungal protection, as referred by Coman et al (2010).

The new developments in the special finishing sector are driven by consumers’ changing lifestyle towards a more casual clothing look, with a greater performance for higher standard of aesthetics, comfort, health and safety, protection and easy care performance, as noted by Mendapara and Karolia (2005). Some of functional finishes are antimicrobial, water repellent, stain repellent, fire proof etc, denotes Jasuja (2004).

2.12 ANTIMICROBIAL FINISHES

2.12.1 Introduction

Over the last few years there has been increased interest in antimicrobial finishes. The main reason for this increased interest includes: the promotion of healthier and physically active lifestyle; an increased awareness of the harmful effects of organisms on textiles as well as on human hygiene and freshness, denotes Holm (2002).

Nowadays antimicrobial material that can create comfortable living environments has attracted more and more attention, as referred by Chen et al (2010) and the greater use of synthetic fibers and blends in items such as shirts, hosiery, blouses and underwear, which tend to cause greater ‘perspiration wetness’ because of poor moisture transport properties as compared to natural fibers, explain Getting et al (2005).

The increasing demand for comfortable, aesthetic, durable, functional, and safe textile products dictates the development of new and contemporary techniques of processing and designing textiles, says Tomsic et al (2008). Garments of healthcare workers are a significant contributor to the spread of infections since they are easily contaminated. Moreover, it has been shown that bacteria can grow and survive on fabrics commonly used in healthcare environments for more than ninety days, contributing to the transmission of diseases, as noted by Appidi et al (2010).
These natural antimicrobial substances are not only eco-friendly, but also form renewable sources. Bacteria and fungi are microbes that can grow on textiles, says Bhoomika et al (2007). Antimicrobial finish on fabrics can minimize the transfer of micro-organisms onto the wearer by creating a physical barrier. It prevents the skin diseases caused by the micro-organisms. The various medicinal plants found in nature exhibit excellent anti-microbial properties. Microbial growth, especially bacteria, in textile materials can result in the deterioration of fabric properties, development of foul smells, skin irritation, and cross infections. Following are the functions of antimicrobial finishes:

- To avoid cross infection by pathogenic microorganisms.
- To control the infestation by microbes.
- To arrest metabolism in microbes in order to reduce the odor formation.
- To safeguard the textile products from staining, discolorations and quality deterioration.

The growth of microbes is favored by high humidity, moderate temperature and diminished light. When this combination of conditions prevails, the deterioration is greatly enhanced. Any fabric/canvas when exposed to fungi under ideal conditions of mold growth can be altered to the extent that it has no measurable strength after a few weeks. This deterioration indicates the tremendous potential of micro-organisms in deterioration of manufactured materials, as referred by Nair (2004).

Germs grow very rapidly by cell division, doubling their population every 20 minutes. They require humidity and an organic medium for growth. Antimicrobial finishing of textile fabrics can prevent the growth of various microorganisms and therefore, contribute to deodorizing. Antimicrobial finishing products are divided into bactericides (causing destruction of bacteria) and bacteriostats (inhibiting bacterial growth), as pointed by Toshniwal et al (2009). Antimicrobials enhance the functionality and value of textile products by keeping the micro-organisms that cause odor and fiber degradation under control. Yarns, fabrics, and finished products can all be treated with antimicrobials, says Thiry (2010). Microbes bacteria, virus, fungi and yeast are present almost everywhere. Whereas human beings have an immune system to protect against accumulation of microorganisms, materials such as textiles can easily be colonized by high number of microbes or even decomposed by them, say Dorugade and Bhagyashri (2010).

The word Antimicrobial is a general term for any product that kills or controls microbes, says Srikanth (2010). Antimicrobial finish causes a fabric to inhibit the growth of microbes in textile materials, as viewed by Kadolph and Sara (2007). Antibacterial fabrics are important not only in medical applications but also in terms of daily life usage, as referred by Erdem and Yurudu (2008).
2.12.2 History of antimicrobial finishes

The first antimicrobial textile material, in modern history, was developed by Lister in 1867, point out by Worley and Sun (2005).

