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Significant relationship between pre-treatments and environmentally safe anti-combustion preparation in enhancing appearance properties of cotton fabrics

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Abstract

In order to enhance the aesthetic value and mechanical qualities of cotton textiles, Dyeing, printing and final processing for cotton are regarded as two of the most significant technological procedures. We find that the use of high-quality clothing requires the use of environmentally safe materials in all stages of production, and on this basis, research is being prepared until 100% cotton fabrics are produced. The text discusses the importance of cotton as a textile material, highlighting its composition, including cellulose and other elements. It mentions the histological structures of cotton fabric, such as simple fabric construction, chilled tissue structure, and Atlantic weaving structure. The structure of cotton fibers is also described, including the core, outer shell, primary wall, and secondary wall.

Keywords: Wet treatments for cotton fabrics; Preliminary treatments of cotton fabrics, 3- Bush removal process; Bleach; Fabric printing; Final preparation of cotton fabrics; Preparing cotton fabrics against burning

Introduction

Regarding the use of cotton, it has been one of the most important sources of fiber since ancient times, and it remains one of the most important sources until now. Unlike fibres, natural fibers are derived from nature and have little harmful effect on anything they come into contact with.

Synthetic fibers are harmful, especially in terms of electrical sensitivity and balance. [1-5]

Up to the advent of convertible fibers, cotton is regarded as one of the significant textile materials that was able to hold a prominent position across time. This is because of two significant factors that make it impossible to overlook: its low cost and ease of usage.

Considering the significance of home apparel in every one of our lives, the home apparel business must grow by introducing new features into clothing products in order to achieve the best possible quality utilizing safe materials at an affordable price.

Long ago, the necessity for cellulose materials with various qualities arose, including resistance to shrinking, resistance to UV radiation, resistance to static electricity, resistance to dampness, and resistance to fire.

The manufacturing process is considered one of the most important processes that cotton goes through, as it includes a group of processes that the fabric goes through after leaving the textile machine, such as bleaching, dyeing, and printing. The purpose is to prepare the fabric to be attractive and have an acceptable appearance. Processing operations also aim to give the properties and qualities of materials. Specific suitable for different purposes.

Previous studies

Composition of cotton and its reactivity

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It is made up of mineral elements, protein, wax, and cotton cellulose, with cellulose making up around 99% of the mixture after bleaching The standard symbol for cellulose is ($C_6H_{10}O_5$), where n represents the number of cellulose's full structural units. About 4000–6000 element units make up a cellulose molecule, and these units are fully connected to one another by strong glucose bonds, each of which comprises Because cellulose contains three free hydroxyl groups (OH), it has a wide range of chemical characteristics, including the capacity to absorb dyes and moisture and the ability to react with a wide variety of chemicals. [6-9]

Histological structures

One of the major influences on the fabric qualities, which change depending on how the flesh is mixed with the gravitational threads, is the tissue structure. [10]

the most common tissue structure:

Simple fabric construction 1/1

It's the most straightforward, easy, and popular combination of tissues because to its simplicity in manufacturing, speed of production, low cost, and ease of cleaning clothes made from it, whether by dry cleaning or wet cleaning.

Structure of chilled tissue

The use of the second tissue structure results in a distinct surface of textiles that can take the form of a slope, both right and left hand-twill, or both herringbones. This difference in appearance is caused by a constructive manner and the intermingling of threads with one another.

The structure of Atlantic weaving

The dispersion of the crossing points produces a brilliant, smooth surface that often identifies the third basic tissue structure. The lowest number that can result in an atlas is 4 wicks and 4 wefts and If the wicks and wefts are less, the atlas won't be generated since the atlas is mostly dependent on the distribution of the markings at a distance apart, without coming into contact with one another.

