The applications of nonwovens in technical textiles

by Muhammad Kamran Iqbal.

The textile industry is one of the largest consumer supported industries which has played a vital role in worldwide economy. The use of fibers, yarns and fabrics for applications other than clothing and furnishing (conventional textile) is not a new phenomenon.

The technical textile defined by the Textile Institute[1] is 'textile materials and products manufactured primarily for their technical and performance properties rather than their aesthetic or decorative characteristics'.

The importance and economic scope of technical textiles stretches far beyond the textile industry and has an impact upon just about every sphere of human economic and social activity. Technical textiles are not a single coherent industry market segment. It is developing in many different directions with varying speeds and levels of success. Technical textiles are becoming one of the most important elements of modern technology and lifestyle. It is present everywhere, their end-uses ranges from simple products such as filters to acoustic and thermal insulation for domestic/industrial appliances.

In some of the most developed markets, technical products already account for as much as 50% of all textile manufacturing activity and output. The technical textiles supply chain is a long and complex one, stretching from the manufacturers of polymers for technical fibers, coating and specialty membranes through to the converters and fabricators, who incorporate technical textiles into finished products or use them as an essential part of their industrial operations[2].

Industrial textiles account for one third of the total textile production in highly industrialized countries such as U.S. and Japan. The global demand and market for technical textiles and products is projected to increase from US$75 billion in 2006 to around US$130 billion in 2010[3].

According to Technical Textile Intelligence report, the fastest growing segments will be medical and hygiene products and geotextiles. World market of technical textiles is projected towards the annual growth rate of 3.6% during the period of 2000-2010. Asia is expected to account for 45% of the market share in 2010 in terms of the weight and volume growth will average between 4% - 5% per annum to year 2010[3].

The leading international trade exhibition for technical textiles, Techtexil by Messe Frankfurt, defines 12 main application areas[2];

- Agrotech: Agriculture, aquaculture, horticulture and forestry.
- Buildtech: Building and construction.
- Clothtech: Technical components of footwear and clothing.
- Geotech: Geotextiles and civil engineering.
- Hometech: Technical components of furniture, household textiles and floor coverings.
- Indutech: filtration, conveying, cleaning and other industrial uses.
- Medtech: hygiene and medical.
- Mobiltech: automobiles, shipping, railways and aerospace.
- Oekotech: environmental protection.
- Packtech: packaging.
- Protech: personal and property protection
- Sporttech: sports and leisure.

To improve textile properties, the ongoing advancement in applications of nonwovens technology give both the economy and industry a boost. It has been established in last few years that the characteristics of technical textiles can be enhanced by using nonwoven technology. For example, durability, breathability, water repellency, fire retardancy, antimicrobial properties and barrier properties etc. can be improved. Nonwoven accounts for about 40% of technical textiles in terms of tonnage.

Nonwoven is a distinct class of fiber-based material with fabric characteristics and useful properties. ASTM defines Nonwoven as; 'A textile structure produced by bonding or interlocking of fibers, or both accomplished by mechanical, chemical, thermal or solvent means and combination of there of'. It can also be defined as 'A fabric made directly from fibers or from the chemicals from which the fibers themselves are made'. Nonwoven for technical textiles are predominantly synthetic polymer-based because of inherent advantages of strength and versatility of such fibers. Polyester and polyolefin account for almost 50% of the total raw material consumption.

Advantages of nonwovens for technical application: Nonwovens' resistance to tears, soil, chemical, puncture, UV light exposure, mildew, rot, freeze/thaw conditions, excellent strength, breathability and barrier properties, attractive fiber and structural appearance of various surface tension at relatively low cost makes them an ideal candidate for technical applications[4].

Fabrics made by nonwovens technology can be made up to five times more durable than conventional textile fabrics of the same weight. They can be designed to be extremely abrasion and heat resistant. Some fabrics can withstand extremely high temperatures for example; mechanical bonded glass fibers can be used at operating temperatures up to 1000ºF and silica materials can be used up to 2000ºF. For acoustic insulation, nonwoven webs are used which weigh 50% less than any comparable material and provide the same or higher absorption values. Nonwoven webs have high barrier properties; they can filter almost anything ranging from macro to nano scale particle sizes.