2.12.3 Origin of antimicrobial textiles

During World War II, when cotton fabrics were used extensively for tent, tarpaulins and truck covers, these fabrics needed to be protected from rotting caused by microbial attack. This was particularly a problem in the South Pacific campaigns, where most of the fighting took place under jungle-like conditions. During the early 1940s, cotton duck, webbing and other military fabrics were treated with mixtures of chlorinated waxes, copper and antimony salts that stiffened the fabrics and gave them a peculiar odor. After World War II, fungicides used on cotton fabrics were compounds such as a hydroxyguinoline salts, copper ammonium fluoride and chlorinated phenols, as viewed by Vishnu et al (2010).

2.12.4 Requirement of antimicrobial finishing

However, there is an increase in public concern about the possible effects of antibacterial finishing related to environmental and biological systems. An ideal textile antibacterial finishing should not only kill undesirable microorganisms and stop the spread of diseases but also fulfill three other basic requirements, says www.google.com.

Researchers are now focusing on safe, durable, and environment friendly natural substitutes, as pointed out by Aly et al (2007). An ideal antimicrobial finishing must satisfy several requirements, of which the most important are a broad spectrum of activity and low toxicity to the consumer, as referred by Silva et al (2011).

2.12.5 Characteristic of antimicrobial finish

This type of finishing inhibits the growth of microbes on the surface of the fabric.

- Maintains hygiene and freshness, stops bad odor
- Controls or eliminates microbial staining
- Improves life of the articles wherever applied
- Improves strength
- Eliminates the chances of transmission of diseases
- Effective on any substances like cellulose, synthetics as well as their blends and any surface other than textiles, explains Babu (2003)

2.12.6 The different methods of Antimicrobial application:

The Antimicrobial agents can be applied to the textile substance, says Srikanth (2010)

Exhaust, Pad – dry – cure, Coating and Spray
2.12.7 Evaluation of activity of treated textile materials

Two types of Antimicrobial testing methods are mostly used. The first method is based on agar zone inhibition, and consists of the immersion of treated material in an agar culture medium containing inoculated microorganisms (bacteria or fungi). It is standardized by standard EN ISO 20645:2004, which set up a method for determining the effect of applied antimicrobial treatments on woven and knitted textiles and relatively new ISO/DIS 20645. The ISO 11721 is a burial test. The antibacterial effect can be defined as an inhibition of bacterial growth under favorable conditions.

The second method is based on bacteria number testing and is based on the determination of bacteriostatic /fungi static activity of the treated material which has been sterilized and inoculated with micro-organisms, by numbering the bacteria/fungi colonies, point out Comana et al(2010). For the assessment of diffusible anti–microbial activity, inhibition of multiplication is calculated by a qualitative procedure AATCC Test method (100–1999); this method is adequately sensitive, but time consuming for routine quality control and screening. The quantitative evaluation of activity can also be performed which gives clear picture of possible percentage kill by such treated materials. When the intent is to demonstrate bacteriostatic activity of diffusible agent, then the Parallel Streak method is used. This qualitative method is relatively quick and easy. It has been proved to be effective over a number of years, in providing evidence of anti – bacterial activity against both Gram positive and Gram negative bacteria.

A number of test methods have been developed to determine the efficacy of antimicrobial textiles, state Hipler et al (2006) & Gao and Cranston (2008). These methods generally fall into two categories: the agar diffusion test and suspension test. The bacterial species Staphylococcus aureus (Gram positive) and Escherichia coli (Gram negative) are recommended in most test methods. These two species are potentially pathogenic and therefore require proper physical containment facilities for handling (e.g. a biosafety cabinet). Many studies have used the innocuous Escherichia coli (Gram negative) as a test micro-organism which can be cultured and handled in a standard laboratory with minimal health risk.

2.13 Finishing test methods

Four test methods are commonly used within the textile industry to measure the activity of Antimicrobial fabrics. They are AATCC 100, AATCC 147, ASTME2149, and JIS L 1902, states Tanner (2009). Quantitative methods involve actual microbe enumeration, with results reported as a percentage or log reduction in the contamination level. Qualitative methods are subjective, using ratings and measured zones of inhibition, says Thiry (2010).