Cotton fiber structure

Cotton fibers consist of long, single-celled threads with pointed ends.The lower part (where it connects to the seed) is open, and the hairs are separated from their sources only by ginning operations with concentric layers known as the core And class An outer shell consisting of lipids, pectin and wax, and beneath the shell there is a primary wall with a cellulose structure The fibers are intertwined in a criss-cross fashion, followed by the secondary wall, which consists of three cellulose layers. [11, 12]

- An area adjacent to the lining of the pulp, which we can only distinguish in very mature cottons, and it consists of mineral salts And proteins derived from the drying of cell sap, in contrast to the first and second layers, which are composed of Cellulose.
- A very thin layer with a spiral direction, with an inclination of 20-35 degrees.
- A very thin layer with a spiral direction and an inclination of less than 20 30 degree.

There are about (80-120) twists in a fully mature original fiber, and their number increases in good fibers and decreases in bad fibers.

Cotton, in general, must contain some immature cells, which reduces its twisting. Therefore, its wall is thin and its core is depressed. Therefore, it is dead fiber that has no benefit. This is due to several reasons, the most important of which is the date of planting and harvesting of cotton.

Wet processes for cotton fabrics

The wet stage of operation of cotton fabrics includes three basic and important processes: primary processors, dyes, printing, and final processing. The initial process involves four main processes: "The removal of posh and boiling in alkaline bleach, and the facilitation or editing of bleach." [13, 14]

Primary treatments

Natural imperfections present in cotton fibers are present in cotton garments. Posh additives are also added when the textile is being prepared. In order to achieve appropriate textiles for further processes, all "nature and additive" impurities are often eliminated in three fundamental procedures called as bleaching operations. One of these procedures is removing posh gilling in the alkaline-oxidizing substance bleach. The cellulose's natural and correct constitution, which gives it a better capacity for dye and processing materials, includes the laceration process in its first treatment. [4, 10, 15-21]

Desizing

the procedure wherein the engraving material is extracted from the dam's threads after being woven into a textile. It is important to identify the type of push being used before beginning the removal procedure, since each type has a unique chemical structure that may be eliminated in a certain.

Types of bushes

- Sizing From natural materials
- Starch and its derivatives

- chemically modified starch products
- cellulose derivatives (Carboxymethyl cellulose - methyl cellulose – oxyethyl cellulose)

Sizing from protein source materials:

- Glue
- gelatin
- albumin

Sizing from Using industrial materials

- Polyacrylate
- Polyester
- polyvinyl alcohol
- Common accumulator of sterols
- Malic acid

Bleach

Bleaching is considered one of the main and basic processes that is carried out on cotton fabrics before the dyeing and printing stage, in which all the remnants of the bushing materials are eliminated and the original color of the cotton is eliminated and transformed into a permanent white color.

In order to make cotton garments white so they won't fade or become yellow over time, the natural color that cannot be eliminated during the first preparation phase needs to be removed using the cotton fiber bleaching procedure. Complex organic compounds that may be reduced or oxidized to simple chemicals dissolved in water or to other non-colored substances are the substances responsible for these hues. These materials are referred to as ovulation materials, and the procedure is known as bleaching.

Reduced bleaching agents

They are substances that depend in their work on interaction with oxygen in water, where active hydrogen is formed, which in turn reduces the colored substances in the raw material, thus forming a new compound that has a color.

These materials are not widely used with cellulosic fibers because they cause damage to the fibers, examples of which are (sodium hydrosulfite).

Oxidized bleaching agents

These materials depend on the formation of active oxygen in order to interact with the colored materials and remove them, as the colored materials are oxidized into dissolved substances that have no color, so their whiteness is constant. Among the most widely used and important of these materials, especially in cellulosic fibers, are sodium hypochlorite and sodium chlorite (but they are harmful to the environment). Hydrogen peroxide is the safest of them for the environment.

Bleaching using hydrogen peroxide

It is one of the most widely used methods for processing cotton and other fibers, and also one of the safest materials for the environment. It is also used to resist mold and odor. It is used commercially in liquid form and in different concentrations, so that it is unstable when exposed to air. Despite this, great care must be taken when using it so that it does not harm the material. To obtain the best results in bleaching cotton, it must be stored well in opaque bottles to prevent the depletion of oxygen water.

After completing the bleaching process, the fabric is washed until the impurities and excess chemicals adhering to it are eliminated, with hot water and then with cold water until successful dyeing and processing is obtained later .

