Sampling of Fiber,

Homeowner collection of asbestos samples is not recommended. However, no law prohibits this practice. Contact our office if you wish to have a State of Michigan accredited asbestos building inspector collect your samples or perform a comprehensive asbestos building inspection. Persons sampling asbestos-containing materials should have as much information as possible on the safe handling of asbestos before sampling. At a minimum, the following procedures should be followed:

1. Wear disposable gloves or wash your hands after sampling.
2. Shut down any heating, ventilating air conditioning systems to prevent the spread of any released fibers.
3. Do not disturb the material any more than is needed to take a sample. Do not release asbestos fibers into the air or onto yourself.
4. Place a plastic sheet on the floor below the area to be sampled.
5. Wet the material using a fine mist of water before taking the sample. The water mist will limit the release of asbestos fibers.
6. Carefully cut a piece of the material (ensuring the full thickness of the insulation is represented) using, for example, a small knife, corer, or other sharp object.
7. Place the material into a clean container (for example, a 35 mm film canister, or high quality re-sealable plastic bag).
8. Seal the container after the sample is in it. Each sample must be submitted in its own separate container.
9. Use a damp paper towel to clean up any material on the outside of the container or around the sample site.
10. Dispose of the plastic sheet and towel.
11. Label the container with an identification number and clearly state the precise location of the sample.
12. Patch the sampled area with caulk, spackle or other repair material, to prevent fiber release.
13. Complete a Chain of Custody form which may be downloaded from: http://www.fibertec.us/chain_of_custody.pdf
14. Send the Chain of Custody form, A CHECK OR MONEY ORDER, and the SAMPLE to Fibertec IHS for analysis.

Fibertec IHS, 1914 Holloway Drive, Holt, Michigan 48842

Cotton Fiber:

Among the seed and fruit fibres, cotton has grown in stature as the most important textile fibre in the world. In fact, cotton is the backbone and basic foundation of the world's textile trade and industry. Cotton is a natural vegetable fibre produced in the cotton plant in many countries of the world even in

Bangladesh also.

Properties of Cotton Fibres:

Properties of cotton fiber can be divided into two parts, one is according to physical structure and another is using process.

A. According to physical structure:

Length of cotton fiber:
Physically the individual cotton fibres consist of a single long tubular cell. Its length is about 1200-1500 times than its breadth. Length of cotton fibre varies from 16mm to 52 mm depending upon the type of cotton.

1. Indian cotton- 16-25 mm
2. American cotton- 20-30 mm
3. Sea Island- 38-52 mm
4. Egyptian cotton- 30-38 mm

Fineness of cotton fiber:
Longer the fibre, finer the fibre in case of cotton fibre. It is expressed in term of decitex and it varies from 1.1 to2.3 decitex.

1. Indian= 2.2-2.3dtex
2. American= 2.1-2.2 dtex
3. Egyptian= 1.2-1.8 dtex
4. Sea Island= 1.0-1.1 dtex

Fineness may be more in case of immature fibre. So it is necessary to express maturity with fineness.

Strength and extension of cotton fiber:
Cotton fibre is fairly among natural fibres in relation to tenacity which is 3-3.5g/dtex. Its tensile strength is between wool and silk fibre but disadvantage is low extension at break which is 5-7%.

Elastic properties of cotton:
Recovery from deformation of cotton fibre, yarn or fabric from applied load is very low. By applying heat it can't be achieved. This property can be achieved by -1.Chemical treatment to improve crease recovery, but the problem is the materials become harsher due to chemical treatment 2. blending or mixing of cotton with elastic fibre, e.g. polyester, blend ratio depends on the end use of the fabric. The initial modulus is

fairly high=0
5 g/dtex (wool=0.25 g/dtex)

Cross-section:
Cross-section of cotton fibre is some what ribbon like. The cell wall is rather thin and the lumen occupies about two-third of the entire breadth and shows up very prominent in polarized light. Fibre cross-section becomes round when mercerized.

Appearance:
Cotton fibre is fairly short, fine and creamy white color. Color of the fibre depends on soil of growth. By adding chemicals in the soil, color of the cotton fibre may be varied.

Crimp:
Cotton fibre is more or less twisted on its longitudinal axis which cab not be seen from out side is called convolution. The twist in the fibre does not to be continuous in one direction i.e. if at first right direction, then left direction. This property of cotton fibre helps in spinning.

B. According to using process:

Comfortable:

Cotton fiber has large amorphous portion and this is why the air can be in and out through cotton fiber. So, the fabric made by cotton fiber is quite comfortable to use.

Soft Hand:

Cotton fiber is too much regular fiber and if properly ginned; this fibre can be the best soft hand feeling fibre amongst the others.

Absorbent:

Cotton fiber has high absorbency power and this is why this fiber can be died properly and without any harassment.

Good Color Retention:

If the printing is applied on cotton fiber, it seems it doesn't spread the color outside the design. So printing efficiency is good on cotton fibre.

Machine Washable & Dry Cleanable:

It is seen that some fibers can't be dried or washed due to it's sensitivity and weak fastness properties but in case of Cotton fiber you will have large number of options to choose. You can easily wash the cotton made fabric by machines and even you will be able to dry this fiber by using electronic drier.

Good Strength:

If you want to seek an average strength which might be enough for you; then cotton fiber can be your ultimate choice. The strength of cotton fiber is quite good.

Cotton Fibre Drapes Well:

The drape-ability of cotton fibre is awesome. You can use the cotton fibre made fabric in any kind of wear which needs more flexibility and drapes.

Sewing & Handling Is Easy:

The sewing efficiency on Cotton made fabric is easier and comfortable than other fiber. This is why the demand of cotton made fabric is higher in all over the world.