2.13.1 AATCC Test Method 30

Antifungal Activity - Antimicrobial assessment on textile materials -The two purposes of this antimicrobial test method (AATCC 30) are to determine the susceptibility of the textile materials to mildew and rot; and to evaluate the antimicrobial efficacy of fungicides on textile materials. The AATCC 30 antimicrobial test method provides two purposes: determining the susceptibility of textile materials to mildew and rot; evaluating the antimicrobial efficacy of fungicides on textile materials. The AATCC 30 Antimicrobial Test standard (Antifungal Activity, Assessment on Textile Materials: Mildew and Rot Resistance of Textiles) contains several tests: Soil-Burial Method - AATCC 30 Antimicrobial Test, Agar-Plate / Pure culture / Sterile Specimen Method - AATCC 30. Antimicrobial Test for cellulose materials only employs the use of Chaetomium globosum: (common name - Yeast), Aspergillus Niger on glucose mineral-salt agar - AATCC 30. Antimicrobial Test is recommended for the evaluation of textile samples in which the significance is concentrated on surface-growing organisms, such as mildew and rot resistance of textile materials. This test method is used to determine the susceptibility of textile materials to mildew and rot, and to evaluate the efficacy of fungicides on textile materials. (AATCC method 30 2008)

2.13.2 Durability of Antimicrobial Textiles

Temporary antimicrobial properties in textiles are easy to achieve in finishing but readily lost in laundering. Temporary antimicrobial textiles are useful only for disposable materials. Durable antimicrobial function is quite challenging to achieve and can last more than 50 machine washes, as referred by Tanveer Hussain (www.freewebs.com).

2.14 Microorganisms

Bacteria and fungi are microbes that can grow on textiles, denote Vukusic et al (2009). Microbes are named in accordance with the binominal system of nomenclature established by Carol Linnaeus in 1735. This system is not restricted to microbes but applies to all organisms. The names are latinized, and each organism carries two names(binominal), the first designating the genus and the second designating the species, states Krasner(2010). Bacteria are cosmopolitan in distribution and are ubiquitous in natural habitats such as soil, water and air points out Rao and Prakruthi (2009). Antibiotics are substances produce by micro-organisms like bacteria, fungi and actinomycetes that kill or inhibit, through growth of other micro-organisms, says Kumari (2007).
A microbe or micro-organism is an organism that is so small that it is microscopic (invisible to the naked eye). Microorganisms i.e. bacteria, fungi, mildew, mold and yeasts, are found everywhere in nature, even in hostile environments, points out Mustafa and Mangat (2010). There are both good and bad types of micro-organisms. Thousands of species of microorganisms that exist are found everywhere in the environment and on our bodies, states Gupta and Laha (2007). Although microbes can be useful in many ways, for example in brewing, baking and biotechnology, they can also be harmful to both textiles and humans, as noted by Casciani (2003). Biocide properties are desired for textile substrates to protect both the wearer and the textile substrate itself, point out Toshniwal et al (2009).

2.14.1 Bacteria

Gram -negative bacteria- bacteria that is not dyed purple when treated with Gram’s stain; Gram-positive bacteria – bacteria that remain purple when treated with Gram’s stain, states Bonin (2005). Bacteria play an important role as part of the body’s micro flora, and along with the skin, are shed continuously. Under acceptable growth conditions, they can multiply from one organism to more than one billion in just 18 hours, notes White et al (2002).

2.14.1.1 Types of bacteria

2.14.1.1.1 Staphylococcus aureus

Taxonomy-Class : Bacilli
Order : Bacilli’s
Family : Staphylococcaceae
Genus : Staphylococcus
Species : Staph, aureus, staph.epidermidis (or) albus, staph, saprophyticus.

Staphylococcus belongs to a group of pathogenic bacteria parasitic to humans. These spherical bacterial cells usually occur in grape like clusters and hence the name bunch of grapes kokkosseed. First observed by Von Reckling Hausen in 1871, these are gram positive bacteria. Genus staphylococcus contains three medically important species: staph aureus, staph epidermises and staph saprophyticus.


2.14.1.1.2 Escherichia coli

Taxonomy-Class : Proteobacteria
Order : Enterobacteriales
Family : Enterobacteriaceae
Genus : Escherichia  
Species : Escherichia

In 1885, Escherich, a German pediatrician, first discovered this species in the feces of healthy individuals and called it Bacterium coli commune due to the fact it is found in the colon; early classifications of Prokaryotes placed these in a handful of genera based on their shape and motility as viewed by Merriam-Webster Online Dictionary (2008).