Cotton fabric printing

When new kinds of manufactured textiles and auxiliary materials appear, as well as when the types of dyes available for printing natural fibers develop, copier printing is the process of transporting various color units, which together make up a recurring specific fee on the material to be printed. [22-28]

There are lists of compounds that are forbidden as well as allergic and allergic dyes that are generally not allowed to be used in tissue goods.

Printing with pigment colours

Pigment dyes do not dissolve in water and do not have any affinity for fibers.

They also do not turn into a soluble substance during any of the stages of their operation and stick mechanically through the use of an adhesive. Therefore, they are not called dyes and may sometimes be called “pigments.”

This group of dyes is used in printing and dyeing fabrics by preparing solutions consisting of colored materials with adhesives. Then the textile is printed and heat treated to stabilize it. Upon heat treatment, the adhesive material is polymerized or condensed, forming a thin film that contains the colored material and is well adhered to the material. Pigment printing has several advantages that make it a major role in printing textiles due to the ease of printing textiles, its cheap price, the variety of colors, and the wide color range that allows them to be easily combined. Used for the printing of cotton fabrics pigment and dyes (direct and effective, basins, Naftol and sulfur) It is considered to be the most popular in printing except for pigment. [21, 28-32]

Cotton printing with pigment

it is characterized by the fact that it does not require subsequent washing or evaporation. It also has good statistical stability, good washing stability, and weak friction stability.

Fixing the print with pigment:

The printed fabric is passed through a printing oven with a length that may reach up to 30-60 meters at a temperature of 120-160 °C, so that the first drying is performed to stabilize the paste in order to prevent any staining or migration and prevent the goods from being contaminated with each other when folded. The thermal stabilization stage begins with one of the techniques.

1- The ram exposes the fabric to temperatures of 160-180-210°C, which ensures complete evaporation of the kerosene or water and the stability of the paste.

2- Toflo: Here the fixation is done with hot air according to the temperature and time, as we need one minute at a temperature of 180°C, and seven minutes at 120°C, and below that the fixation is not complete.

3- The incense burner: Here the installation is done using steam at a temperature of 102-105°C for 7-10 minutes.

Direct dye printing

It is easy to apply the dye printing process using direct dyes because it is cheap, but it also has disadvantages, which are its poor stability on fabrics.

The printing process is applied after mixing is complete, after which the drying stage begins.

Fixation in a steamer at a temperature of 102-105°C for 15-30 minutes, then we wash in stages according to the following order:

1. Warm rinse at 40°C, cold deluxe.
2. Wash bath with a solution containing 1 g/l detergent at a temperature of 60° for 3 minutes.
3. Warm rinse at 40°C, cold deluxe.
4. Fixation bath with 5-20 gal cationic stabilizer, followed by final drying without rinsing at 140-150. 5 minutes duration

Printing cotton clothes with effective dyes

It is carried out through eight basic stages:

1. Initial preparation
2. Preparing the printing paste
3. Printing
4. Drying
5. Moisturizing
6. Installation
7. Drying and washing
8. Drying and final fixation

Initial preparation

Initial preparation. This stage is implemented through processes:

A. Boiling or shortening:

B. Fixing and gluing: This is done by rolling the fabric into a cylinder shape (Rollo roll on the ram) and gluing the edges to prevent it from being rolled on the printing machine carpet during the printing stage.

Therefore, the most important errors that can occur at this stage are:

1. Printing on garment head sewing joints.
2. Inadequate fixation.
3. Paste staining on the printing mat due to insufficient or irregular fixation.

Preparing the printing paste:

The success of this stage is linked to a number of steps, the most important of which are:

A. Choose the most appropriate type of dye.

B. Weight of the pigment.

C. Method of preparing the dye solution.

D. Method of mixing the pigment solution with the thickener.

Therefore, the most important mistakes that can occur at this stage are:

1. Formation of pigment clusters.
2. Foam formation.
3. Changing the specifications of the paste during storage.

Printing

The printing process is carried out according to four basic methods:

A. Printing roller.

B. Rotary screen printing.

C. Silkscreen printing.

D. Drip inkjet printing printing jet ink.

Therefore, the most important mistakes that can occur at this stage are:

1. Poor printing adjustment: colors being drawn or shifted away from each other, color rippling and a decline in printing clarity rates with the appearance of some pigment pimples.
2. Errors in the design or implementation of templates.
3. Stains on white floors.

