NEW DEVELOPMENTS IN BLEACHED COTTON FOR NONWOVENS

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Abstract

During recent years considerable marketing and product development effort has been directed towards the growth of bleached cotton as a fiber for new nonwovens markets. This paper will describe technical advancements in this area, including improved openness and cleanliness of bleached cotton fiber, and new engineered finishes and fiber treatments, including antimicrobial bleached cotton.

Introduction

Founded in 1900, Barnhardt Manufacturing Company got its start by supplying cotton batting for horse collars and buggy seats. During World War I, the Company began supplying medical supplies to the American Red Cross. This was the beginning of our long history of supplying the medical textile market.

In 1929 the Company built a bleachery for raw stock cotton in order to produce purified cotton for surgical dressings. We became a leading supplier of medical supplies and surgical dressings during World War II and were awarded the Army-Navy E Flag award for dedication to the war effort.

In 1979 we built an entirely new, state-of-the-art cotton bleachery. By this time our cotton business had expanded into the dental, professional beauty, pharmaceutical, and filtration industries, as well as contract bleaching for outside customers. In 1989 a major expansion of the bleachery was done to accommodate the growing business.

Today our bleached cotton is marketed worldwide, and can be found in hospitals and doctors' offices, pill bottles, beauty salons, discount department stores, liquid filtration media, and even in apparel. Throughout our history, we have taken a custom engineered approach to our products based on customer specified requirements.

Discussion

A question that is often asked is, "Why use bleached cotton in nonwovens?" Since cotton is often used in personal care/hygiene and medical products, maximum purity is necessary. Most nonwoven manufacturers, especially those with equipment in place already processing synthetic fibers, do not have the opening and/or cleaning equipment for handling raw cotton with its natural impurities and plant trash. Most also lack the finishing equipment to properly scour and bleach cotton in fabric form. Therefore, the purchase of bleached cotton is desirable. It should be mentioned here that bleached cotton is exempt from the OSHA cotton dust regulations.

The end uses for bleached cotton are quite varied – almost any nonwovens application – industrial, consumer, or medical.

Table 1. Cotton in Nonwoven Products

Consumer	Medical
Baby Diapers	Surgical Packs, Gowns
Sanitary Napkins, Tampons	Adult Incontinence Pads
Beauty Care	Sponges, Bandages
Fabric Softener Sheets	Sterilization Wraps
Premoistened Wipes	Caps, Masks, Shoe Covers
Training Pants	Pharmaceutical Coil
Adult Pads	Dental Rolls, Pellets
Other (Utility & Other Wipes, Towels, Underpads, Cosmetic Pads, First Aid)	Sponges

Table 1. Cotton in Nonwoven Products – Continued

Industrial Nonwovens	
Wiping Cloths	Blankets
Apparel Insulation	Tablecloths
Napkins	Abrasives
Oil Sorbents	Pillowcases
Filter Media	Polishing Media
Interlinings	Felts
Apparel Interfacing	Display
Stiffeners	Noise Absorption
Stays	Coated/ Laminated Fabrics
Shoulder Pads	Wall coverings
Chest Pieces	Upholstery
Insulation	Luggage
	Tablecloths
Protective Apparel	Agricultural Fabrics
Headrests	Building Insulation
Laboratory Pads	

Cotton Fibers for Bleaching

In our operation we bleach a full range of cotton fibers: #1 grade or virgin cotton, and various types of cotton waste by-products, both from ginning and yarn manufacturing operations, such as comber noils, strips, cotton shoddy, gin motes, and even some first-cut linters. Micronaire and trash content are very critical fiber parameters for the bleaching operation. Staple length, while not critical to the bleaching operation, is, of course, important in all nonwoven processing.

Bleached Cotton Production

At Barnhardt we bleach by a batch process using large kiers. The following seven steps represent the different stages of the process:

1. Opening and Cleaning
   Multiple bale laydowns are used, and depending on the type of cotton, step cleaners can be used for cleaning prior to cake formation.

