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met

THE NEXT MOVE

ADVANCING SUSTAINABILITY IN NONWOVENS

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SAUDI ARABIA

Juthor Paper to install one of the world's fastest high-capacity tissue machines

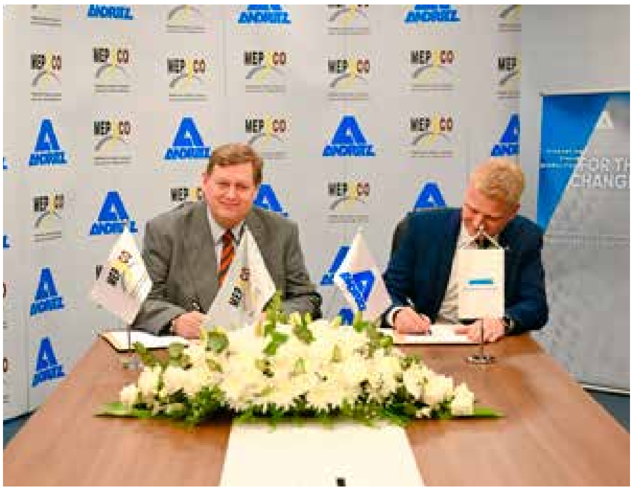
ANDRITZ has received a major order for a tissue production line from Juthor Paper Manufacturing Co., part of Middle East Paper Co. (MEPCO) Group, Kingdom of Saudi Arabia. Start-up is scheduled for 2026.

Middle East Paper Co. is one of the largest paper manufacturers in the Middle East and North Africa (MENA) region. With the foundation of Juthor Paper, MEPCO entered the tissue market a couple of years ago.

The line will be equipped with the latest ANDRITZ technologies from stock preparation to the reel to ensure low energy consumption and high product quality. The PrimeLineTM W 2200 tissue machine will be one of the world's fastest high-capacity machines, with a design speed of 2200 m/min and up to 5.47 m width at the reel. A comprehensive automation and digitalization package will contribute to high performance and operational efficiency.

Adel Alfar, Director Operations, Juthor Paper says: "We partnered with ANDRITZ because they are a high-end technology provider with a focus on optimized energy consumption for high-capacity and high-quality tissue production. Their commitment to support us in achieving our targets has convinced us."

Gerald Steiner, Senior Vice President Paper & Tissue, ANDRITZ, says: "High speed, high capacity, and high quality – Juthor Paper is pursuing an impressive growth strategy, and we are proud to be the chosen partner on this journey! With all the expertise in both companies, we look forward to setting new standards in tissue production together – not only in terms of volume and efficiency, but also for sustainability and digitalization."



Signing of the contract: (left) Rob Jan Renders, CEO MEPCO Group, and Gerald Steiner, Senior Vice President Paper & Tissue, ANDRITZ. Photo: ANDRITZ

ALGERIA

WAFA Group boosts tissue capacity

Algerian tissue producer WAFA Group has partnered with Toscotec for the turnkey supply of a new AHEAD tissue line (PM1) at their Ain Oussara facility, south of Algiers. The project is planned for 2026.

The AHEAD machine has a sheet trim width of 2,850 mm and an annual production capacity of over 40,000 tons. Designed to deliver superior drying efficiency with the lowest possible energy consumption, it is equipped with the latest press generation, a third-generation design TT SYD Steel Yankee Dryer with a patented heads insulation system, and high-efficiency TT Hood. The tissue line will process 100% pre-dried virgin pulp and converting broke.

Lamine Zebda, General Manager at WAFA Group, says, "This project represents a milestone in WAFA Group's growth strategy. As for our selection of a turnkey supplier, we welcome the beginning of this cooperation with Toscotec. They offered the highest guarantees of product quality and efficiency, which are essential to position our products in the market. That is why we strongly believe in the importance of investing in the best available technology."