Drying

This is done using one of the following four techniques:

A. Dryer Cylinder.
B. Dryer with hot air.
C. A corset with tenter pins.
D. Dryer loop Short.

Therefore, the most important mistakes that can occur at this stage are:

1. Poor leveling and smudging due to poor air distribution according to the dryer's air circuit.
2. Cracking of the printing paste due to the high temperatures used during heating processes.

Wetting

A layer of wet sawdust is spread over the printing paste, which is considered to protect it from sudden changes Whether changing temperature or humidity, we thus ensure a homogeneous fixation process on the one hand, and prevent cracking of the paste Or spotting it on the other hand.

Installation

It is applied via one of the following four techniques:

A. Dry baking.
B. Steaming under normal atmospheric pressure
C. Steaming High Temperature HTS.
D. Steaming High Pressure (HPS).

Rinse baths

where the rinsing and washing operations are carried out using their own soap baths or washing machines first, and then the process of returning the bathrooms is cleaned when necessary.

We can apply these bathrooms with a number of techniques, machines and equipment, such as:

Open sinkers, winches and jigs.

Therefore, the most important mistakes that can occur at this stage are: Incomplete disposal of the remaining printing paste or dyes depending on the type of auxiliary materials used, their concentrations, processing time, and appropriate temperatures for each stage.

Drying and final stabilization

This is done to set the final specifications required for the printed products: such as the specific gravity (meter) And softening or filling Therefore, it is often done on RAM.

Final preparation of cotton fabrics

Both soft and curly-resistant treatments are included there are other names for wrinkle and cartridge preparation, such as Easy-Care and Easy-Care.

The features of Durable-Press, Anti-Peace Permanent Stabilization, No Iron, Wash and Wear and apos etc., are primarily applied to cellulose fibers, which include Cotton, linen, ramie, and other fibers lacking a natural retrograde status. In contrast, wool and silk possess a natural retrofit to resist wrinkles; hence, the flexibility or retroactivity of fibers influences the ability of fabrics to regain their original position after being bent, thereby impacting their resistance to wrinkles.

Wrinkle theory and processing mechanics

When hair is bent, it is exposed to high stress, which causes it to become prolonged beyond its limit of flexibility. This means that when strong forces stop acting, the hair is not fully restored and instead remains as a permanent avalanche, causing fractures that are difficult to remove.

Additionally, the bending of the fabric causes the second of the threads to become prolonged. This causes wrinkles or fracturing of fabrics.

High stress is applied to hair when it is bent, causing it to lengthen beyond its maximum flexibility. This implies that the hair is not completely repaired when powerful forces cease working; rather, it stays as a permanent avalanche, resulting in fractures that are challenging to heal. Furthermore, the second thread lengthens as a result of the cloth bending. Fabrics rinkle or break as a result of this.

Types of materials used in preparing cotton fibers against wrinkles:

Types of materials used in the processing of cellulose fibres The processing materials are divided into three groups:

A. Synthetic resins that bleach with themselves
B. Reactive resins
C. Non-retroactive substances

The resins are complex organic materials of high partial weight, consisting of the assembly of simpler products by lymph or condensation, and there are many groups, perhaps the most common of which are urea formaldehyde compounds.

Synthetic resins that self-polymerize

It's made with itself and interacts with itself under the conditions of processing from heat and more catalysts than with cellulose molecules, such as Yuria Formaldehyde and Melamine Formaldehyde.

They are represented by the Dimethylosioria and Trimethylol melamin CH2 OH Methodol and the

active group of these compounds is the methylol group It's the group that interacts with cellulose, and these compounds are environmentally unacceptable for containing formaldehyde.