2.14.2 Antifungal

Antifungal works by exploiting differences between mammalian and fungal cells to kill the fungal organism without dangerous effects on the host. Unlike bacteria, both fungi and humans are eukaryotes. Thus, fungal and human cells are similar at the molecular level, making it more difficult to find a target for an antifungal drug to attack, that does not also exist in the infected organism. Consequently, there are often side effects to some of these drugs. Some of these side effects can be life-threatening if the drug is not administered properly, explains Wikipedia, the free encyclopedia. Fungi are eukaryotes. Morphologically, they can be divided into two groups - the yeasts and the molds. The yeasts are unicellular and are larger than bacteria, and may reproduce by budding. Molds are the most typical fungi and are multicultural, consisting of long, branched, and intertwined filaments called hyphae says Robert L Krasner . Fungi are ubiquitous, found in air, water, soil, on plant or animal bodies, note Rao et al (2009).

The term fungi describe a taxonomic classification of organisms but no longer include organisms such as slime molds and water molds that had traditionally been considered to be fungi. Fungi require organic compounds for energy and carbon source, often from dead organisms. Most fungi are aerobic (or) facultative anaerobic. Only a few fungi are anaerobic, points out Veena (2008)

2.15. Mosquito repellent finish:

Mosquito repellent finish protects human beings from mosquito bites, thereby promising safety from mosquito-borne diseases. Malaria, dengue fever (DF), Nile fever, dengue hemorrhagic fever (DHF), chicken guinia and filariasis, are serious public health problems in tropical regions, especially in Africa and Asia. These diseases are transmitted to human beings only through mosquito bites. Since there is no effective vaccine available for the control of these diseases, prevention of mosquito bites is one of the main strategies to control or minimize incidence of these diseases, as referred by [(fiber2fashion.com ), Krishnaveni (2009)].

This repellence of plant material has been exploited for thousands of years by man, most simply by hanging bruised plants in houses, a practice that is still in wide use throughout the developing countries, note Moore et al (2006). “Natural” smelling repellents are preferred because
plants are perceived as a safe and trusted means of mosquito bite prevention, denote Casas et al (2001).

2.15.1 Need for mosquito repellent textile

Global warming is the cause of the distribution of mosquitoes which has expanded from tropical regions to northern latitudes, and that leads to a spread in sources of viral infection from mosquitoes. First at the West Nile District of Uganda in 1937, and then infections were confirmed in Israel, France and South Africa and it is now showing signs of spreading further all over the world. The first outbreak occurred in New York City in 1999, which spread rapidly to over 4000 people all over the U.S. and killed over 240 people. It is likely that the virus arrived via wild birds imported as pets and via plane or boat in an infected mosquito. Reports of persons diagnosed with the disease have recently been confirmed in the island country of Japan. In this era of globalization, the Ministry of Health, Labour and Welfare requires cases to be reported for preventive action, to the rural governors under regulations for disease control and prevention, as pointed out by Malik and Parmar (2008) (fiber2fashion.com).

2.16 Odor control

Odor control is a hot topic in the apparel and hosiery sectors. Odor can be controlled by applying an antimicrobial finish, removing the odor molecules as they are formed or covering up the odor with a fragrance, states Doshi (2008). The use of bios tats to inhibit odor development resulting from biological growth on textiles exposed to perspiration had not been considered a real need until relatively recently, notes Geettings (2005).

Four factors are required for the complete characterization of an odor: intensity, character, hedonics and detect ability. To date, detect ability is the only factor that has been cased in the developments of statutory regulations for nuisance odors, odors can be measured by sensory methods and specific odorant concentrations can be measured by instrumental methods ,as referred by Sivaramakrishnan (2010). Antimicrobials are used on textiles to control bacteria, fungi, mold, mildew, and algae. This control reduces or eliminates the problems of deterioration, staining, odors, and health concerns that they cause. In the broad array of microorganisms there are both good and bad types says White et al (2002).