Established in 1998 in Algeria, WAFA Group is a family-owned enterprise and a leading producer of tissue products in the region. Renowned for its high-quality products, the company has built a strong reputation in the local market and exports its products to numerous countries. It operates three facilities in Algeria, specializing in the production of a diverse range of converted tissue paper, wet wipes, aluminium foils, buckets, stretch film, and various cosmetic products.

WAFA Group and Toscotec at contract signature in Algiers, Algeria.

PALESTINE

APIC acquires 51% of Reema Hygienic Paper Co.

Arab Palestinian Investment Company (APIC) entered into a strategic partnership with Reema Hygienic Paper Company (Reema) through the acquisition of a 51% stake in the company.

Tarek Aggad, Chairman and CEO of APIC, stated that this acquisition aligns with APIC's strategy to bolster its investment footprint in Palestine, with a particular focus on the manufacturing and consumer goods sectors.

Aggad emphasized that, despite the harsh and challenging conditions in Palestine due to the ongoing war on Gaza, APIC's investment underscores its unwavering commitment to supporting local industries and employment in Palestine. Furthermore, this move is set to deliver significant value to APIC, its subsidiaries, shareholders, and the communities in which it operates.

Through this investment, APIC will partner with the existing shareholders to further institutionalize and expand the business particularly by uplifting its sales through APIC's subsidiary, Unipal, which is the leading and largest distributor of fast-moving consumer goods in Palestine with a vast network of over 6,000 retail outlets.

Jadallah Jadallah, Reema shareholder, said that Reema, which was founded in 1982, stands as the premier player in Palestine's sanitary paper industry, employing over 90 skilled professionals across manufacturing, marketing, sales, and logistics, with a market share of around 40%.

APIC is a public shareholding investment holding company. It holds diversified investments across the manufacturing, trade, distribution and service sectors in Palestine, Jordan, Saudi Arabia, the United Arab Emirates, Iraq and Turkey through its group of subsidiaries.

GERMANY

Metsä Group plans major changes to strengthen Kreuzau tissue mill's competitiveness

Metsä Group's tissue paper business has unveiled a strategic plan to enhance the long-term competitiveness of its Kreuzau mill in Germany, aiming to secure future profitable growth. Faced with rising energy and raw material costs, the tissue industry is navigating a highly competitive market. In response, Metsä Group has outlined measures to boost efficiency, modernize production, and realign capacity at its Kreuzau facility. Key actions include upgrading production equipment and shutting down one aging paper machine to balance paper-making and converting capacities. The mill will also shift its focus exclusively to consumer tissue products, reinforcing Metsä's position as a leader in sustainable tissue manufacturing.

As part of the restructuring, Metsä Tissue has initiated change negotiations with the Kreuzau mill's works council, with up to 120 jobs potentially affected.

"We are committed to securing the long-term success of our Kreuzau mill. While these capacity adjustments and related personnel impacts are difficult, they are necessary to strengthen our position in the competitive German market," said Tobias Lüning, SVP West and Country Manager of Metsä Tissue GmbH. "We will collaborate with our personnel and the works council to find the best possible solutions."

Kreuzau is one of Europe's largest tissue paper mills and the biggest within Metsä Group, supplying fresh fiber-based tissue products to Central European markets.

INDIA

Gayatrishakti Tissue starts tissue business

Indian producer Gayatrishakti Tissue has started up a complete AHEAD tissue machine supplied by Toscotec at their facility in Vapi, Gujarat state. With this successful start-up, they have entered the Indian tissue market.

The AHEAD tissue machine has a sheet trim width of 2,850 mm, an operating speed of 1,800 m/min, and a production of over 35,000 tpy.

Kiran Barad, Whole Time Director at Gayatrishakti Tissue, says, "Toscotec has proven to be the right partner for Gayatrishakti on this strategic investment. As a major board manufacturer in India, we understand the importance of operating state-of-the-art technology to deliver the highest quality to our customers and stand out in the Indian market. We have fully achieved our target with this successful start-up."

Gayatrishakti Tissue's and Toscotec's teams in front of PM1 at Vapi's mill in India.