It reacts to the surface of the ore and gives the unwanted surface of CH2 OH Methodol The active group of these compounds is the methylol Group, which interacts with cellulose, and these compounds are environmentally unacceptable for containing formaldehyde to a large extent, a carcinogen and reacts to the surface of the ore and gives an unwanted surface.

Reactive resins

Reactant Resins It is also a type of resin and its primary reaction to cellulose and interacts with itself as well, but to a lesser degree than the first type and the most famous type is dimethylol dihydroxy-ethylene Yuria. To date, the Dimethylol DiHydroxy Ethylene Urea DMDHEU DMDHEU is the main compound used at the commercial level and used in the formation of spin offs between cellulose chains and using MgCl2 chloride as a catalyst. DMDHEU on the formation of spinal links in the unsparked area of fibres During the reaction, formaldehyde is released, and the incorrect curing process at high temperatures leads to the release of formaldehyde, which makes it environmentally objectionable, as the levels of formaldehyde that result from it are large and unacceptable, and it also causes a significant loss in tensile strength.

DMDHEU has been developed to be environmentally compatible with the Echo specifications and is now an environmentally permitted Low Formaldehyde, and the formaldehyde ratio is reduced by washing fabrics after stabilization or roasting to eliminate excess formaldehyde ratios.

Reactors Non-resinous Reactors

They are organic compounds that do not contain formaldehyde and are fully environmentally safe, such as polycarboxylic acids and Citric Acid Tetracarboxylic acid butane quarter carboxyl code BTCA, which, in the presence of an appropriate auxiliary agent, earned cotton the permanent iron properties of Durable Press, which existed even after washing, but this acid is hampered by the problem of the price far above the price ofother processing materials with little formaldehyde content, such as formaldehyde materials Other processing not containing formaldehyde:

Acetals, glycosals, and glycosal interdepend-dencies with any of the glycolytes Or amides. However, the use of these materials is flawed by the deterioration of the strength of the grinding and yellow of treated fabrics, and whether the processing materials are few or no formaldehyde content, the processed cellulose fabrics lose much of their strength, with a loss of 30 to 60 per cent of the strand for untreated fabric.

Prepare the fabric against burning

Combustion resistance theories

Theories of combustion resistance are summarized into six theories:

(Covering theory - gas theory - thermal theory - hydrogen bond theory -The theory of factors that help in extracting a water molecule from cellulose – chemical theory).

Coverage theory

This theory dates back to the scientist "Guy Loslik" in 1861. This theory states that the materials used to resist combustion must break down at low temperatures, in order for a group of non-combustible gases to form, and also to form a glassy foam layer that works to Protecting fabrics from the air necessary for the combustion process, in addition to working to isolate direct flames away from the fabrics.

Gas theory

This theory states that the material used to make fabrics resistant to combustion must be transformed at combustion levels into combustible gases, which reduce the concentration of oxygen necessary to start the combustion process. These gases are such as (carbon dioxide, ammonia, hydrochloric acid gas, sulfur dioxide, and water vapor).

Thermal theory

This theory states that materials that have the ability to give cotton fabrics the property of combustion resistance can perform their function by dispersing the heat content of the flame or heat source, through a thermal change resulting from these materials, and thus the heat does not reach the point at which the fibers burn.

Hydrogen bonding theory

This theory states that a material that is resistant to combustion is a material that has the ability to make hydrogen bonds, and thus works to create hydrogen bonds between cellulose chains and not break them when burned.

However, there are many objections to this theory as a result of the fact that the strongest hydrogen bonds are between hydrogen and fluorine, and their strength is 9:10 kilocalories/part, and the weakest is 4-6 kilocalories/part, and thus They are weak bonds that cannot be stable at high temperatures.

The theory of converting cellulose into water and carbon

It's done through water removal using cofactors: This theory assumes that the material used to give fabrics the property of combustion resistance must help convert cellulose into carbon and water. The ideal resistance of cellulosic fibers is that which consists of coal and water, and this can be achieved by extracting the water parts from the cellulose molecule. It is known that water extracting materials are good materials for giving the cellulosic fibers resistance to flammability. In this case, the flammable gases as well as the vapors are reduced to a degree. Noticeable in fibers treated against combustion that are exposed to the source of flame, and it is the theory closest to a scientific and logical explanation Any of the treatment materials reduces or prevents the formation of a substance (levoglocozan) so that the cellulosic fabric becomes resistant to flames.