Application areas and end users of technical textiles in non-textile industries

Advertising	Agriculture	Automotive	Aviation	Building	Ceramic	Chemical
Environmental	Electrical	Computer	Protection	Fishing	Food	Furniture
Home Textile	Horticulture	Landscaping	Leather	Mech. Eng.	Medical	Mining
Oil Industry	Packaging	Pharmaceutical	Plastics	Printing	Recycling	Rubber
Space	Wire	Transportation	Wood proc.			

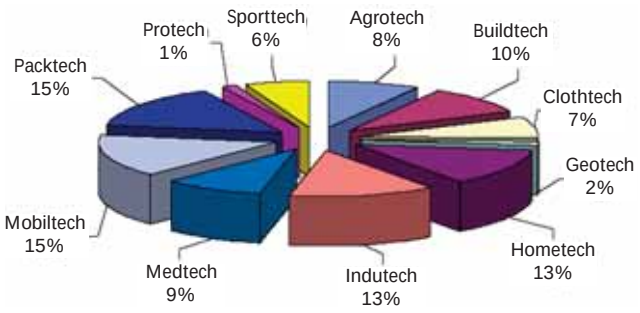
Source: Sabit Adanur, Wellington Sears Handbook of Industrial Textile, Technomic Lancaster PA (USA), 1995.

Nonwoven webs offer superior color and texture matches that is why they are used throughout the automotive industry. for example in case interior materials in vehicle manufacturing, the colorant is added during the fiber formation process, which makes it highly resistant to color fading and rub off. These webs are able to be molded and contoured to fit most interior and complex surfaces. Web thickness, rigidity and fiber compositions can be manipulated for more demanding requirements. The quality, flexibility and high production of nonwoven webs makes the materials more cost effective.

Applications of nonwovens in technical textiles

Typically, nonwovens in technical applications include:

1. **Agrotech:** Crop covers, seed blankets, weed control fabrics, greenhouse shading, root bags, biodegradable plant pots, capillary matting cover, protection and collection, fishing and tying[4].
2. **Buildtech:** Roofing and tile underlay, underslating, thermal and noise insulation, house wrap, facings for plaster board, pipe wrap, concrete moulding layers, foundations and ground stabilization, vertical drainage, protection and display, textile construction, building components, reinforcements and high quality wallpapers[4].
3. **Clothtech:** Shoe components, insulation and structure, sewing products, interlining, cleanroom garments, and shoe and leather goods applications[4].
4. **Geotech:** Asphalt overlay, soil stabilization, drainage, sedimentation and erosion control, pond liner, impregnation base, drainage channel liners, separation, reinforcement, filtration, offshore land reclamation, roadside, railside, river and canal banks, and reservoirs[4].
5. **Hometech:** Carpet components, furniture components, consumer wipes (baby, personal and household wipes), and industrial wipes (food service, industrial general, industrial specialty, and medical wipes), air and water filtration, interior design, drapes, covers, ticking, and composites[4].
6. **Indutech:** Electrical components (cable instructions, floppy disc liners, insulation tapes and micro filters), filtration and separation (air, liquid and gases), satellite dishes, clothing surfacing tissues/veils, conveyor belts, reinforced plastics, PVC substrates, flame barriers, noise absorbents, battery separators (alkaline, acid and fuel cells), anti slip matting, lifting and pulling[4].
7. **Medtech:** Drapes and gowns, sterile wrap, swabs (operating room and ward use) and dressing, cleaning, coverstock, wound-care, protective apparel, bedding and sheets and masks[4].
8. **Mobiltech:** Boot liners, parcel shelves, heat shields, shelf trim, molded bonnet liners, boot floor covering, fuel/oil filters, headliners, rear parcel shelves, airbags, cabin air filters, engine intake and exhaust air filters, silencer pads, insulation materials, car covers, under padding, car mats, tapes, backing for tufted carpets, seat covers, door trim and insulation, floor-coverings, protection and composites[4].
9. **Packtech:** Bulk packaging with predefined 3D structure, scrap and disposable, spacer and tying and absorbent food pads[4].
10. **Protech:** Chemical and biological protection, particulate protection, flame retardant, cut resistant, shields and gowns worn in emergency response, chemical handling, hazardous waste control, cleaning and filtration[4].
11. **Sporttech:** Luggage components, sports equipment, sportswear, wipes, covers, disposable and camping equipment[4].
12. **Oekotech:** Environmental protection, exhaust air and waste water filtration, dust collection, leak oil absorbent, gas and odor removals[4].



