An assortment of nonwoven baghouse filters used on GE air filter systems

Primer On Nonwoven Fabric Filtration

Nonwoven fabrics have been an ongoing success story in the steadily growing filtration industry.

By Edward C. Gregor

Nonwoven fabrics have seen impressive growth with penetration into a number of filtration industry end-use market segments. Until nonwovens began to seriously access the market in the 1970s, woven textiles were the material of choice in many industry sectors. Nonwovens offered a less expensive alternative and often a distinct technical advantage by the basic attributes of the nonwoven construction. Today, the filtration industry worldwide is growing at 2 to 6 percent per year above gross domestic product. Even so, the industry's best years are ahead, with steady and accelerated growth expected for the foreseeable future.

Filtration Market Size

In terms of synthetic nonwoven fabric sales, filtration totaled $735 million in 2007, according to the Association of the Nonwoven Fabrics Industry (INDA), which reported filtration as the largest dollar end-use nonwovens market in North America. It is arguably the most profitable segment. If one were to add in wetlaid cellulose filtration media, total nonwoven fabric filtration media sales approach $1 billion for North America and $2.1 billion to $2.3 billion worldwide. The only other filtration media of comparable volume are membranes, with $2 billion to $2.2 billion worldwide roll good sales in 2007. Together, nonwoven fabric and membrane filtration media dominate the filtration media market, with more than 90-percent combined market share in terms of roll goods filtration media volume in comparison to all other material forms. Nonwovens and membranes never compete with each other in a specific application, as each has its specific advantages, and they often are combined to complement each other. Typically, nonwoven fabrics add backup support and/or mechanical strength to comparatively weak membrane media, allowing membranes to function at peak performance.

Nonwoven fabric filtration media have dominated in applications such as coolant filtration, baghouse filtration media, vacuum cleaner bags and many heating, ventilating and air conditioning (HVAC) applications. In these and other applications, nonwovens are highly price-competitive. Yet, a number of other end-use segments generate impressive profits, especially in liquid applications when combined with membranes.

Air applications consume approximately 65 to 70 percent of the nonwoven filtration media, with liquid uses consuming the remaining 30 to 35 percent. Liquid application end-uses tend to generate higher margins for the nonwovens producer because of the specialized constructions and performance requirements, particularly in the medical, pharmaceutical and microelectronics industries. In addition, there are rapidly expanding global needs for pure and potable water.

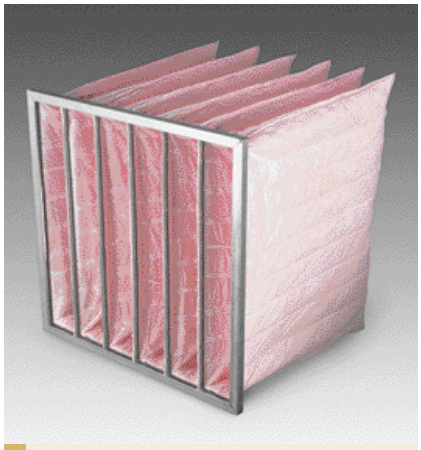
Trends And Drivers

Several factors are driving nonwoven fabric filtration media growth, but two megatrends dominate. First, manufacturers worldwide are filtering with greater frequency at finer micron levels to achieve higher product quality. Examples include chemical processing, "produced water," mining, food and beverage, including high-purity processes such as pharmaceutical and semiconductor. Second, environmental thinking worldwide is expanding at an increasing rate in virtually every segment of our economy. Federal, state and local regulators are enacting laws and regulations specifically targeted at discharges and waste streams at an accelerating rate. Most industry followers believe the new administration in Washington will support further initiatives and regulations, with the filtration industry being a major beneficiary.

Where Nonwoven Fabrics Dominate

To understand nonwovens growth in filtration, one must understand the close relationship with membrane filtration media. In many liquid applications, microporous and reverse osmosis membranes are experiencing rapid growth. Most membrane applications are growing by 8 to 10 percent annually. Those dealing with water and wastewater are growing up to 15 percent per year and more. In light of requirements for finer levels of filtration in many market segments, a number of industry experts believe this or even higher levels of growth will be sustainable for many years. The major beneficiary of membrane growth and market penetration continues to be nonwovens used in combination with membranes in various configurations. For example, nonwoven wetlaid polyester substrates support reverse osmosis membranes in spiral wrap modules in a $30 million worldwide nonwovens market. The modules are found in systems predominantly located in arid regions where seawater is converted to potable water. Spunbond fabrics are used as pleat supports and separators in virtually every microporous membrane cartridge sold, accounting for nonwoven sales of approximately $35 million per year.

Nonwoven meltblown and spunbond fabric along with nonwoven glass filtration media are the principal air filtration media for HVAC — an 825 million- to 850 million-square-meter nonwoven market in North America. High-efficiency particulate air (HEPA) wetlaid glass nonwoven filtration media represent an additional 90 million to 100 million square meters. Air filters are found in end-use markets from general dust filtration to high-efficiency filtration in many different configurations. These filters are rated by a Minimum Efficiency Reporting Value (MERV) standard, which rates filters from 1 to 20 in terms of their degree of efficiency. At the high end, MERV 17- to 20-rated HEPA filters are typically used in situations that require absolute cleanliness for the manufacture of microchips, liquid crystal display screens, pharmaceutical production and microsurgery in hospital operating rooms. HEPA filters are primarily constructed from wetlaid glass nonwoven filtration media, with a smaller portion of the market serviced by polytetrafluoroethylene (PTFE) membranes laminated to a polyester base substrate for support. MERV 1-16, considered HVAC-grade filters, are principally constructed of synthetic meltblown, spunbond or glass fabrics. Overall, 75 percent of synthetic nonwoven media go into commercial markets, such as manufacturing facilities, offices, theaters, hospitals, cruise ships, casinos and other such markets; with about 25 percent found in residential and general consumer air filters.