Combustion resistance mechanics

Determining the impact of the combustion resistance material on the environment is aided by an understanding of the mechanics of combustion Fibers are not easily burned. The degree of ignition, the quantity of energy consumed, the rate of humidity, and the thermal and chemical characteristics of the glucose portion of the cellulose fibers, as well as the amount of oxygen and non-sulose chemicals present, all influence the burning process.

The combustion process is impacted by each of these elements. When cellulose fibers burn, certain volatile vapors and coal are produced For combustion resistant qualities that differ considerably from those that escalate from untreated fibers, carbon ash, water vapor, and the thermal break-up products of untreated cellulose fibers are also regarded to be water vapor, dioxide, and cellulose fiber combustion products.

There are two main stages to the explanation of the combustion resistance mechanism:

A. Combustion of cellulose
B. The role of processing materials

Combustion of cellulose:

The process of combustion of cellulose occurs through two basic methods:

ignition and glow, both of which occur through exposure to a direct flame, or exposure to a hot surface for more than 300°C, as the products of thermal cracking of untreated cellulose fibers are gases, liquids, tar, and solid materials, some of which are burned, and remain It contains very little ash.

The temperature of 400°C: 450°C is the temperature at which cellulose begins to burn, while the degree of glow reaches 600°C. The process of combustion of cellulose at low temperatures is accompanied by the process of breaking the glucose bonds in the cellulose molecule, and what is called (Levoglocosan) is formed, which turns into tar. After removing part of the water from it, and continuing to expose it to high heat. The equation that follows provides an illustration of this:

(heat-breaking water, tar, flammable fumes, and carbon oven) When combustion occurs at a high temperature, coal glows long after the flames have gone out, which may lead to regeneration of combustion. The final two chemicals in the previous Mechanisms aid in the continuation of combustion Therefore, preventing or minimizing the presence of the components that aid in their combustion is the function of the processing materials against combustion.

Maintain the ignition or change the way the materials that arise from thermal break-up are distributed.

The role of processing materials:

There are two famous mechanisms by which fireproofing materials can be explained:

Obstructing the formation of flammable materials either in the solid or solid phase, or causing this obstruction in the gaseous phase

The first mechanism

includes increasing the formation of carbonized materials, carbon dioxide, and water, and this It means reducing the formation of substances that help sustain ignition, through a process known as dehydration or through another process known as crosslinking.

The second mechanism

which involves obstructing the oxidation process in the gas phase, through free radicals (Free radicals) which results in a reduction in the fire's supply of fuel, and thus the amount of thermal energy resulting from combustion decreases. Halogen compounds are considered among the materials that are released according to the second mechanism.

Summary

The given text selection provides information about the significance and characteristics of cotton as a textile material. It mentions the composition of cotton fibers, including cellulose and various elements present in cotton. It also discusses the histological structures of cotton fabric, such as simple fabric construction, chilled tissue structure, and Atlantic weaving structure. The text further

describes the structure of cotton fibers, including the presence of the core, outer shell, primary wall, and secondary wall.

The text also covers the manufacturing process of cotton, including bleaching, dyeing, and printing. It explains the purpose of these processes, such as improving the fabric's appearance, enhancing properties, and preparing it for further treatment. Additionally, the text discusses wet processes for cotton fabrics, such as desizing and bleaching. It provides information on the types of bleaching agents and the use of hydrogen peroxide in bleaching cotton.

Furthermore, the text delves into cotton fabric printing, including pigment printing, direct dye printing, and effective dye printing. It explains the stages involved in the printing process, such as initial preparation, preparing the printing paste, printing, drying, wetting, installation, and rinse baths.

Overall, the text provides a comprehensive overview of cotton, its properties, manufacturing processes, and printing methods.

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