Micro-organisms metabolize nutrients, such as sweat and soil present in textile products, producing odor-causing intermediates that cause irritation. Controlling moisture is also a major concern for many manufacturing companies because micro-organisms only attack fibers when they are damp, denotes Purwar and Joshi (2004). The growth of microorganisms on textiles inflicts a range of unwanted effects not only on the textile itself but also on the wearer. These effects include the generation of unpleasant odor, stains and discoloration in the fabric, a reduction in the fabric's mechanical strength and an increased likelihood of contamination. Odors are formed as a result of

2.17. Microencapsulation
2.17.1 Introduction

The micro encapsulation technique was brought to use for the first time in 1940 by B.K. Green, for the production of No Carbon Paper (NCR), views by Alat and Saraf (2005). Micro-encapsulation is the process of enclosing a substance in the form of small particles or droplets within a permeable or dissolvable miniature “capsule”, so that the substance can be easily released. The technique is used to trap solids, liquids or gases within a barrier layer made from gelatin, plastic, starch or other materials, which isolates and protects them from evaporation, oxidation and contamination by the external environment. The encapsulated product is released either by breaking the shell or by slow, progressive diffusion through the microcapsule, denotes www.just-style.com (2010)

The development of micro encapsulation products started in the 1950s with research into pressure–sensitive coatings for the manufacture of carbonless copying paper. The textile industry has, however, been slow to envisage applications for innovative micro encapsulation techniques. Micro encapsulation technologies offer many opportunities to improve the properties of textiles or to give them new functions, say Dixit and Goel (2007)

Tarafder (2010) states that the technology of production of encapsulating materials is rather complex, production of micro and macro capsules involve many general coating devices. Smaller the size, more the production of microencapsules. To carry out micro encapsulation of fabrics it is very easy. The particles could be temporarily or permanently fixed onto the fabrics depending on the end–uses.

Micro encapsulation is a technique in which tiny droplets of benefit laden products such as moisturizers, fragrances, deodorizers, vitamins or repellents are packed in microscopically small capsules sealed hermetically thereby preserving them. It is vital that microencapsules are stable and durable. The diameter of capsule varies from 1m depending upon the application; an area of 1sq cm would contain 1 million capsules, as referred by Ramalingam and Subramanian (2006). Micro encapsulation has attracted the interest of the Dyeing, Printing and Finishing in textile wet processing method, for the last decade; note Bairagadar and Katkar (2010).

2.17.2 Definition

Micro–encapsulation may be defined as a micro packaging technique, wherein an active core material is encapsulated in a polymer shell of limited permeability. The objective of this technology is either to protect the active core material from the external environment till required or to affect the
controlled release of the active core to achieve desired delay until the right stimulus is encountered, state Bairagadar and Katkar (2009).

2.17.3 Uses

Microencapsulating is a new technique that is rapidly emerging. It is widely used in Pharmaceutical, chemical, cosmetic, agricultural and food processing and in recent years, in textile finishing. In textiles, the major interest in microencapsulating is currently in the application of durable fragrances and skin softeners. Other applications include insect repellants, dyes, vitamins, antimicrobial agents, phase – change materials and medical application, such as antibiotics, hormones and other drugs, as reviewed by Thilagavathi, et al (2007). The areas of application are dyeing, printing, finishing and fiber manufacturing. Different types of binding agents could be employed for achieving permanency. They can affect the release property and hence change the market value of the fabric. Fibrous form of encapsulated entities could also be incorporated in the conventional textile structures, says Tarafder (2010)

2.17.4 Advantages of Encapsulation

Encapsulation of active ingredients is carried out for one or more of the following purposes, points out Nelson (2002)

- To render the liquids into powders, to prevent clumping and improving mixing.
- To protect active ingredients from oxidation, heat, acidity, alkalinity, moisture or evaporation.
- To prevent ingredients from interacting with other compounds in the system, which result in their degradation or polymerization?
- To mask the taste of unpleasant flavors or odors.
- To improve handling of an ingredient before processing.
- To release active ingredients in a controlled or targeted fashion.
- To protect workers or end users from exposure to hazardous substances.