NETHERLANDS

ANDRITZ acquires recycling technology specialist ATN Engineering

ANDRITZ has acquired ATN Engineering B.V., a Dutch company specializing in advanced recycling technologies. This strategic acquisition strengthens ANDRITZ's position as a global leader in recycling solutions by adding ATN's state-of-the- art degassing and de-oiling systems to its portfolio.
ATN Engineering is recognized as an innovator in the recycling sector with its unique drill head system, which enables the safe and efficient removal of hazardous oil and gas from end-of-life refrigerators. The company also supplies feeding logistics and equipment for the recycling of industrial coolers, air conditioning equipment, and heat pumps.
ATN provides engineering, manufacturing, installation, commissioning and servicing of recycling equipment. To date, the company has delivered more than 200 degassing units worldwide.
Thomas Gemeiner, Vice President, Recycling at ANDRITZ commented: "This acquisition is another significant step forward for our recycling offering. By integrating ATN Engineering's expertise and proprietary technology, we now cover all critical process steps in refrigerator recycling from a single source. This strengthens our leading position in the area and our ability to provide our customers with comprehensive turnkey solutions. We are very pleased to welcome the ATN team to our group."
With this acquisition, ANDRITZ not only expands its technology portfolio but also underscores its commitment to advancing the circular economy through innovative, sustainable solutions. In addition to refrigerator recycling, the ANDRITZ Recycling team focuses on key growth areas such as e-scrap recycling, battery recycling, and waste-to-energy systems.

Thomas Gemeiner, Vice President, Recycling at ANDRITZ. Photo: ANDRITZ

SWEDEN

ANDRITZ acquires analyzer and measurement company PulpEye

ANDRITZ has acquired the Swedish analyzer and measurement technology company PulpEye. The acquisition complements ANDRITZ's capabilities by adding the core pulp quality analyzers and measurements into the group's automation and digitalization portfolio.
PulpEye is a technology company, focusing on online applications and services for the global pulp and paper industry. The Swedish company provides pulp, paper and board producers with a wide range of proven online pulp analyzers, measurements and controls ranging from chip quality, kappa to fiber properties and more throughout the process. Since 2002, PulpEye products have contributed to stabilized and higher pulp quality, process efficiency and reduced energy consumption in pulp production.
ANDRITZ will continue to invest in the further development of the PulpEye product line and will establish a dedicated service network to provide customers with global support.
The acquisition complements the extensive portfolio of Smart Series, ANDRITZ Intelligent Instruments, and leverages the group's position to provide total solutions combining measurements, analyzers, advanced process control and optimization, as well as a broad range of services.
Stephan Keuschnigg-Zingl, Senior Vice President Pulp and Paper Automation and Digitalization at ANDRITZ, says: "We are very pleased to welcome the PulpEye team with its excellent analyzer portfolio to ANDRITZ. This acquisition further strengthens our offering in automation and digitalization and allows us to provide reliable analyzers to measure all the main quality parameters of pulp processing, as well as new solutions and services leveraging them."

USA

Sofidel becomes the fourth largest tissue paper producer in North America

Sofidel has finalized the acquisition of the tissue division of Clearwater Paper Corporation.
The transaction, worth $1.06 billion and the largest in the Group's history, represents a strategic step in Sofidel's journey.
Thanks to the acquisition of four production plants—Shelby (North Carolina), Lewiston (Idaho), Las Vegas (Nevada), and Elwood (Illinois)—Sofidel will increase its production capacity by 25% (340,000 metric tons per year), expand its commercial offerings (two of the six acquired paper machines are TAD – Through Air Drying machines, and optimize its geographic coverage.
Sofidel is advancing its North American expansion, increasing paper mill capacity by 50% at its Circleville (OH) plant and adding converting lines and an automated warehouse in Duluth (MN).