Uses of Cotton Fiber:

Cotton fiber is a versatile fibre which has wide variety of uses. But the Cotton fibre is mostly used on the Apparel Industry to make the wearing cloth like Sweaters, Skirts, Shirts, Swimwear, Kids wear, Blouses, Pants, Hosiery and to make other type of dresses

COTTON FIBERS

Updated: April, 2004- Raghavendra R. Hegde, Atul Dahiya, M. G. Kamath

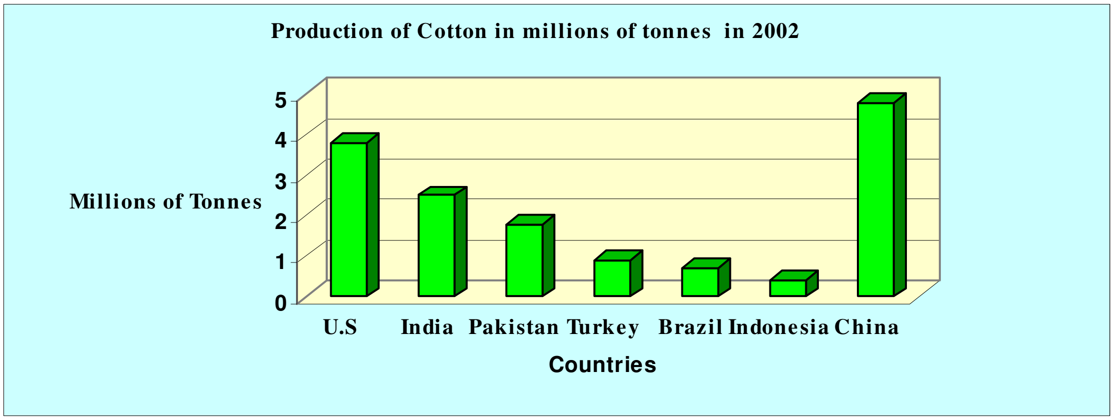
1. INTRODUCTION

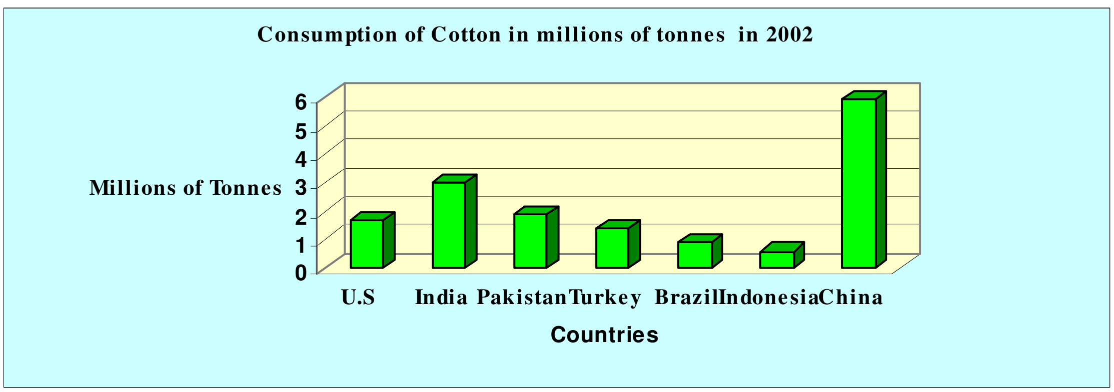
Cotton today is the most used textile fiber in the world. Its current market share is 56 percent for all fibers used for apparel and home furnishings and sold in the U.S. [1]. Another contribution is attributed to nonwoven textiles and personal care items. It is generally recognized that most consumers prefer cotton personal care items to those containing synthetic fibers. World textile fiber consumption in 1998 was approximately 45 million tons. Of this total, cotton represented approximately 20 million tons. [2]. The earliest evidence of using cotton is from India and the date assigned to this fabric is 3000 B.C. There were also excavations of cotton fabrics of comparable age in Southern America. Cotton cultivation first spread from India to Egypt, China and the South Pacific. Even though cotton fiber had been known already in Southern America, the large-scale cotton cultivation in Northern America began in the 16th century with the arrival of colonists to southern parts of today's United States. [3] .The largest rise in cotton production is connected with the invention of the saw-tooth cotton gin by Eli Whitney in 1793. [4] With this new technology, it was possible to produce more cotton fiber, which resulted in big changes in the spinning and weaving industry, especially in England.

2. COTTON CONSUMPTION AND PRODUCTION IN MILLION TONS IN YEAR 2002

The graph bellow shows Production and consumption of leading cotton producing countries in Millions of tones in year 2002 [5].

COUNTRIES	PRODUCTION	CONSUMPTION
US	3.8	1.7
India	2.5	3
Pakistan	1.8	1.9
Turkey	0.9	1.4
Brazil	0.7	0.9
Indonesia	0.4	0.6
China	4.8	5.9





Today, cotton is grown in more than 80 countries worldwide. The Distribution of cotton is shown in the bellow Map:

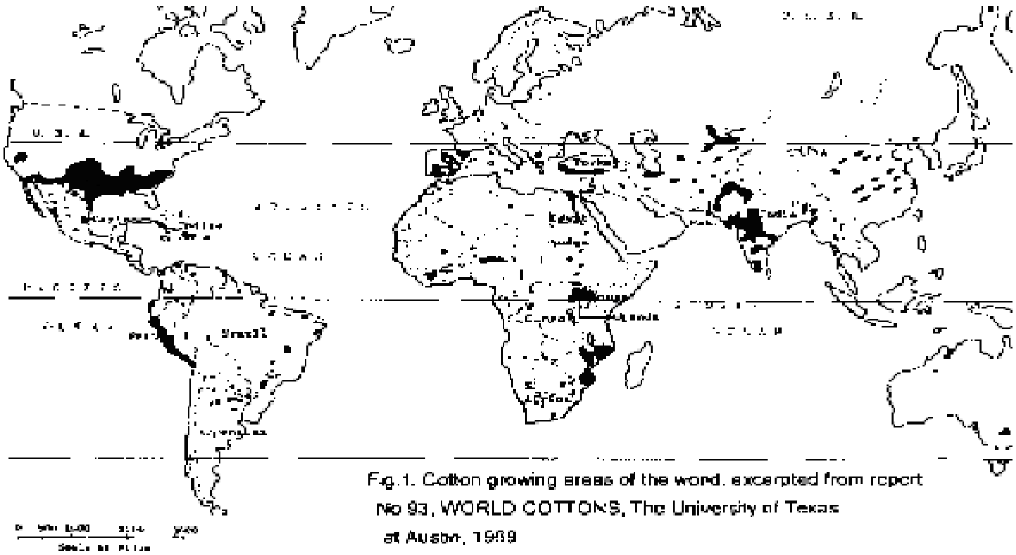


Fig.1. Cotton growing areas of the world, excerpted from report No 93, WORLD COTTONS, The University of Texas at Austin, 1969