2.17.5 Choice of Encapsulation Techniques

The choice of the encapsulation technique depends on factors such as the functionality of the capsule needed to provide in the finished product, and the type of coating material. The coating material should not react with either the ingredient to be encapsulated, or the formulation in which the capsule will be added. The process conditioning the encapsulation, must survive before releasing the contents, and the concentration of the core material in the microcapsule. The mechanism of release of the active agent from the microcapsule, eg.agitation, pH, pressure, solubility, time, etc, depends on the type of release (targeted, sustained or controlled) of the active ingredient. The particle size, density, and stability requirements for the active ingredient, the cost of the capsules and the cost of the formulation or application into or onto the final product, as pointed out by www.google.com
2.17.6 The characteristics of a microcapsule:

- Size and size distribution
  - Low size increases the mechanical strength and also eases application.

- Loading fraction
  - This is the weight ratio of core to wall of the microcapsule, higher this ratio, better the production efficiency, but lower would be the stability.

- Release properties
  - Rate of release from microcapsules depends largely on the structure of the polymer wall, which in turn is influenced by the conditions employed in the preparation. Wall characteristics like crystallinity, when cross – linked to the density of the wall, increases, and the release rate reduces substantially

- Thermal stability
  - The microcapsule during its formation and application should be stable at higher temperatures, as referred by Bairagadar & Katkar (2009).

2.18. Nanotechnology

2.18.1 Introduction

Nanotechnology is an emerging and highly interdisciplinary field based on the ability to manipulate structural materials on the level of individual atoms and molecules, say Anita et al (2010). In today’s industrial era, textile is the major industry which markets a range of nanotechnology finished products to the consumers. Textile products are the most popular materials which maintain comfort, easy care, health and hygiene while ensuring protection against mechanical, thermal, chemical and biological attacks on humans, denote Rajendran et al (2009). The application of nanoscale materials and structures, usually ranging from 1 to 100 nanometers (nm), is an emerging area of nanoscience and nanotechnology. Synthesis of noble metal nanoparticles in applications such as catalysis, electronics, textiles, environmental protection, and biotechnology is an area of constant interest; Nanoscale science and technology have emerged over the past decade as the forefront of science and technologies. The intersecting fields of study that create this domain of science and engineering, perfectly typify the rapid, multidisciplinary advancement of contemporary science and technology, as referred by Rajendran et al (2010). Enhancement of textile materials by nanotechnology is expected to become a trillion dollar industry in the next decade with tremendous technological, economic and ecologic impact, denote Usha et al (2010).

Nanotechnology means any technology done on nanometer, or 10-9 meter scale, say Charles et al (2003). It is derived from the Greek word “nanos” which means “dwarf”, meaning abnormally small. To explain, an atom is 1/5 nm in diameter and 100,000 nm times smaller than bacteria. So, it is all about generating new solutions based on atomic and molecular scale. It commonly refers to the fabrication, study and manipulation of structures having a size in the range of...
1 to 100 nanometer (1 nanometer is 10^{-9} \text{ m}) because in this range electrons display special behavior. Thus, it has became an umbrella term for a wide range of processes and technologies that can manipulate or exploit materials with an organized structure at the nanometer scale, state Pant and Sharma (2006).

With the advent of nanoscience and technology, a new area has developed in the field of textile finishing called” Nano finishing”. Coating the surface of textiles and clothing with nanoparticles is an approach to the production of coveted fabric. The first commercial application of Nano Technology in the textile and clothing industry, is found in the form of nanoparticles through a finishing process, which is generally known as nanofinishing, say Rathinamoorthy et al (2011).

Nanotechnology material innovation is an important focus on creativity in the textile sector and many fashion designers consider technological fabrics the future of fashion, as pointed out by Hinestroza (2007).

2.18.2 Definition for nanotechnology

A new technology to resist spills and stains in fabric employs “nanotechnology,” which is the infusion of microscopic nano-materials; in the case of fabrics, nano-fibers are infused directly into the product so that it becomes inherently spill and/or stain resistant, states http://www.noharm.org/us

2.18.3 Existence of two basic types of manufacturing methods

There are two ways of synthesizing nanophase materials, such as the top down approach and the bottoms up approach. The first involves breaking down the bulk materials to nanosizes (e.g. mechanical alloying). In the other approach, nanoparticles are also made by building atom (e.g., inert gas condensation). The first commercial application of nanotech in the textile and clothing industry was in the form of nanoparticles (sometimes called nanobead) through a finishing process which is generally known as nano finishing, as viewed by Prince and Raja (2006).