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2. Cake Formation
   The most critical step in a kier bleaching process is the formation of large cakes prior to chemical treatment. Cake density must be consistent to ensure uniform bleaching, and the micronaire be known as it affects how the cakes pack.

3. Scouring
   Scouring is the first chemical treatment in bleaching. The primary purpose of this step is to make the cotton absorbent.

4. Bleaching
   The next step in the chemical process is bleaching, which in our case, is done with hydrogen peroxide.

5. Finishing
   The last part of the chemical treatment is the finish step. It is necessary to add some type of fiber lubricant to replace the natural oils and waxes removed during the scouring process. The following is a list of some of the type finishes available:

   a. USP Grade
      This finish will allow the bleached cotton to pass U.S. Pharmacopeia test standards for purified cotton for use in medical and consumer products. Soap and butoxyethyl sterate (BES) are two examples of this type of finish.

   b. Needle-Ease
      This is a proprietary finish that we have developed in recent years, primarily targeted for nonwoven roll goods manufacturing involving needlepunch, air laid, hydroentangling lines, etc. The finish was developed as part of a companion project in which we successfully developed a "spin finish" for spun yarn production of bleached cotton.

   c. Non-Absorbent
      There are a few applications where the customer prefers the bleached cotton not be absorbent, and we can supply this type of finish.

   d. Anti-Stat
      An anti-static agent can be added to bleached cotton during the finishing step if desired by the customer.

   In addition to these finishes, we have recently developed the ability to add an antimicrobial treatment to our cotton. This will be discussed in a later section.

6. Drying
   After kier bleaching is complete, the cakes are removed and put through an extraction or centrifuging process to remove excess moisture. Then the cotton is dried in a hot air dryer and baled with a moisture level of 6% to 7% for good processing.

Premium Products for Nonwovens

High Q Cotton

High Q is a #1 grade bleached cotton product, selected on micronaire, length, and strength properties, and designed to give optimum processing and product performance in nonwovens. High Q cotton offers superior cleanliness and openness through new technology for opening and cleaning cotton fibers. This technology came about through a joint machinery development project between John D. Hollingsworth and Cotton Inc. The machine, known as the Lintmaster Opener/Cleaner, uses the "air doffing" process to aggressively open and clean the cotton fibers at a high rate of speed with little or no fiber damage.

The Lintmaster resembles a conventional 40" card, with the doffer removed and an air doffing system installed to remove fiber from the main cylinder. This system allows all the fiber to be removed from the main cylinder without recirculation, which is a key factor in attaining high production rates while avoiding fiber damage, such as neps and broken fibers. The lickerin and main cylinder speeds are approximately twice that of a conventional card. These speeds cause high centrifugal forces which result in excellent cleaning efficiency. There are three locations on the machine where trash is removed (see figure 1):

1. Under the lickerin (two mote knives).
2. Between the stationary flat plates (vacuum slots).
3. Between front card plate and air duct (knife blade and vacuum).

During our first year of commercial operation, we accumulated data on trash removal to show the effectiveness, or cleaning efficiency, of this process. The tests were done using the Uster AFIS-T tester and measuring the percent visible foreign matter (VFM). Cleaning efficiency is calculated by the following formula:

$$\% \text{ cleaning efficiency} = \frac{\% \text{ VFM in} - \% \text{ VFM out}}{\% \text{ VFM in}} \times 100$$

Using our conventional process through the bleachery, with a #1 grade high micronaire cotton, we had an average cleaning efficiency of 25.7% after opening and cleaning, and an average total cleaning efficiency of 68.5% after bleaching. The "air doffing" process gave an average cleaning efficiency of 76.2% after processing through the Lintmaster, and an average total cleaning efficiency of 90.2% after bleaching (see figure 2).

The availability of this technology is beginning to stimulate interest from nonwovens manufacturers, particularly with lightweight fabrics where even small amounts of plant trash would be a critical defect.