■ Cotton growing parts of the world

3. CHARATERISTICS OF COTTON

Cotton, as a natural cellulosic fiber, has a lot of characteristics, such as;

- Comfortable Soft hand
- Good absorbency
- Color retention
- Prints well
- Machine-washable
- Dry-cleanable
- Good strength
- Drapes well
- Easy to handle and sew

4. END USES OF COTTON:

- Apparel - Wide range of wearing apparel: blouses, shirts, dresses, childrenswear, active wear, separates, swimwear, suits, jackets, skirts, pants, sweaters, hosiery, neckwear.

- Home Fashion - curtains, draperies, bedspreads, comforters, throws, sheets, towels, table cloths, table mats, napkins

5. STRUCTURE AND PROPERTIES OF COTTON FIBERS

5.1 FIBER STRUCTURE AND FORMATION

The botanical name of American Upland cotton is *Gossypium Hirsutum* and has been developed from cottons of Central America. Upland varieties represent approximately 97% of U.S. production [4].

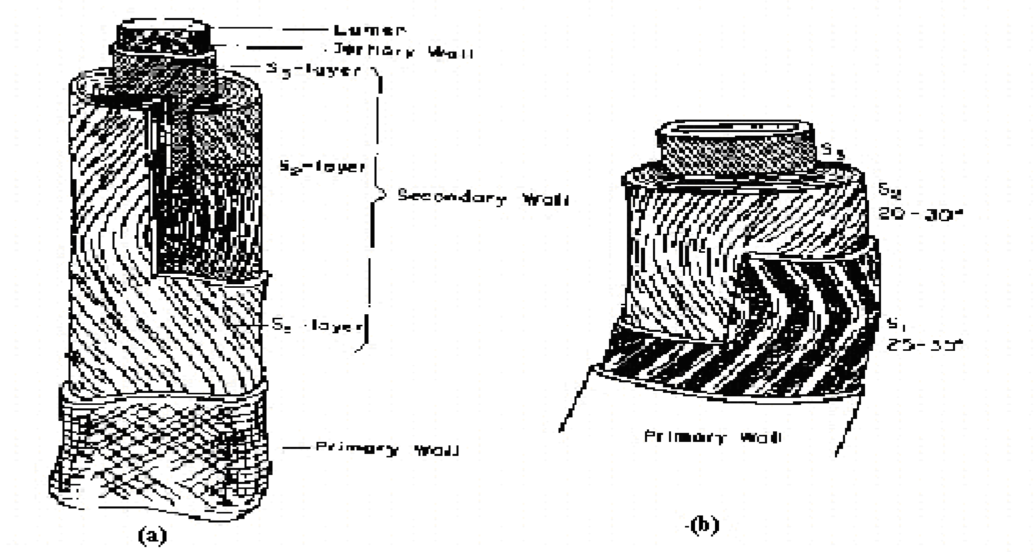


Fig 3. Schematic Diagram of Cotton Fiber (a) Layered Structure (b) The tubular Orientation of The secendory structure

Each cotton fiber is composed of concentric layers. The cuticle layer on the fiber itself is separable from the fiber and consists of wax and pectin materials. The primary wall, the most peripheral layer of the fiber, is composed of cellulosic crystalline fibrils. [9] The secondary wall of the fiber consists of three distinct layers. All three layers of the secondary wall include closely packed parallel fibrils with spiral winding of 25-35^{o} and represent the majority of cellulose within the fiber. The innermost part of cotton fiber- the lumen- is composed of the remains of the cell contents. Before boll opening, the lumen is filled with liquid containing the cell nucleus and protoplasm. The twists and convolutions of the dried fiber are due to the removal of this liquid. The cross section of the fiber is bean-shaped, swelling almost round when moisture absorption takes place.

The overall contents are broken down into the following components.

5.2 RAW COTTON COMPONENTS:

80-90%	Cellulose
6-8%	Water
0.5 - 1%	Waxes and fats
0 - 1.5%	Proteins
4 - 6%	Hemicelluloses and pectin's
1 - 1.8%	Ash

During scouring (treatment of the fiber with caustic soda), natural waxes and fats in the fiber are saponified and pectin's and other non-cellulose materials are released, so that the impurities can be removed by just rinsing away. After scouring, a bleaching solution (consisting of a stabilized oxidizing agent) interacts with the fiber and the natural color is removed. Bleaching takes place at elevated temperature for a fixed period of time [1]. Mercerization is another process of improving sorption properties of cotton. Cotton fiber is immersed into 18- 25% solution of sodium hydroxide often under tension [9]. The fiber obtains better luster and sorption during mercerization.