This pocket air filter from Filtration Group is made of meltblown fabric.

Nonwoven fabrics are also used as stand-alone filtration media in pleated cartridges. One noteworthy example is cartridges, principally spunbond media, in the $30 million pool and spa market. Other recognized cartridge applications include pleated cellulosic automotive engine air-intake filters and oil filters on the family car, large semi-rigs and off-road vehicles; as well as the smallest fuel filters on home lawnmowers, chain saws, power washers and other small engines. Cellulosic media are relatively inexpensive, and are self-supporting when pleated, a key factor along with the compatibility of construction materials with fluids and temperatures found under the hood.

Wetlaid cellulosic and spunbond polyester media that range from 200 to 300 grams per square meter (gm^2) are used in pleated dust collection cartridges. In North America, dust collection media represents a 15 million-square-meter market that is growing at 5 percent per year, according to INDA. Pleated cellulose- or polyester-based filters offer significantly greater surface area than needlefelt filter bags for a given space as an alternative filter configuration in baghouse applications. Typically, dust collection cartridges and baghouse filters are found in manufacturing environments and facilities that process materials that generate large quantities of fine, airborne particles or dust. The filters are used to reduce particulate exhaust and prevent spontaneous explosion when large quantities of fine particles accumulate in factory air.

Although pleated dust collection cartridges are an alternative to

North American Nonwoven Man-Made Fiber Markets — 2007

Filtration	$735 million
Air	$478 million
Liquid	$257 million
Hygiene	$724 million
Medical	$582 million
Wipes	$530 million
Carpet	$227 million
Geotextiles	$170 million

Source: INDA 2008

needlefelt baghouse filters, needlefelt filter bags remain the clear industry leader in terms of dollars. Needlefelt sales approach $120 million in North America and $530 million worldwide, with China being by far the major driver of growth in recent years. Approximately 10 percent of the baghouse needlefelt fabrics are laminated with a PTFE membrane providing for finer filtration and/or longer bag life. Separately, the value of micron rated needlefelt fabrics constructed into liquid filter bags is approximately $25 million to $30 million in North America and $65 million worldwide. For liquid applications, nonwoven filter bags are used as final filters and in some cases as prefilters, prolonging the life of final filters in heavily contaminated streams.

Nanofibers In Filtration

Pleated dust collection and engine air-intake filters have a lightweight cover of synthetic nanofibers over a base substrate of a wetlaid cellulosic or polyester nonwoven in a growing number of applications. The nanofibers are as fine as 200 to 300 nanometers in diameter, with the amount of nanofiber add-on being quite thin in cross-section and typically weighing less than 1 gm^2 to 2 gm^2. The nanofibers are laid down over what will become the upstream side of the substrate using an electrospinning process, and in one case, an ultrafine meltblown process. These nanofibers create a labyrinth of fibers with pores finer than particles in the incoming air stream. Particulate deposits and resides on the surface of the fine nanofiber web, allowing the user to clean the filter by shaking off loose particles from the surface or by using an automated clean-air backpulse system. The market is growing rapidly and is becoming an important market sector. All major suppliers of air filters to the automotive and dust collection market have either internal manufacturing processes in place or access to nanofiber media from outside suppliers.

By last count, more than 30 companies worldwide have electrospinning manufacturing processes, but only a few have decent commercial volume. Many have the objective of producing a heavier-weight, 15- to 90-gm^2 stand-alone nanofiber web, without the cellulose or polyester base substrate. The primary goal is to create filtration media to fill the micron rating gap between the finest meltblown media and microporous membranes. Some manufacturers seek to mimic microporous membrane micron ratings with higher flow rates. With regard to manufacturing costs, the relatively low production speed of electrospinning is ideally suited for lightweight covers over substrates in the dust collection and engine air-intake filters, as these applications require only a few grams of fiber to cover the base substrate. Thus, heavier-weight electrospun webs have remained a challenge because of low process throughput and high production cost compared to alternative filtration media choices. However, there has been some headway by air filtration media producers who seek to replace glass media in MERV 17-20 HEPA applications. Nanofiber nonwoven filtration media for applications in the MERV 10-16 range and potentially for liquid applications clearly remains the largest untapped potential. Should a lower-cost and/or alternative manufacturing process to electrospinning be developed that can produce 15- to 60-gm^2 nanofiber filtration media in the $3- to $5-per pound range, enormous opportunities exist for the first successful producer.

Pictured above is a cutaway of an Entegris Intercept® HSM 20nm pleated cartridge filter.

Conclusion

Nonwoven fabric contributions have been an important mainstay for the success of the filtration industry for many years, and the future is very bright. As the industry grows, new constructions will be the order of the day, as there are many unmet media end-use needs and growth opportunities for an innovative nonwovens producer. The filtration market has a large number of application niches in which customers are willing to pay for performance. Thus, the most profitable nonwoven fabric producers offer proprietary materials in less than commodity run size for niche or near-niche applications. Some of today's mainstays are gradually fading as new nonwoven fabrics come to market as differentiated constructions for customers seeking solutions to unmet industry needs. TW

Editor's Note: Edward C. Gregor is managing director of Edward C. Gregor & Associates LLC, a Charlotte-based consultancy that brings new technologies to market and provides merger and acquisition services in the fiber, technical textile, nonwoven fabric and filtration industries.