"**Ultra Block" Antimicrobial Bleached Cotton**

Since early 1996 Barnhardt Manufacturing has been in the process of evaluating various antimicrobial agents as a treatment for bleached cotton. This was done originally with small pilot kier trials, and then scaled up to full production runs. Our work has involved the successful application of both anti-bacterial and anti-fungal treatments of bleached cotton. These two antimicrobial products can be used together or individually as treatments for bleached cotton, depending on the end use desired by the customer.

Our goal in this work was to provide customers with a value-added bleached cotton product in bale stock form which would (1) eliminate the need of post-treating finished products for antimicrobial protection, and (2) eliminate the need of blending in synthetics with inherent antimicrobial properties to produce desired end use characteristics.

For this product, we have selected the Ultra-Fresh family of antimicrobials marketed internationally by Thomson Research Associates. Some of the features listed by Thomson for their products which we feel are essential are:

1. Completely safe when used as directed.

2. Provides effective antibacterial and/or antifungal properties to preserve hygienic freshness.

3. Inhibits growth of odor-causing bacteria, fungi, molds, and mildew.

4. Resists product deterioration and discoloration caused by bacteria and fungi.

5. Can be easily used in existing manufacturing processes without additional equipment or interruptions in production.

Test Results

Two test methods which we have used to judge the effectiveness of these treatments are AATCC Test Method 147-1993 and AATCC Test Method 30-1993 (Test III). These are described as follows:

Antibacterial Activity Assessment of Textile Materials: Parallel Streak Method

Number – AATCC Test Method 147-1993.

General Purpose – The method is useful for determining a rough estimate of bacteriostatic activity on textile materials.

Reporting – Report of results will include an observation of zones of inhibition and growth under the specimen if present.

Key Terminology –

Activity – of antibacterial agent, measure of effectiveness of the agent.

Antibacterial Agent – any chemical material which kills bacteria (Bactericide) or interferes with the multiplication, growth or activity of bacteria (Bacteriostat).

Zone of Inhibition – clear area of growth of a micro-organism, cultured onto the surface of agar growth medium, in proximity to the borders of a specimen placed in direct contact with this agar surface. Inhibition occurs as a result of the leaching action of an antimicrobial agent from the specimen.

Antifungal Activity, Assessment of Textile Materials: Mildew and Rot Resistance of Textile Materials

Number – AATCC Test Method 30-1993 (Test III).

General Purpose – The two purposes of this test method are (1) to determine the susceptibility of textile materials to mildew and rot and (2) to evaluate the efficacy of fungicides on textile materials.

Reporting – Values are reported indicating growth or no growth of fungi, Aspergillus niger, on an inoculated product, which is cotton in this case.

Key Terminology –

Mildew Resistance – in textiles, resistance to development of unsightly fungal growths and accompanying unpleasant, musty odors on textile materials exposed to conditions favoring such growths.

Rot Resistance – in textiles, resistance to deterioration of a textile material as a result of fungal growth in or on it. NOTE: such deterioration is normally assessed by measuring loss in tensile strength.

Test results for two production runs made recently are as follows:

Table 2. AATCC Test Method 147-1993 – Staphylococcus Aureus

Sample Description	Growth-Free Zone (mm)	Contact Inhibition (%)
1. Bleached comber noils, USP grade finish*	>15	100
2. Bleached #1 grade cotton, spin finish*	>15	100

Comments: Both samples demonstrated excellent activity against the S. aureus organism, as evidenced by the large growth-free zones.

*Antimicrobial treatment included combination of US-40 (anti-fungal) and NM (antibacterial).

Table 3. AATCC Test Method 30-1993 – Aspergillus niger

Sample Description	Growth-Free Zone (mm)	Contact Inhibition (%)
1. Bleached comber noils, USP grade finish*	2	100
2. Bleached #1 grade cotton, spin finish*	3	100

Comments: Both samples inhibited growth of the A. niger organism, as evidenced by the 2 mm and 3 mm wide growth-free zones produced.

