Potentiality of cotton nonwoven fabrics

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Cotton, the age old fibre in the field of textiles, still holds its potentiality. Various developments and modifications, both physical and chemical, have been made to the fibre with a parallel importance given to product development and identifying the diversified fields of application. The world statistics indicate that cotton fibre accounts for more than 46% of all textile fibres used today. The properties that make it particularly suitable for nonwovens are its absorbency, vapour permeability, handle, wicking, crimp retention, biodegradability, low electrostatic build up, good cover and opacity. Cotton can also be easily sterilized to find a place in the field of medical application and personal care products. Above all, it is comparatively cheap and readily available in India and several other countries. This paper relates the importance of cotton fibre for specific end use products made from nonwovens, highlighting the potentiality of this fibre in various fields of application.

Keywords: Acoustic insulation, Cotton fabric, Geotextiles, Medical textiles, Nonwovens, Personal care products

1 Introduction

With the advent of synthetic fibres during the last few decades, it was felt that the natural fibres would be in oblivion. But the physical and chemical modifications made to the natural fibres along with product development and identification of newer fields of application proved the above assumption to be unfounded.

Barring few industrial applications, natural fibres are getting considerable importance in the areas like medical and geotextiles and for ecofriendliness. Development of these structures involves all the techniques of fabric manufacturing, e.g. weaving, knitting, nonwovens and their combination.

It is well known that cotton possesses the unique combination of properties like comfort, handle, absorbency, wicking and so on. Therefore, though the synthetic fibres occupied the market, the cotton fibre itself accounts for more than 46% of all the textile fibres used today in the world1 (Fig.1).

The application of cotton fibre in the areas of weaving and knitting is well established as far as the conventional applications are concerned. The newer fields of application in non-conventional areas are centered around nonwoven technique of fabric manufacture. This paper relates the importance of cotton fibre for specific end use products made from nonwovens, highlighting the potentiality of this fibre in various fields of application.

Fig. 1—Worldwide consumption of fibres in 1990 [A-cotton, B-polyester, C-polyamide, D-other cellulosics, E-acrylics, F-wool, and G-others]
friendliness. The virgin cotton without finish possesses absorbency of 25.7 g/g, whereas the mercerized cotton, 31.1 g/g. Further, looking at its easy processibility to produce nonwoven structure, industrial applications can also be identified.

2.1 Personal Care Products

Since the ancient times, cotton has continuously been preferred by the customers where comfort, handle and reliability are important. Applications where skin contact is a criterion, such as underwear, bed linen, towels and baby wipes, have chosen cotton as an unsurpassable fibre. Newer areas of application such as wet wipes, make-up removal pad, swabs, tampoons and feminine hygiene products are equally sensitive to consumer demand in favour of cotton. Another thrust area of personal care product is disposable diaper. The choice is unparalleled for cotton since a mother prefers to use a pure natural soft material next to baby’s skin. A recent survey in US (Fig.2) indicates a dominant choice of cotton fibre for cosmetic puffs or balls and swabs. About 80% of the consumers expressed overwhelming response for selecting cottons in these products.

A market study on nonwoven consumer product sales in US during 1987 (Table 1) shows that there is a big potential in disposable baby diapers followed by sanitary napkins, tampoons, etc. A detailed study on the end use market of nonwoven in Western Europe (Table 2) also indicates that apart from other industrial applications, medical/surgical, wipes and coverstock hold a large chunk of the market. Thus, it reveals that these are the most promising areas where cotton can be promoted easily and exclusively.

2.2 Medical Applications

The use of nonwoven fabrics in medical field can be classified broadly in three groups, viz. wound pad and adhesive plaster, wound dressing, and operation theater clothing. Most of these products are spun-bonded nonwovens. However, mechanically-bonded nonwovens using cotton fibres sandwiched with other layers can also be used as wound pads and surgical covers owing to the good absorbency, permeability and sterile nature of cotton.

The area of wound dressing can be classified into two groups, viz. primary and secondary wound dressings. The primary wound dressings are those which are placed adjacent to the wound surface while the secondary wound dressings are placed next to the primary wound dressings. Traditionally, cotton has been used for these purposes. But its success was marred by the inherent impurities of the fibre, viz. lint, trash, dirt and dust, which had an adverse effect on the finished product for medical application. With the development of new machineries and processes, these problems are now mostly averted.

2.3 Industrial Applications

2.3.1 Filtration

Earlier, it was difficult to process cotton fibres in
needle-punching machine. But with the development of improved design of needles, fibre finishes, etc., the nonwoven cotton fabric can produce a good filtration media by virtue of its unique surface technology. Many companies\textsuperscript{5} are taking interest in needle punching cotton. Development of jute-cotton blended filtration media is also under way\textsuperscript{6} for both air and liquid filtration. The initial emphasis has been given for air filtration media but it is possible to develop both primary and secondary types of filter.