USA

Irving Consumer Products to install a new Advantage ThruAir Drying tissue machine

Valmet will deliver a third Advantage ThruAir Drying (TAD) tissue machine to Irving Consumer Product's mill in Macon, Georgia, USA. The startup is planned for 2027.
Once operational, the production line will increase Irving Consumer Products' annual tissue production capacity by 75,000 tons.
Valmet and Irving Consumer Products have a long-standing partnership, with the latest projects including two TAD machines successfully launched at the Macon mill in 2019 and 2021.
"I am very pleased to announce our Phase 3 expansion at Irving Tissue Macon. The USD 600 million investment will add another 100 jobs and include a third ThruAir Drying papermaking machine, additional converting lines, and a new fully automated warehouse. We are excited to once again partner with Valmet and its team on this important expansion and proud to continue to grow alongside them," says Robert K. Irving, President of Irving Consumer Products.
"Valmet and Irving Consumer Products have a successful history of cooperation, and we are very pleased to win their trust and support them in this important expansion project. It is a testament to the trust and excellent collaboration between Valmet and Irving Consumer Products. We look forward to delivering another successful project and achieving a smooth startup together," says Soren Eriksson, Director of Sales, Tissue, North America, Valmet.

COLUMBIA

Quimicolor inaugurates first spunlace factory in Colombia

Quimicolor inaugurated its spunlace factory in Guarne, Colombia. The first of its kind in the region, this state-of-the-art facility represents a major advancement in Quimicolor's capabilities and commitment to innovation and sustainability. With the equipment from ANDRITZ, Quimicolor has now integrated nonwoven roll production into its existing converting facilities. Covering 2,600 square meters, the new nonwoven factory is the culmination of a project that was initiated during the pandemic to address supply chain challenges, with the financing support of the French public investment bank Bpifrance.
Capable of processing both synthetic and natural fibers, the spunlace line delivered by ANDRITZ is the first ever installed in South America outside Brazil. The line features a high-speed TT card, which makes it the most productive installation on the continent with a capacity of 10,000 tons per year.
This ANDRITZ-supported project showcases Quimicolor's successful vertical integration as a renowned converter. Additionally, it marks a significant step towards a robust sustainable development initiative by cutting down on imports of nonwoven rolls from Asia.
Antonio Mendivil, CEO of Quimicolor, says: "This investment allows us to actively participate in the local reindustrialization efforts and to promote job creation locally. Producing our own rolls also drastically reduces our carbon footprint by avoiding all the inconveniences related to international transport."

MEXICO

A.Celli ships a new iDEAL® FORGED Yankee Dryer to Grupo Corporativo Papelera

As part of Grupo Corporativo Papelera's TM5 completion project, A.Celli Paper provided one of its distinctive forged Yankee Dryer for the customer's plant in Huehuetoca, Mexico.

After the successful project involving a new tissue production line, started up with great results in March 2020, Grupo Corporativo Papelera renews its trust in A.Celli Paper's expertise and solutions to complete the TM5 plant dedicated to the production of 100 tons per day of 13-35 gsm tissue paper.
The Yankee Dryer is A.Celli's patented iDEAL® FORGED YD, characterized by a seamless forged steel shell, the use of bolts instead of welds for the connection of heads to shell and heads to journals and a minimized root shell thickness. All this allows A.Celli's solutions to significantly reduce the required periodical inspections while delivering maximum drying capacity.
The Yankee Dryer features a diameter of 15" and will be used in a production line with a design speed of 1800 m/min to obtain reels with a width of 2700 mm at pope reel.

Luis Fernandez, Deputy CEO of Grupo Corporativo Papelera, declares: "After a long term relationship, and particularly looking to the great results reached with the 2020 Turn-key Tissue Plant project, for which we have exceeded the guaranteed performances, we fully trust in A.Celli Paper technical capability and reliable service support. This latest order placed to complete the TM5 is a clear indicator of our intentions, and we look forward to working together again, confident of achieving another great result."

A.Celli's iDEAL® FORGED YD Yankee Dryer

EDANA Events & Training courses

EDANA, the leading global association serving the nonwovens and related industries, is proud to announce its comprehensive program of events and training courses for 2025. Designed to foster innovation, sustainability, and industry expertise, the calendar highlights EDANA's ongoing commitment to supporting the growth and evolution of the sector.