Source: David Rigby Associates, Technical textiles and nonwovens, World market forecasts to 2010.

In developing countries, out of various application areas the growth and development of infrastructure like roads, highways, airports, ports etc. makes Geotech the foremost sector for investment. Health, hygiene, medical end use, makes Medtech sector with some potential, but require awareness of the usage of such products among huge population. Also Agrotech, in an agricultural country, offers enough scope for lucrative investments. It has to reach out to country's agricultural education and research institute and then to villages.

Agrotech

The main applications areas of textiles in agriculture include farming, animal husbandry and horticulture. The most important requirements of textile for agriculture applications are weather resistance, and resistance to micro-organisms. Nonwoven covers and sheets protects the plants against temperature extremes by day and by night, thus creating the foundation for earlier harvest with excellent results. They are permeable to both air and water; UV stabilized, and resists mildew, rotting and destructive micro-organisms.

The market for agriculture nonwovens include crop protection, weed control, seed blanket, greenhouse shading, biodegradable plant pots, capillary matting, protection from frost and insects. In agriculture, the nonwoven material is used as a ground cover to inhibit weed growth, protection against the elements (frost, wind, hail and excessive rain), and protection against harmful insects. Moisture retention, erosion control, seed germination, row crop covers and shade cloth. The advantages of nonwoven fabric are they are porous while offering protection[4].

Nonwovens are used effectively for optimizing the productivity of crops, gardens and greenhouses. Their protective nature reduces the need for pesticides and keeps manual labor to a minimum. Geotextiles are tailor-made products, and the list of applications is never-ending[12].

The use of hydro seeding or seed-impregnated fabric can be an effective method to establish vegetation. hydro seeding, sometimes referred to as hydro mulching, is a fast, efficient and economical process of planting grass[12].

The rate of erosion depends on factors such as climate and temperature as well as the consistency of the soil. Experts estimate that some 40 percent of the world's agricultural land is seriously degraded due to erosion. The applied nonwovens must be tailor-made and configured according to the consistency and the fineness of the soil: the finer the particles, the finer the fabric required[12].

The use of nonwoven crop covers on the land increases yields and improves crop quality. Very light, flexible sheets are laid over seed beds, creating a microclimate in which the heat and humidity are controlled. Plant growth is accelerated, and the plants are protected from adverse weather conditions and vermin. In capillary mat applications, nonwovens promote the healthy growth of flowers and vegetables in greenhouses by offering soilless growing methods[12].

The spaces among the intersecting fibers of nonwoven sheets are big enough to allow air and water to penetrate the fabric and reach the crop, but small enough to keep out insects. The protection allows plants and crops to grow without the need to use pesticides and herbicide[12].

Nonwoven fabrics are used as an underlay to reduce mud on cattle paths and trails. Nonwoven mats, nonwoven sheets, light resistant nonwoven polyester fabrics are used in the inside of greenhouses to protect the plants from extreme hot or cold. They are also used on the outside of the greenhouses as screens to control sunlight. Fabric protective greenhouses provide virus-free cultivation of young plants. Nonwoven sheets are also used in the field to protect young plants[6].