2.3.2 Acoustic Insulation

An important example of current concern in the environment is the control or reduction of noise in factories, offices and houses. The use of textile in noise absorption is based on its advantages of low specific gravity, low cost of raw material and low production cost, particularly when nonwoven process is considered. Shoshani\textsuperscript{7} proposed the feasibility of application of cotton-based nonwoven needle-punched fabric as a backing material in the tufted carpet for noise absorption purposes.

2.3.3 Geotextiles

The applications of natural fibres as geoproducts can be broadly classified in two areas: (i) applications such as separation, filtration and reinforcement where required life span is short; and (ii) applications in erosion control. The use of jute, coir and other natural cellulosic fibres has been proposed\textsuperscript{8} in the field of geotextiles. Over a century ago, sheets of cotton canvas were incorporated in the earth field to reduce the lateral thrust exerted behind retaining walls. Some fifty years ago, cotton duck fabric was used in USA to stabilize dirt roads\textsuperscript{9}.

An attempt\textsuperscript{10} was made in VJTI, Bombay, to evaluate the properties of chemically-bonded cotton geotextiles treated with sodium pentachlorophenate as an antimicrobial agent. The chemical was applied to both the sides of the fabric and the soil burial test was carried out for 45 days. Both the treated and untreated samples were kept under the soil so that both sides of the fabric were in contact with soil. It was found that the loss in tensile strength of untreated sample was significant as compared to that for treated samples. Similarly, there was reduction in the work of rupture and abrasion resistance of untreated fabric when compared with that of the treated fabric. Though these results are not much encouraging, the possibility of needle-punched cotton nonwovens treated with coal tar or resins can be tried.

In erosion control, where the short life span of the geofabric is an advantageous property, natural fibre can easily be used. Jute and coir have found widespread applications in control of erosion of hill slopes and embankment slopes\textsuperscript{11}. Cotton fibre perhaps can be tried in this area provided the property of the fabric is engineered to the specific end use.

3 Problem Encountered

Like in conventional spinning, cotton cannot be easily processed in nonwoven needle-punching method\textsuperscript{12}. The presence of natural waxes and fats which act as lubricants, are suitable for spinning grey fibre. However, to enable the nonwoven manufacturers to process cotton by the preferred short process route, it is necessary to remove first the waxes and fats by scouring the fibre and then the pectins to optimize whiteness by bleaching with hydrogen peroxide. The conventional kiering process, wherein cotton is boiled in sodium hydroxide under pressure to remove waxes and fats followed by the bleaching cycle in hydrogen peroxide, requires considerable mechanical agitation of the fibre which, in turn, results in fibre twisting and entanglement. It becomes difficult to process these fibres in needle-punching loom with existing needles which causes excessive needle breakage. Special needle design have been developed to encounter the problem and further to improve the speed of needling machine.

4 Ongoing Projects

The consumers' increasing awareness of the environmental issues generates the following enquiries in their mind:

- What harmful effluents (liquids or gases) result from the production of fibres?
- How can the product be disposed of? Is it biodegradable?

Naturally, the answer is Cotton. The biodegradability of cotton coupled with its pricing advantage and the lure of disposable diaper market are the main reasons for the ongoing push of the US cotton suppliers into the nonwoven business.

Bleached and scoured cotton was long considered to be inconsistent to run on high speed nonwoven equipment. With the help of improved needle design and lubricant finishes, processing problems are gradually being overcome.

The US Department of Agriculture (USDA) is spearheading in cotton nonwoven research\textsuperscript{12}. Identifying the major demand of cotton nonwovens in different areas, a large quantity of bleached and scoured cotton is required. Conventional kiering, a batch process, is unable to meet the demand. Hence, a number of organizations have designed and developed continuous bleaching and scouring process. Alpha Cellulose Inc. and Cotton Inc. in US...
and Edward Hall Ltd of UK are to name a few in this field. Besides, the research is looking into high cotton/synthetic blend, primarily of polypropylene (PP) but also utilizing bicomponent and other fibres later. Some initial work is also being done with PP or polyester laminates and cotton. According to Cotton Inc., a marketing and research arm of cotton growers of US, who has assumed the leadership role to promote cotton among the nonwoven manufacturers, infers that problem with the nonwoven industry is lack of experimental data to support the claim made by most of its suppliers which limit the propagation of cotton in this field. The US $500,000 research, promoted by the US government in early 1987, is still under way.

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