*Antimicrobial treatment included combination of UF-40 (antifungal) and NM (antibacterial).

Throughout our project work, we have continually had similar test results, indicating that an effective means of applying antimicrobial treatments to bleached cotton has been developed. The product is now available, and we are looking to our customers as partners in evaluating this new product and determining its marketability.

Bleached Cotton Processing Suggestions

Conditioning

For best results, bleached cotton bales should be opened and conditioned in the manufacturing area for at least 4 hours prior to use. Room conditions should be 75-80 degrees Fahrenheit, and at least 60% relative humidity.

Blending

A multiple bale laydown is recommended, with a minimum of 6 to 8 bales and a staggered, or stair-step manner is preferred.

Opening

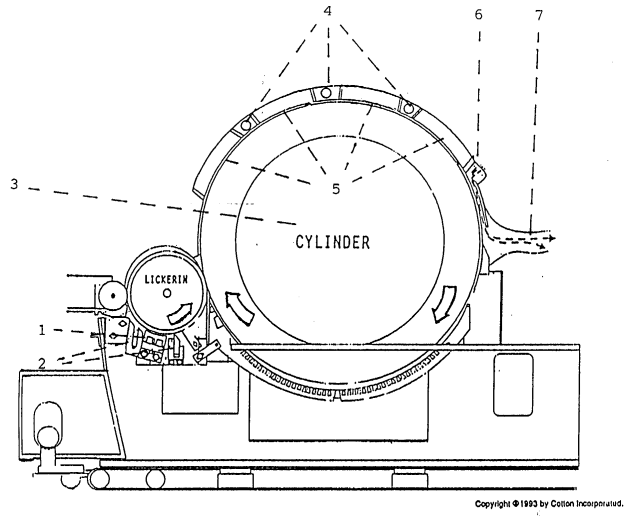
A standard opening line for cotton fibers is necessary, and should include at least a hopper feeder with inclined, spiked apron and beater, a reserve box, and a fine opener.

Carding

Carding of bleached cotton should be done on cards with metallic clothing, with either stationary plates or revolving flats. A chute-feed system for the cards is recommended for best sliver or web uniformity.

Summary

With the new developments and improvements in bleached cotton during recent years, including improved openness and cleanliness, engineered fiber finishes, and antimicrobial treatments, new opportunities are now available to the nonwoven manufacturer to use bleached cotton in a variety of new markets which had previously been dominated by synthetic fibers.



LINTMASTER™ OPENER/CLEANER

1. Carding segment (Additional)
2. Mote Knives
3. Main Cylinder (steel)
4. (3) Vacuum slots (Cleanmaster™)
5. (4) Stationary Card plates (Cardmaster™)
6. Knife blade and vacuum (trashmaster™)
7. Air doff duc

Figure 1.

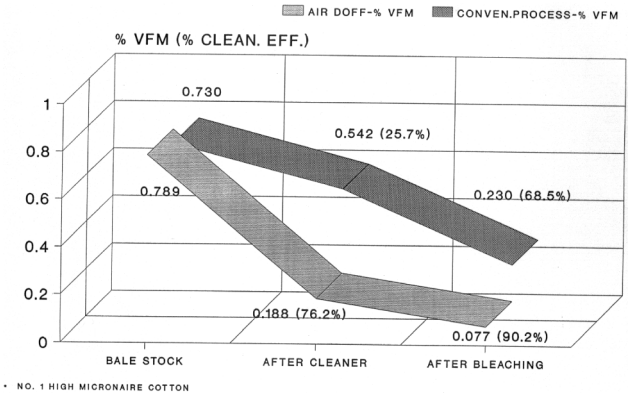


Figure 2. Cotton trash removal comparison. No. 1 high micronaire cotton. % Visible Foreign Matter and Cleaning Efficiency.