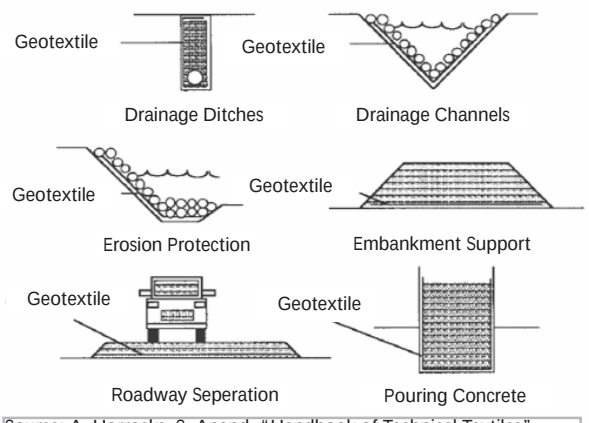
Synthetic fibers are the choice of material for agricultural products. Polyester and Polypropylene are two primary polymers used in Agrotech because of the enhanced strength and versatility. Polyester is a thermoplastic fiber with a high tenacity and modulus. It is one of the most widely used polymers. High tenacity and high modulus is attributed to high speed spinning that provides high orientation which results in high strength of the fiber. The high tenacity of polyester fiber is due to its highly crystalline polymer system. It has high abrasion resistance. It is a hydrophobic polymer and has a good acid resistance.

The use of spunbonded nonwovens is increasing in agricultural application at the expense of woven fabrics[6]. The bonding technique mostly used is needle-punching because needle punched nonwoven is flexible with relatively sufficient strength, and high elongation. They can be produced with a good control on the porosity and permeability of the structure.

Geotech

Geotech is a part of a wider group of civil engineering and are extremely diverse in their construction and appearance. The functions and applications of Geotextiles fabrics include separation, reinforcements, filtration, drainage and/or as a moisture barrier (when impregnated) for roads and railways, off shore land reclamation, road side, rail side, river and canal banks and reservoirs. Nonwoven resistant to tear, soil chemicals, puncture, UV light exposure, mildew, rot, freeze/thaw conditions etc. makes them an ideal choice for the applications. Major uses of nonwoven in the geotextiles market include asphalt overlays, separation of dissimilar materials, lining systems, reinforcement of weak soils and other materials and drainage/filtration systems[4].

The three main properties which are required and specified for a geotextiles are its mechanical responses, filtration ability and chemical resistance. The mechanical response of a geotextiles will depend upon the orientation and regularity of the fibers as well as the type of polymer from which it is made. Chemical resistance will depend upon the size of the individual component fibers as well as their chemical composition[2]. Finer the fiber, higher the surface area and it is more prone to chemical attack. Whereas filtration capabilities of the material is better, when fine fibers with high surface area is used.



Source: A. Horrocks, S. Anand, "Handbook of Technical Textiles", Textile Institute Manchester, 367, 2000.

The raw materials used for the manufacture of geotextiles are mainly polyethylene and polypropylene, polyester is used when high strength is required. The technology used for making geotextiles is needle punching. Needle punched nonwoven fabrics are made from blended webs of continuous or staple filament that are passed through banks of multiple reciprocating barbed needles. These needles interlock the web and make it stronger mechanically.

Medtech

When compared to textiles, nonwovens are lower in cost, easier to use, more versatile, safer and feature better disposability. The main attributes of medical nonwovens are barrier properties, Water repellency and oil repellency. Spunbond meltblown spunbond structure is generally said to be mechanical barrier because melt blown is a micro porous structure and breathable at the same time.

For example, the viral barrier gowns gives protection from viruses, viruses are in nanometer size, therefore protective films are used. In viral barrier gowns moisture vapor permeation is very important that is the rate at which it passes the moisture vapor through. So normally it is three layer structure, SMS, film and then again SMS. Films are non porous but highly hydrophilic so it can pass the moisture vapor through and make it breathable.

Disposability is the main reason, that hospitals and operating rooms prefer nonwoven over woven fabrics. Nonwoven used in gauze swab should absorb exudates, protect from external contamination, cushion from further trauma, gauze are normally highly absorbent, softer and have good air permeability. Generally, medical nonwovens offer unique antimicrobial solutions. It gives increased protection for the user and less potential for cross contamination.