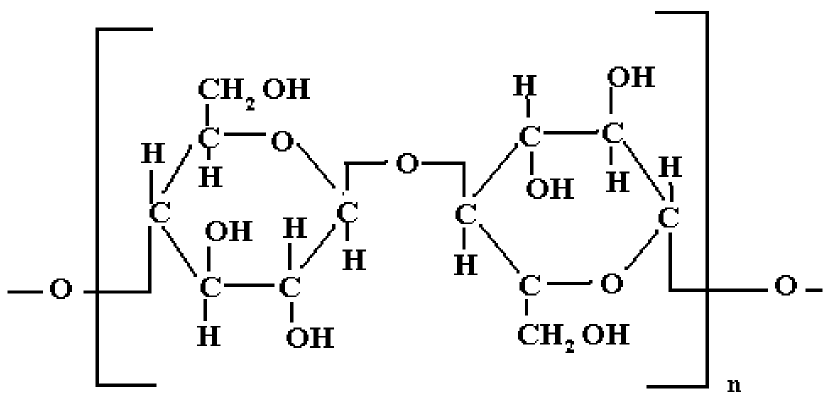
After scouring and bleaching, the fiber is 99% cellulose. Cellulose is a polymer consisting of anhydroglucose units connected with 1,4 oxygen bridges in the beta position. The hydroxyl groups on the cellulose units enable hydrogen bonding between two adjacent polymer chains. The degree of polymerization of cotton is 9,000-15,000 [1]. Cellulose shows approximately 66% crystallinity, which can be determined by X-ray diffraction, infrared spectroscopy and density methods.

Each crystal unit consists of five chains of anhydroglucose units, parallel to the fibril axis. One chain is located at each of the corners of the cell and one runs through the center of the cell. The dimensions of the cell are a = 0.835nm, b = 1.03 nm and c = 0.79 nm. The angle between ab and BC planes is 84º for normal cellulose, i.e., Cellulose I [8].

5.3 REPEAT UNIT OF CELLULOSE

The current consensus regarding cellulose crystallinity (X-ray diffraction) is that fibers are essentially 100% crystalline and that very small crystalline units imperfectly packed together cause the observed disorder.

The density method used to determine cellulose crystallinity is based on the density gradient column, where two solvents of different densities are partially mixed. Degree of Crystallinity is, then, determined from the density of the sample, while densities of crystalline and amorphous cellulose forms are known (1.505 and 1.556 respectively). Orientation of untreated cotton fiber is poor because the crystallites are contained in the micro fibrils of the secondary wall, oriented in the steep spiral (25-30^{o}) to the fiber axis.



6. PHYSICAL PROPERTIES OF COTTON

6.1 FIBER LENGTH

Fiber length is described [7] as "the average length of the longer one-half of the fibers (upper half mean length)" This measure is taken by scanning a "beard " of parallel fibers through a sensing region. The beard is formed from the fibers taken from the sample, clasped in a holding clamp and combed to align the fibers. Typical lengths of Upland cottons might range from 0.79 to 1.36in.

Cottons come from the cotton plant; the longer strand types such as Pima or Sea Island produce the finest types of cotton fabrics [18].

6.2 LENGTH UNIFORMITY

Length uniformity or uniformity ratio is determined as " a ratio between the mean length and the upper half mean length of the fibers and is expressed as a percentage"[7]. Typical comparisons are illustrated below.

LENGTH UNIFORMITY	UNIFORMITY INDEX [%]
Very High	>85
High	83-85
Intermediate	80-82
Low	77-79
Very Low	<77

Low uniformity index shows that there might be a high content of short fibers, which lowers the quality of the future textile product.

6.3 FIBER STRENGTH

Fiber strength is measured in grams per denier. It is determined as the force necessary to break the beard of fibers, clamped in two sets of jaws, (1/8 inch apart) [7]. Typical tensile levels are illustrated. The breaking strength of cotton is about 3.0~4.9 g/denier, and the breaking elongation is about 8~10%. [20]

DEGREE OF STRENGTH	FIBER STRENGTH [g/tex]
Very Strong	>31
Strong	29-30
Average	26-28
Intermediate	24-25
Weak	<23

6.3 MICRONAIRE

Micronaire measurements reflect fiber fineness and maturity. A constant mass (2.34 grams) of cotton fibers is compressed into a space of known volume and air permeability measurements of this compressed sample are taken. These, when converted to appropriate number, denote Micronaire values.

COTTON RANGE	MICRONAIRE READING
Premium	3.7-4.2
Base Range	4.3-4.9
Discount Range	>5.0

6.4 COLOR

The color of cotton samples is determined from two parameters: degree of reflectance (Rd) and yellowness (+b). Degree of reflectance shows the brightness of the sample and yellowness depicts the degree of cotton pigmentation. A defined area located in a Nickerson-Hunter cotton colorimeter diagram represents each color code. The color of the fibers is affected by climatic conditions, impact of insects and fungi, type of soil, storage conditions etc. There is five recognized groups of color: white, gray, spotted, tinged, and yellow stained. As the color of cotton deteriorates, the process ability of the fibers decreases.

Work at the University of Tennessee has led to color measurement using both a spectrometer CIE-based average color measurement and a color uniformity measurement using image analysis to improve the accuracy and provide additional measurement for color grading [19]. Later the investigators developed two color grading systems using expert system and neural networks.

6.5 TRASH

A trash measurement describes the amount of non-lint materials (such as parts of cotton plant) in the fiber. Trash content is assessed from scanning the cotton sample surface with a video camera and calculating the percentage of the surface area occupied by trash particles. The values of trash content should be within the range from 0 to 1.6%. Trash content is highly correlated to leaf grade of the sample.

6.6 LEAF GRADE

Leaf grade is provided visually as the amount of cotton plant particles within the sample. There are seven leaf grades (#1-#7) and one below grade (#8).

6.7 PREPARATION

Preparation is the classer's interpretation of fiber process ability in terms of degree of roughness or smoothness of ginned cotton.

6.8 EXTRANEOUS MATTER

Extraneous matter is all the material in the sample other than fiber and leaf. The classer either as “light” or “heavy” determines the degree of extraneous matter.

6.9 NEPS

A nep is a small tangled fiber knot often caused by processing. Neps can be measured by the AFIS nep tester and reported as the total number of neps per 0.5 grams of the fiber and average size in millimeters. Nep formation reflects the mechanical processing stage, especially from the point of view of the quality and condition of the machinery used.