Plan your year ahead to connect, learn and share!

Premier Events for 2025

Filtrex™ 2025	→ 25–26 March 2025 \ Vienna, Austria
EDANA Innovation Forum	→ 11–12 June 2025 \ place to be confirmed
Outlook™ 2025	→ 23–25 September 2025 \ Budapest, Hungary
EDANA Sustainability Forum	→ 3–4 December 2025 \ Brussels, Belgium

Learning & Development for all expertise levels

The **Nonwovens** learning cycle

Nonwovens basics

- 21 January 2025 \ online
- 29 April 2025 \ online
- 2 September 202 \ online

Nonwovens essentials

- 18–20 February 2025 \ Brussels
- 9–12 September 2025 \ online

Nonwovens advanced Carding

- 12–13 March 2025 \ CETI France
- 19–20 November 2025 \ CETI France

Nonwovens advanced Meltblown / Spunbond

- 19–20 March 2025 \ CETI France
- 26–27 November 2025 \ CETI France

Sustainability Basics

- 11 March 2025 \ online

Fundamentals in Filtration

- 27–28 March 2025 \ Vienna

Absorbent Hygiene Products

- 2–3 April 2025 \ Brussels
- 21–24 October 2025 \ online

REVOLUTIONIZING NONWOVENS: HOW AGRICULTURAL WASTE IS TRANSFORMING THE INDUSTRY

Nonwoven technology has emerged as one of the most modern, innovative, and vital textile production methods. Today, nonwovens represent roughly one-third of the global textile market, serving a wide range of applications, from disposable items to durable, long-lasting products.

In 2022, the global nonwoven fabric market was valued at approximately USD 43 billion. Projections indicate continued growth, with the market expected to reach around USD 68 billion by 2030, reflecting a compound annual growth rate (CAGR) of approximately 5.6% from 2022 to 2032. Disposable products account for the majority of nonwoven usage, representing around 65–70% of total consumption.

The COVID-19 pandemic in 2019 further accelerated demand, especially for personal protective equipment (PPE) such as gloves, face masks, facial covers, and gowns. Most nonwoven fabrics are made from thermoplastic polymers like polypropylene (PP), polyethylene (PET), polyester (PES), polyamide (PAI), and polycarbonate (PC), which, while efficient, are non-biodegradable and contribute to microplastic pollution.

Polyester, in particular, stands out as the most widely used raw material in global nonwoven production. Among the key end-use products, wet wipes and feminine hygiene items are not only essential everyday products but are also consistently listed among the top 10 marine litter items found on beaches.

RETHINKING NONWOVENS RAW MATERIALS

The challenge of recovering conventional nonwoven materials, which are primarily composed of synthetic fibers, has accelerated the development and commercialization of biodegradable nonwoven fabrics. These eco-friendly alternatives are typically produced from bio-based materials that can decompose naturally in soil with the aid of microorganisms. Integrating biodegradable materials into nonwoven production plays a key role in managing waste, reducing the need for landfill space, and utilizing renewable resources.

Agricultural waste fibers represent a significant and underutilized resource. Each year, millions of metric tons of waste fibers are generated, and this figure continues to rise due to the intensification of agricultural activities. In many developed countries, agricultural waste fibers constitute a large share of total agricultural waste. Biomass is globally available in abundant quantities, making it an attractive alternative for industries with high material demands, such as textiles.

Lignocellulosic waste fibers, including agricultural residues, forestry waste, and energy crops, show promising potential as feedstocks for nonwoven production. Their use contributes to material recovery, landfill reduction, and sustainable resource utilization. Furthermore, global legislative efforts focused on sustainability are encouraging industries to seek alternatives to fossil-based synthetic materials, opening the door for natural and biodegradable Fibers.

The effective use of agricultural waste Fibers not only converts waste into valuable products but also creates new economic opportunities for farmers by diversifying their activities. Natural Fibers offer notable advantages in terms of comfort, a key property in nonwoven applications. Factors such as fabric aesthetics, skin interaction, thermal comfort, and air permeability are critical, and natural fibers excel in these areas. Their moisture-absorbing and electrostatic-dissipating properties help reduce unwanted electrical charges during production, enhancing comfort and safety.