Disposable mask is expected to protect 98% of the bacteria from reaching the user, it should not cause skin irritation, and has to be water proof, therefore SMS structures are used. Surgical gown should protect from hazardous substances, must offer water resistance and less weight that is 35 g/m^2. Some protective applications include gowns, laboratory coats, coveralls, and other type of protective clothing using composite nonwovens. They prevent blood or potentially infectious material from passing through under various usage conditions. It should have barrier properties, comfort, and water vapor transmission, tear resistance, burst strength, puncture propagation tear resistance, abrasion resistance, and flex cracking resistance. Some other attributes depending on the use are flame resistance, surface resistivity or electrostatic charge, linting resistance.

The materials used to make medical nonwovens include fiber, filament, films and antimicrobial finishes. Fibers used must be non-toxic, non-allergic, non-carcinogenic and must be sterilized without imparting any changes in the physical or chemical characteristics. Polyolefin's are not thermally stable at high temperature, therefore are not used when there are chances of them to be exposed to high temperature or in case of sterilization (through radiation) may affect PP therefore PET is used instead of PP.

In order to impart the desired properties onto the product, combination of natural and synthetic fibers is used. Natural fibers for absorbency for example wood pulp is used in large amounts because of its high absorbency and low cost.

Whereas, synthetic fibers like PP for good rheological properties, hydrophobic nature and lower cost. PET is used, when strength, mechanical properties and ease of sterilization are of prime importance. Synthetic fiber can impart strength, solvent resistance, static dissipation and antimicrobial properties. Micro fibers are used for barrier properties, soft handle, flexibility and smooth surface.

Cotton is widely used in medical nonwovens due to its highly absorbent nature. It is a naturally breathing fiber (prevents the passage of fluids), but let's gas and vapor pass, it has good aesthetic characteristics, keeps dimensional stability and strength even at high temperatures.

It may be noted that manufacturing methods are different with different products, for example for medical gowns, drapes Spunlacing is primarily used to give absorbency as woodpulp and spunlaced nonwovens show low linting behavior. Overall in medical nonwovens, PET and PP is highly used, Polyester for strength and thermal stability and PP for hydrophobicity and cost. These fibers are bonded with SMS technology because it gives barrier properties in protective mask and clothing.

In developing countries, demand for medical textiles especially for disposable absorbent products is also expected to rise significantly as a result of a fast growing, increasingly urbanized, young, brand-conscious population[5]. Surgical drapes made of nonwoven materials have captured about 95% of the total drape market. Surgical gowns have captured an estimated 90%of the gown market[4].

Other Asian countries

The world market for technical Textiles products to around 23.77 million tonnes by 2010, worth $127 billion and among them India and China will be global demand growth driver for Asia. Asia's consumption for technical textiles products is expected to grow at 10,645,000 tons by 2010. This market is growing at approximately 4%. Particularly nonwoven products are expected register higher growth rate in Asia than the world market with 9.6 per cent per annum[8].

'Emerging and developing economies' will on average grow by 6.3% in 2008 and by 6.4% in 2009. By contrast, 'advanced economies' are forecast to grow by only 1.3% in each of those years.

China is one of the important countries for technical textiles in Asia with the country accounting for approximately 50% of total spending in Asia. The demand is still growing at rate of 10% per year. Spending on nonwoven is growing at 30% a year. China is having more than 500-600 nonwovens manufacturing companies[8].

Other important Asian country is India. According to some industry experts estimations overall technical textiles market for India will grow at a rate of 10% which is $189 million by year 2007-08. Use of functional textiles in fields like Automotive, Medical uses, construction is already on the move[8].

India is expected to be one of the largest producer and consumer of technical textiles and nonwovens by 2012. India's share in the global technical textile market was around 6% in 2005 which is expected to be 12% by 2012: Growing at a CAGR of 10.4%. At present the total nonwoven production in India is 90,000 tonnes and is expected to grow to 200,000 tonnes by 2010. The market size for technical textile and nonwoven in India in 2005-06 was US$ 6.7 bn which has increased to US$9 bn by 2007-08. It is interesting to note that 93% of the present market is domestic and the remaining 7% is for exports[9].

There is much interest in both private and public sectors to look into opportunities beyond the conventional textile chain (i.e. fiber to fashion). This situation is quite a contrast to what is happening in the reports about U.S. and the rest of the developed economies. Recent reports about the U.S. textile funding for 2008 estimate that the funding will remain similar to the 2007 level with a major cut in the R&D spending for textiles[10].