7. CHEMICAL PROPERTIES OF COTTON

Cotton swells in a high humidity environment, in water and in concentrated solutions of certain acids, salts and bases. The swelling effect is usually attributed to the sorption of highly hydrated ions. The moisture regain for cotton is about 7.1~8.5% and the moisture absorption is 7~8%. [20]

Cotton is attacked by hot dilute or cold concentrated acid solutions. Acid hydrolysis of cellulose produces hydro-celluloses. Cold weak acids do not affect it. The fibers show excellent resistance to alkalis. There are a few other solvents that will dissolve cotton completely. One of them is a copper complex of cupramonium hydroxide and cupriethylene diamine (Schweitzer's reagent [11])

Cotton degradation is usually attributed to oxidation, hydrolysis or both. Oxidation of cellulose can lead to two types of so-called oxy-cellulose [12], depending on the environment, in which the oxidation takes place.

7.1 INSERT FORMULA OR EQUATION: OXY-CELLULOSE

Also, cotton can degrade by exposure to visible and ultraviolet light, especially in the presence of high temperatures around 250~397° C [20] and humidity. Cotton fibers are extremely susceptible to any biological degradation (microorganisms, fungi etc.)

7.2 OPTICAL PROPERTIES OF COTTON

Cotton fibers show double refraction when observed in polarized light. Even though various effects can be observed, second order yellow and second order blue is characteristic colors of cellulosic fibers. [10] A typical birefringence value as shown in the table of physical properties, is 0.047.

7.3 COTTON CLASSIFICATION

Cotton classification is used to determine the quality of the cotton fiber in terms of grade, length and Micronaire [1]. USDA [7] classification specifically identifies the characteristics of fiber length, length uniformity, strength, Micronaire, color, preparation, leaf and extraneous matter. In the past, these qualities were classified just by hand-and-eye of an experienced classer. Since 1991, all classification has been carried out with a set of up-to-date instruments, called "HVI"(High Volume Instrumentation) classification [1]. However, measuring techniques of other qualities of cotton fiber, such as fiber maturity and short fiber content, are also being developed.

7.4. COTTON IN NON-WOVENS

Cotton is the most important apparel fiber throughout the world. It is a fiber that was used fairly extensively during the early, developmental period of the Nonwovens business primarily because the emerging dry-laid producers came from the textile industry and had an intimate knowledge of cotton and its processing characteristics [25].It was in the early part of 20th Century that a few cotton mills in the US wanted to find ways to upgrade the waste cotton fibers into saleable products. The first method used was bonding the short cotton fibers (fiber waste) with latex and resin. These products were used mainly as industrial wipes. After World War II, products like draperies, tablecloths, napkins and wiping towels were developed. It was realized that woven fabrics have much better properties than Nonwovens; so, the approach was to claim the market where superior qualities of woven or knit fabrics were not essential but where qualities better than those of paper were needed. As the quality requirements for nonwoven fabrics increased and particularly as the need for white, clean fabric emerged; the use of raw cotton became unacceptable and was abandoned by the industry except for a few isolated product areas. Within the last decade, bleached cotton fiber suitable for processing on conventional nonwoven equipment has become available and has substantially increased interest in this fiber. This is particularly true in medical and healthcare applications, wiping and wiper markets, and some apparel markets. The raw cotton consists of about 96% cellulose and 4% of waxes, pectin, and other pertinacious and plant material. These minor constituents that must be removed in the scouring and bleaching process to give the soft, clean, white, absorbent fiber that is satisfactory for the nonwovens industry after the application of an appropriate finishing oil. The fiber length of cotton is important, particularly as to its process ability. Longer staple cotton (0.75 in. to 1.25 in.) is satisfactory for nonwoven production. The fiber has excellent absorbency and feels comfortable against the skin. It has fairly good strength both wet and dry, and has moderate dimensional stability and elastic recovery. But the resilience of cotton is relatively low, unless it is cross-linked by a chemical treatment. In nonwoven applications, the purity and absorbency of bleached cotton are utilized in growing medical and healthcare applications. The spun lace process usually produces such fabrics. For similar reasons, cotton spun lace fabrics are well accepted in personal and related wipes, especially in Japan and the ASIAN region. In a sense, bleached cotton fiber for nonwoven application is a relatively new fiber. It is a comparatively expensive fiber and available from only a few sources. Consequently, its use still is restricted to specialized applications. This situation is likely to change in the future as the price is further reduced and availability increased.

8. FIBER PROCESSING

About 30% of world cotton machines harvest production. Australia, Israel and USA are the only countries where all cottons are picked by machines. Fifteen percent of world cotton production is ginned on roller gins and almost all rest of cotton is saw ginned in most countries [14].Cotton fibers in non-wovens are generally used in their bleached form. A lot of research and development has taken place for the efficient production of bleached fibers. The Kier bleaching process produces most of the bleached cotton fibers. Since cotton of lesser grades is useful for non-wovens, a conventional cleaning system does not suffice. This might include a coarse wire carding, called Cotton Master Cleaners, for cleaning the cotton.

- The conventional bleaching method for cottons meant for non-wovens is a 9 step process are:

  a) Fiber opening and cleaning
  b) Alkali scouring application
  c) Alkali reaction stage
  d) Rinsing
  e) Bleach application
  f) Bleach reaction stage
  g) Rinsing
  h) Finish application
  i) Drying

A continuous textile processing system and method have been disclosed recently for producing a nonwoven web containing bleached cotton fibers in a single line system which includes a supply of fibers such as a bale opening device, The final nonwoven web consisting of bleached cotton fibers may be made into highly purified and absorbent wipes, pads, and other articles for medical, industrial, or domestic use [17].

Finally, there is opening and bale formation.

- Cotton Incorporated patented a processing line, which promised better productivity and quality. It consists of:

  a) Fiber opening and Cleaning
  b) Formation of web
  c) Steam purging and Alkali impregnation onto the sandwiched cotton web between 2 porous conveyors.

  d) After reaction, a pressure squeezing operation.
  e) Similar processes for bleaching and then finishing.

