Development of nonwovens industry

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Abstract: This paper highlights the advantages of nonwovens for technical application in the textile industry and the various modern technologies and methods used in the world. Fabrics made by nonwovens technology can be made up to five times more durable than conventional textile fabrics of the same weight. Nonwovens 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. 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. A special focus is placed on the various technology used in the manufacturing of nonwovens.

Introduction

The term 'nonwoven' arises from more than half a century ago when nonwovens were often regarded as low-price substitutes for traditional textiles and were generally made from dry laid carded webs using converted textile processing machinery. The yarn spinning stage is omitted in the nonwoven processing of staple fibres, while bonding (consolidation) of the web by various methods, chemical, mechanical or thermal, replaces the weaving (or knitting) of yarns in traditional textiles. However, even in the early days of the industry, the process of stitch bonding, which originated in Eastern Europe in the 1950s, employed both layered and consolidating yarns, and the parallel developments in the paper and synthetic polymer fields, which have been crucial in shaping today's multi-billion dollar nonwovens industry, had only tenuous links with textiles in the first place.

Therefore, the nonwoven industry as we know it today has grown from developments in the textile, paper and polymer processing industries. Today, there are also inputs from other industries including most branches of engineering as well as the natural sciences.

EDANA, (The European Disposables and Nonwovens Association) defines a nonwoven as 'a manufactured sheet, web or batt of directionally or randomly orientated fibres, bonded by friction, and/or cohesion and/or adhesion', but goes on to exclude a number of materials from the definition, including paper, products which are woven, knitted, tufted or stitch bonded (incorporating binding yarns or filaments), or felted by wet-milling, whether or not additionally needled.

The INDA, North America's Association of the Nonwoven Fabrics Industry further describes nonwoven fabrics as 'sheet or web structures bonded together by entangling fibres or filaments, by various mechanical, thermal and/or chemical processes. These are made directly from separate fibres or from molten plastic or plastic film.' Nonwovens are engineered fabrics that can form products that are disposable, for single or short-term use or durable, with a long life, depending on the application. In practice, the life of a nonwoven product can be measured in seconds, minutes, hours or years, but the design and engineering requirements of these fabrics are often complex and challenging regardless of the intended product life.

Nonwovens are engineered to provide specific functions to ensure fitness for purpose. These properties are combined to create the required functionality, while achieving a profitable balance between the expected product life and cost. Nonwoven technology also exists to approximate the appearance, texture and strength of conventional woven and textile fabrics and in addition to flat monolithic fabrics, multi-layer nonwoven composites; laminates and three-dimensional nonwoven fabrics are commercially produced. In combination with other materials nonwovens provide a spectrum of products with diverse chemical and physical properties.

This is reflected in the large variety of industrial, engineering, consumer and healthcare goods into which nonwoven fabrics are incorporated. The conversion of nonwoven role products into finished products is a further important component step in the process and can also affect final product properties.

Today's nonwovens overwhelmingly (98%) utilize manufactured fibres, such as polypropylene, polyethylene, polyester, nylon, rayon, pulp, etc. That can be efficiently used for producing (generally non-reusable) products for many end use application and markets, such as disposable sanitary products, hygienic and cosmetic products industrial and household wipes, surgical and gowns and masks, medical end use products, bedsheets, air and filters, roofing materials, automotive interior components, military camouflage, tents, combat gear and other work outfits, geo and landscaping, reinforced composites and laminates, and even semi-durable durable (reusable) apparel/garments.

Market structure and development

Until about the 1990s, much of the world's nonwovens industry was based in those areas where the process technologies were conceived and developed, the USA, Europe and Japan.

Table 1: Production of nonwovens in European countries

Classification	Percentage of total
Hygiene	33.1
Medical / Surgical	2.6
Wipes, personal care	8.1
Wipes, other	6.7
Garments	0.8
Interlinings	2.1
Shoe leathergoods	1.9
Coating substrates	2.4
Upholstery and household	6.8
Floorcovering	2.3
Liquid filtration	3.7
Air/ gas filtration	2.4
Building/ roofing	12.5
Civil engineering/underground	5.4
Automotive	3.9
Other/ unidentified	5.3

Source: The European Disposables and Nonwovens Association (EDANA).

Technical Textiles & Nonwovens

Many of these companies were and still remain small-scale enterprises, sometime as a part of textile companies operating with a limited range of technologies often centered around carding and dry laid web formation and needle punching, chemical or thermal bonding.