Some cotton nonwoven products

Personal Care/Hygiene	Wipes	Medical
Baby diapers	Industrial wipes	Surgical: disposable caps, gowns, masks and shoe covers
Feminine hygiene products	Surgical wipes	Drapes, wraps and packs
Adult incontinence products		Sponges, dressings and wipes
Dry and wet wipes		Bed linens
Training pants		Contamination control gowns
Cosmetic removal pads		Examination gowns
Nursing pads		Transdermal drug delivery
Nasal strips		Shrouds
Adhesive for dental plates		Underpads
Disposable underwear		Procedure packs
		Heat packs
		Ostomy bag liners
		Fixation tapes
		Incubator mattresses

The government of India is coming under pressure to provide incentives to sustain and develop the textile industry, which contributes to nearly one third of foreign exchange income through exports. In addition, the textile industry provides the second highest employment next to agriculture. Therefore, both from economic and political point of view, the government has to support the growth of textile industry by tapping into untapped segments such as nonwovens and technical textiles[10].

The governments' program provides 10% capital subsidy upfront or new projects involving new machinery in technical textiles with the addition of 5% interest subsidy on the loans. The basic custom duty on imported technical textiles machinery has been reduced from 10% to 5%, so that the effective customs rate totals around 20%. The government has created special economic zones (SEZs) with the aim of enhancing foreign direct investments and exports from India. There are 14 SEZs in India that have been approved, which focus on textile related activity. These SEZs provides duty free imports and domestic procurement for 100% exports[10].

Gigantic projects such as the man-made Palm Jumeirah Islands in Dubai can only be built with the use of extremely durable nonwovens.

In China, geononwovens include staple fiber needlepunch nonwovens and spunbond needlepunch nonwovens, which are used in water conservancy, highway, railway, and construction, port of sea and air and military affairs. The growth rate of geononwovens is about 15%, exceeding the growth of China's GDP.

In the past 20 years, the Chinese government has invested in its infrastructure on a large scale. Large highways, railways and water throughways have been built throughout the country in response to increased economic activity. Investments, both private and public, have stimulated the need for geononwovens in the market. Additionally, a series of design and application standards involve geononwovens[11].

Use of cotton in nonwovens

Pakistan is the fourth largest producer of cotton in the world, the third largest exporter of raw cotton, the fourth largest consumer of cotton, and the largest exporter of cotton yarn. Cotton and cotton products contribute about 10% to GDP and 55% to the foreign exchange earnings of the country.

It's common sense that cotton is playing a very important role in the traditional textile industry, but also more and more for sectors of the nonwovens industry, such as medical, personal hygiene and many others like protective clothing, medical applications, hygiene applications, environmental protection and home textiles[13].

Bleached cotton has become a very attractive material in the last few years, says Jean-Philippe Dumon, sales and marketing director of France-based NSC nonwoven, thanks to its competitiveness against viscose and its "green" approach. It helps nonwovens producers' marketing efforts to renew their customers' interest in their products. Two main end-uses, using spunlacing bonding technologies, are pads and wipes[13].

Conclusion

Technical textile industry is truly a dynamic and constantly evolving industry in which nonwoven is the key to success. Innovation has become essential to survival for companies in the increasingly competitive textile industry.

The future development of the technical textile markets and products in Pakistan will largely be centered upon new materials, processes and applications. Improvement in textiles that is nonwoven technology is leading to significant cost savings in some cases and enhanced performance and durability in a vast array of applications.

Despite the current difficult economic climate, the nonwoven industry remains a strong and growing market with nearly every producer reporting sales growth and several announcing expansion plans in a number of technologies. On the spunmelt side, Brazilian producer Fitesa and Companhia Providencia have announced plans to enter North America and additional investment is planned by Pegas in the Czech Republic and PGI in Mexico[7].

As reported earlier, world market of technical textiles is projected towards the annual growth rate of 3.6% for the period of 2000-2010. For Asian region, it is more at 4.33%.

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