- The recent system for scouring a bleaching of cotton fiber is the Continuous Wet Finishing Technique' patented by Lawrence Girard and Walter E Meyer and assigned to Greenville Machinery Corporation. It consists of:

a. Opening and Cleaning

b. Conversion of fibers into a bat, weighing 10-30 ounces/sq. yard, by Needle punching or Air-lay technique.

c. Scouring

d. Bleaching

e. Finishing

f. Washing

g. Drying

h. Fiber opening

Advantages of Continuous Finishing Techniques are:

a) Uniformity of scouring and bleaching
b) Uniformity of finish application
c) Shorter time in process for the materials
d) Lower water consumption and less effluent for treatment
e) The ability to provide additional chemical treatments to the cotton.

8.1. COST OF PRODUCING COTTON

The international cotton advisory committee (ICAC) undertakes a survey of the cost of the production of cotton every three years based on the data from 31 countries. [16] Several factors are considered, such as land rent, fertilizers, insect control, irrigation, harvesting and ginning. The cost of seed cotton is more than $500 in USA to produce one hectare of seed cotton. The net cost of producing lint from one hectare (the value of seed and land rent were excluded from the total cost) is highest in Australia (US$1,056) followed by the USA (US$889), Pakistan (US$814), Zimbabwe (US$426) and China (US$416). It is most expensive to produce a kilogram of lint in the USA (US$1.20), Australia (US$0.75) and china (US$0.48).

8.2. WEB PROCESSING WITH COTTON

Cotton fibers are used in the manufacture of nonwovens either alone or in a blend. The various processes for the manufacture of non-wovens are:

8.3. HYDROENTANGLEMENT:

This method of bonding provides strength to the Nonwovens, comparable to woven fabric of the same basis weight. This method yields high strength without interfering with the absorbency, tensile strength and aesthetic properties of cotton. This type of nonwovens can be wet processed like the conventional woven textiles for bleaching, dyeing and finishing. To manufacture soft loose nonwovens, partially entangled webs are produced by subjecting cotton webs to low water jet pressures (approx. 300-500 psi). These types of webs can be wet processed in a pad/batch state. The limitations of this process are that production has been limited to fiber blends because of problems in recycling water and the quality of bleached cotton.

8.4. NEEDLE PUNCHING:

Needle punched cotton provides highly efficient filter media based on the irregular fiber shape and absorption properties. Increased tenacity in the wet condition can be an important advantage for cotton filters. To build strength, scrim materials can be used as in bed blankets and industrial fabrics. Needles of 36-42 gauges have been found appropriate for the production of cotton needle punched nonwovens. For very heavy fabrics, use is made of gauge 32 and for finer fabrics 40-42 gauge needles are being used.

8.5. THERMAL BONDING:

In this process cotton webs with blends of thermoplastic fibers are passed between 2 hot rollers (Calendar rollers). The thermoplastic fiber softens/melts and bonds the web. The initial work was done with polyester as the thermoplastic fiber. Later polypropylene was extended for the study because of economics, density and melting temperature considerations. This was mainly to study the application as a diaper lining material. Substantial work is still being done to develop this type of nonwovens.

8.6. OTHER BONDING SYSTEMS:

a. Impregnating the web with a resin or other adhesive material.

b. Stripping off of the web with adhesive, which bonds the fibers together at regular intervals.

c. Stitch bonding: cotton web is stitched like in sewing and the product performance depends on web weight, stitch/inch and type of sewing thread.

9. APPLICATIONS AND MANUFACTURERS OF COTTON NON-WOVENS

Cotton nonwovens are used as swabs, puffs, wipes, filters, weddings, personal care products like in diapers & feminine hygiene products, semi-durable segments like bedding, household furnishing, pillow fillers, etc.

9.1.MANUFACTURERS OF COTTON

- BARHARDT MANUFACTURING
- BBA NONWOVENS VERATEC
- BRANNOC FIBERS Ltd.

- COTTON INCORPORATED
- IHSAN SONS (PVT) LIMITED
- LEIGH FIBERS
- TEXTILES AND NONWOVENS DIRECTORY

10. RECENT RESEARCH

- New instrumentation to measure cotton contamination [21].
- Cotton linters to replace the traditional 100% wood pulp fibers for producing absorbent cores for disposable diapers and famine pads [22]
- New quality measurements of small sample cotton are being developed [26
- Cotton is being blended with kenaf fibers to improve the softness and hand [27]
- Buckeye Technologies has developed 100% natural cotton for tampon manufacture [29
- Clustering analysis is developed for cotton trash classification [30]
- New method to improve the dyeability of cotton with reactive dyes. [31]

10.1 RECENT DOVELOPMENTS IN COTTON

10.1.1 COLORED COTTON

Cotton fiber is dyed with chemical dyes in order to get wide range of colors. These chemical dyes and their finishing demands large amount of water in turn when these water is disposed they cause soil and water pollution. Many dyes are of chemical origin; particularly the azure ones and these are not environment friendly. Hence many countries, including India, have prohibited use of these dyes.

The negative effects of dyeing can be reduced by naturally colored cotton. This colored cotton is developed by gene transplantation. Crossing the genes from wild cotton varieties with the cultivated white ones develops this colored cotton. The research is being conducted at The University of Agricultural Sciences (UAS), Dharwad Karnataka India, to promote the cultivation of natural colored cotton. The colors that have been developed are White, Orange, Red, Yellow, Green, Purple, Brown, Blue, And Black. These negative effects of dyeing can be avoided by extensive research and growth of colored cotton. (33).

10.1.2. BT COTTON

Cotton requires severe pesticide in order to combat numerous pests after some years of use of pesticide by farmers these pests develop resistance to Particular pesticide. This resistance force farmers to use more amounts of pesticides. BT Cotton is developed by transgenic technique of implanting Bacillus Thuringiens bacterial gene in to cottonseeds, which makes the cotton plant and seeds resistant to majority of pests including bollworm (A. Lepidoptera), Tobacco budworm (Heliothis virescens). Bt cotton is now one of the most widely used transgenic crops. It is currently grown throughout the United States. More than 2 million acres of Bt cotton are grown in the United States alone. Other countries include China, India, and Australia. (34) According to Dept. of Agricultural and Resource Economics, University of Arizona. *Bt* cotton planted from 1996 to 1998 is estimated to have yielded 5% more on average than if traditional and decreased the quantity of foliar spray [35].