The large-scale production facilities set up by the big companies were highly capital intensive, making it too risky for smaller companies to set up production, certainly of spun laid, wet laid, air laid pulp and hydro entangling businesses.

The industry can still be regarded as capital intensive today, when considering that, according to the latest estimates; some 40 companies are responsible for 90% of total global nonwovens sales. The nonwoven products produced by European countries is given in table below:

Most world regions now have nonwovens production and growth remains high, with many countries still in the early stage of industrialization.

Nonwovens manufacturing technologies

There have been many technologies and their derivatives in the past few decades to manufacture nonwoven fabrics, the various modern technologies and methods that are most commonly deployed today to produce functional woven-like, nonwoven fabrics for numerous applications, such as care, medical, hygiene, household, industrial, automotive, filtration, and the like, predominantly using manufactured fibres, such as polypropylene, polyethylene, polyester and rayon and sparsely using natural fibers, such as cotton, jute, pulp, wool, etc.

Web formation methods

Spun-bonding

This is the most commonly used method for producing a web from thermoplastic polymer chips that are melted and extruded on line into synthetic fibers, such as polyethylene, polypropylene and polyester.

The extruded fibres are placed together to form a wide web-like sheet that is allowed to cool, thereby allowing inter-strand binding. The web or sheet may be rolled and shipped to converters or may be further processed on line to modify its aesthetics and/or functional performance for the intended end product for a specific application. Spun bonding offers greater productivity by an order of magnitude compared with traditional weaving and knitting. For example, a typical spun bonding process may efficiently produce a continuous fabric-like structures up to 200 yards per minute, compared with only a yard or so in a weaving process.

Meltblown

In this method, an extruded fibrous sheet of a molten polymer is subjected to a continuous jet of hot air, before the sheet is allowed to cool and bond, which splits the extruded filaments into very fine fibers. This method of producing roll goods (webs) for subsequent nonwoven products is also highly productive.

Carded webs

This method is utilised for staples fibers, whether natural, synthetic or blends. Fibres are carded using conventional machines to form a web, which then can be cross lapped to attain the desired thickness and mass. It is a relatively slow and more expensive method to convert fibres into a continuous web of specified integrity.

Dry and wetlaid

In the dry-laid technique, staple fibres, along with certain resins or thermally fusible fibres, are pneumatically "gathered" and laid to form a web of required density. This method does not involve carding. In the wet-laid technique, fibres of relatively short length, such as pulp, are passed through water or some other medium, which provides the required inter-and-intra fibre adhesion and cohesiveness to form a continuous web of desired integrity for further downstream processes.

Bonding technologies

Needle-punching

A needle-punch is a machine that provides a mechanical bonding of a web's constituent fibres. Many barbed needles of proper specifications perform the mechanical bonding action.

Although this nonwovens technology is not as efficient as other mechanical or chemical bonding technologies, it still is at least 20 times faster than traditional weaving and needle–punching is at least 5 times faster than knitting.

Hydroentangling

This probably is the most common technology for mechanical bonding of cohesive fibers and webs.

This method further reinforces and strengthens structural integrity and improves functional performance of a nonwoven substrate.

High pressure water jets are used to provide the necessary energy to impart the required mechanical bonding of constituent fibres of underlying substrate. Sometimes, spun lacings, which was first developed and named by **DuPont** several decades ago, is also the terminology used for hydro entangling technology. It is very fast and productive and offers many online operations to attain different designs, finishes, and other attributes.

Chemical/Resin/Thermal Bonding

These bonding techniques are generally applied for producing certain nonwoven composites for numerous end-use applications, including industrial, awnings, building materials, furnishings, automotive components, and the like.

Stitch-through technology

Although an old technology, it is still used for mass production of nonwovens for bedding, military, blankets, mattress components, etc. Warp knitting and sewing techniques are employed to reinforce a needle-punched or some other nonwoven substrate that by itself may not be strong enough for the intended application.

Finishing

The technologies for finishing nonwovens vary depending on their end-use applications. However, unlike traditional woven and knitted fabrics, the nonwovens generally are not piece goods bleached, dyed, and processed on a stinger. Dyes are added generally during the fibre extrusion process.

For bleached cotton nonwovens, cotton in fibre state is generally bleached, which is costly. However, nonwovens are chemically and mechanically modified in many ways to obtain product specific attributes.

References

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