10.1.3 COTTON'S FUTURE TRENDS

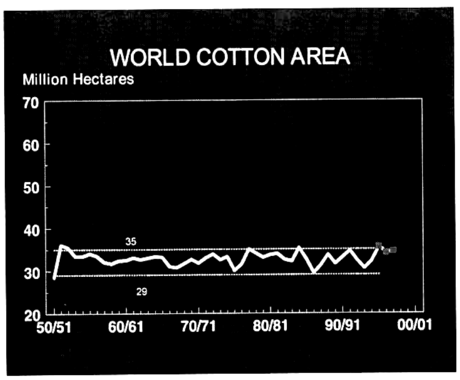
The world's cotton fiber production is approximately 89 million bales [6]. In 1997, a production forecast [6] shows that the U.S. is the largest cotton producer (18.4 million bales), followed by China (17.5 million bales), India (12.8 million bales), Pakistan (8.0 million bales) and the former U. S. S. R. republics (7.7 million bales). Other important cotton producers are Australia, Egypt, Turkey, Brazil, Argentina, Paraguay, Greece and Mexico. The highest cotton consumption is attributed to China (21.2 million bales), India (12.9 million bales) and U.S. (11.3 million bales).

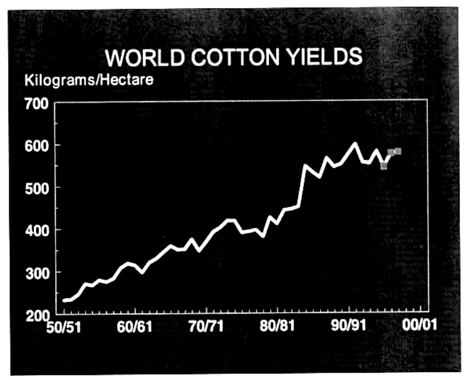
SUPPLIES: The world production will increase a little bit. The 1998 U.S cotton crop is best described as a disaster due to cool wet spring in the west and inadequate rainfall in the southeast [24].

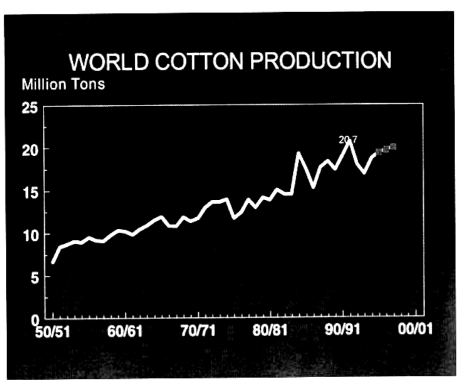
CONSUMPTION: World cotton consumption is lagging a bit behind production. After a surge in the mid-1980s, world cotton consumption has been rather flat. But the long term potential for cotton demand remains large [23].

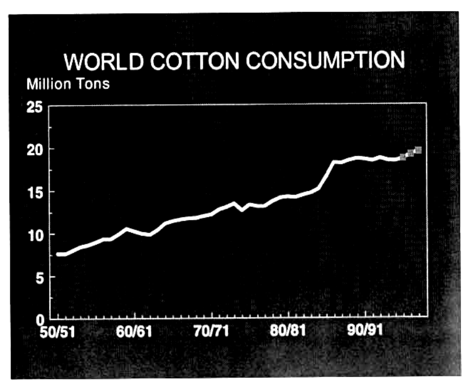
All cotton plantings for 1999 are expected to total 14.6 million acres, 9 percent above 1998, and 5 percent greater than 1997. Upland cotton is expected to total 14.2 million acres, up 9 percent from last year. Growers planted 318,200 acres of American-Pima cotton. This is a 3% decrease from last year's number, but 27% higher than the acreage of 2 years ago. Planting in Georgia started extremely slow due to a severely dry spring, but by June 1 was nearly on pace with average. Conversely, Texas experienced a near normal planting season although some replanting was necessary due to wind and hail damage [15].

11.Graph of World cotton area/World cotton yields/World cotton production/World cotton consumption[11] Graph of Cotton Prices









12. CONCLUSION

Cotton nonwovens can be recycled, re-used or disposed off by natural degradation conditions. Cotton is a readily renewable resource with long-term supply assurance. Extensive research works is improving bleached fiber quality and quantity. Nonwoven industries are producing various types of nonwovens with different manufacturing techniques, for better production. Cotton share of the textile fiber market has been steadily increasing and will continue to increase as cotton-containing items is preferred by the consumers.

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Fiber analysis (separate) file

Technical Tests for Fiber Identification

There are two types of methods that are used for identifying different fibers - the nontechnical tests and the technical tests. The nontechnical tests include the feeling test and the burn test. The technical tests include microscope test and chemical test. The technical tests for fiber identification are carried out in laboratories and require technical knowledge and skills. As such, they are much more reliable methods for testing end product as compared to the non technical tests.

The Nontechnical Tests- Feeling Test and Burning Test
Feeling test involves touching a fabric and feeling the fabric to know its component fibers. For example, wool fabrics will feel warm when touched because the heat generated by wool, which is a nonconductor of heat, will remain in the touched area itself. On the other hand, the fabrics made up of plant fibers such as cotton fabrics, linen fabrics and even the rayon fabrics, that are made from the cellulose of wood pulp or cotton fiber, feel cool to touch. As they are conductors of heat, the heat generated by the finger passes off making the fabric cold. However, it requires a long experience of handling different fabrics over a period of time for such skillful perception. Also, it is difficult to examine and compare the fabrics made of different fiber contents with the feeling test.

The other nontechnical test for fiber identification by the burn test- involves burning a sample of fabric and observing the various characteristics shown by it after burning in order to determine its fiber content. The burning test is more efficient than the feeling test but it also has its limitations. For example, fabrics made of biconstituent fibers, that are combination of two different textile polymers, can not be identified with this test.

The Technical Tests- Microscope Test and Chemical Test
The technical tests for fiber identification done with the help of laboratory equipment are far more reliable than the nontechnical tests. However, technical knowledge and skill, particularly while handling chemicals, are the basic requirements for conducting these tests.

Microscope Test
Microscopes having magnification of at least 100 power, can be successfully employed for testing and identifying the fiber contents of a fabric. Microscope test is very effective for testing the natural fabrics. Difficulties can be faced while testing synthetic fabrics as many of them have similar appearance. However, one must know, what the fibers look like under a microscope as many finishing processes like mercerizing and delustering, change the appearance of fibers under microscope. Apart from it, dark colored fabrics also cannot be tested with microscope as light cannot pass through dark substances. For such fabrics, either the textile dyes haveto be removed by stripping, bleaching etc. or they have to be chemically tested.

Natural fibers have their own peculiar structures, spots, lines and other marks that help in identifying them. Following are some examples of natural fibers and how they look like under a microscope:

Cotton: The cotton fiber is a single elongated cell. Under a microscope, it looks like flat, spirally twisted ribbonlike tube with rough granular surface. However, mercerized cotton doesn't have natural twist. The finishing process makes them swollen, straight, smooth and round with a shining surface.

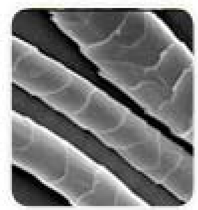
Linen: Linen fiber, under a microscope, looks like having multiple sided cylindrical filaments with fine pointed edges. The filaments show nodes at intervals. It, in fact, looks like a bamboo stick having joints that results into a little unevenness.

Wool: Wool fiber has irregular, roughly cylindrical, multi cellular structure with tapered ends. Under a microscope, three basic layers are shown- epidermis (outer layer), cortex (middle layer) and medulla (inner layer). Medulla is seen only in coarse and medium wool fibers and that too under a highly powerful microscope.

Silk: Raw silk fiber, composed of two filaments, has elliptical shape under the microscope. The two fine and lustrous filaments are shown clearly looking like transparent rods with triangular shape. Wild silk or tussah fiber has different appearance than the cultivated silk. It is flattened, coarse, thick and broader fiber having fine, wavy lines all across its surface whereas cultivated silk is narrower fiber with no marks on it.

Manmade fibers are difficult to identify through microscope because of similar appearance of many fibers. However, their certain distinguishable characteristics under a microscope have been mentioned below.

Rayons: Rayon fiber has uniform diameter with glass like shine. If delustered then rayon fiber shows marks similar to pepper, when viewed cross sectionally. Viscose fiber of rayon looks irregular when viewed cross sectionally.



Acetate: Acetate fiber looks lesser irregular than viscose rayon when viewed cross sectionally. It has indentations that look like occasional marks when viewed longitudinally.

Nylon: There are many variants of nylon fiber. However, generally it appears fine, round, smooth and translucent. Sometimes it has shiny appearance. If it looks dull, it will also be dotted under the microscope.

Aramid: If viewed longitudinally, aramid fiber looks smooth and straight. If viewed cross sectionally, it may be round or like peanut's shape.

Polyester: Generally, polyester fiber is smooth, straight. It looks round cross sectionally. However, with various finishing processes, its appearance changes in context of texture and luster.

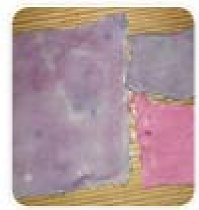
Spandex: Spandex fiber have the outstanding characteristic of appearing like groups of fibers fused together. However, different variants of spandex show different characteristics too. The Lycra fiber looks like fused multifilaments cross sectionally. Individual fibers are dotted and in shape like that of dog-bone. If viewed longitudinally, they appear straight.

Polypropylene: When viewed cross sectionally, polypropylene fiber looks somewhat round but it looks straight and smooth when viewed longitudinally.

Glass: The glass fiber looks smooth, round, translucent, shiny and flexible.

Chemical Tests

Chemical tests for fiber identification can only be conducted in well equipped laboratories. There are two primary methods to conduct chemical testing- stain and solvent.



Stain Method: Stain technique uses acid and alkali on different fabrics to identify their fiber contents. Most of the fibers have two color reactions when treated with stain. A fiber stained with dilute acetic acid turns to a specific color. The same fiber when stained with mild alkali like soda carbonate turns to a different color again specific to that fiber only. Acetate changes to light green color when acetic acid is used and turns orange when dilute carbonate of soda is used. Likewise, nylon turns beige in one and bright red in other. As double testing is done in this method, it is sometimes referred to as double-barreled stain identification.

Solvent Method: Various solvents are used in this method to distinguish one kind of fiber from another. However, there is no single solvent or chemical that can be used on all fibers. Additionally, different solvent procedures are adopted to separate and identify the fibers that are combined together. It becomes very difficult to use solvent methods in view of fibers that have similar chemical characteristics. Also, when more fibers are mixed to produce blended fabric, then also it becomes tough to identify the fibers with the help of solvent method. However, it is a very effective method for cross checking but in order to have accurate reports, the fabric has to be cleaned thoroughly and the finishing chemicals should also be removed completely. The fabric has to be unraveled, yarns have to be untwisted and the fibers have to be put in the solutions in as loose a condition as is possible.

As an example of solvent method, consider differentiating animal fibers from plant fibers with alkali. If wool or silk fiber has to be eliminated from a blended fabric then strong alkalies can be used because animal particles are destroyed in it. Five percent of caustic soda or sodium hydroxide is used in water. The action of the chemical is hastened by boiling the solution before immersing the sample fabric in it. The wool or silk fiber gets completely dissolved in it. The plant fibers remain unaffected. For differentiating them, acid has to be used as the dilute acids destroy plant fibers. A drop of sulfuric acid has to be put on the sample fabric which, in turn, is placed between two blotters and pressed with hot iron. If it contains cotton, linen or rayon then the fabric gets charred at the spot.