In recent decades, the demand for natural fiber-based nonwovens has increased significantly as they present a viable substitute for conventional materials in various products. Natural fibers also provide good thermal and acoustic insulation, reduce dermal and respiratory risks, and deliver a softer touch. However, they are often more expensive than synthetic alternatives due to limited availability and resource dependency. Additionally, there is ongoing concern about the competition between land use for food production and fiber cultivation. For instance, polylactic fibers derived from corn are a bio-based option, but they compete directly with food resources.

While biodegradable synthetic fibers offer partial solutions to plastic-related environmental issues, many are not yet cost-effective. To balance performance and affordability, manufacturers often blend natural fibers with synthetic ones, although this approach does not fully resolve environmental concerns. Ongoing research focuses on cost-effective methods for replacing synthetic components with lignocellulosic materials. Low-cost cellulosic raw materials, such as agricultural and forest waste fibers, are particularly attractive due to their availability and lower production costs.

From the consumer's perspective, these fibers are seen as “green” and can mimic the desirable properties of conventional fibers like polyester and polypropylene. When properly managed, their use in nonwovens can reduce environmental impact while remaining technically and economically viable.

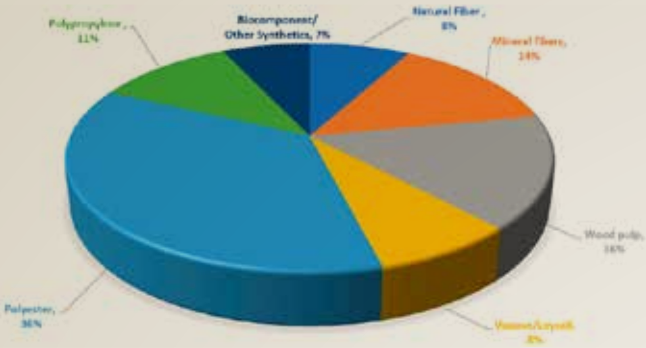


Figure 1. Global nonwoven staple fiber consumption.

A large portion of lignocellulosic fiber waste generated from agricultural and forestry activities is still burned in open fields, contributing significantly to environmental pollution. However, growing interest has emerged in utilizing these fibers for nonwoven fabric production, driven by their advantageous structural properties and environmental and economic benefits. Natural cellulosic fibers are increasingly used in the production of nonwoven fabrics and nonwoven-reinforced composites due to their biodegradability, low density, thermal and acoustic insulation properties, good strength, low health risks, and affordability.

Among the most suitable methods for converting plant-based fiber waste into nonwoven fabrics are the air-laid and wet-laid processes. These techniques allow the incorporation of high amounts of short fibers (above 90 wt.%) and typically use biodegradable or water-soluble binders to consolidate the structure. More recently, spun-laid technologies have also been adapted to produce nonwovens using thermoplastic cellulose fatty acid esters through melt-spinning, offering renewable and recyclable alternatives, especially for hygienic textile applications.

NONWOVENS PRODUCTION

Nonwoven fabrics are produced through a combination of web-forming and bonding processes, each influencing the material's structure, performance, and environmental impact.

In terms of web formation, dry-laid methods manipulate fibers in their dry state using techniques like carding, cross-lapping, or aerodynamic air-laying. Wet-laid processes suspend fibers in water and deposit them onto a screen, forming a web as the water drains. While this process is similar to papermaking, it typically uses longer fibers (greater than 3 mm), resulting in different material characteristics. Polymer-laid or spun-melt techniques—including spun-bond, melt-blown, flash-spun, and apertured films—rely on polymer extrusion to form webs, which are subsequently bonded using various methods.

Once the web is formed, bonding techniques are used to consolidate the fabric. The main method for consolidating a fibrous web structure is mechanical bonding, which includes needle-punching, hydroentanglement, and stitch-bonding. Needle-punching uses barbed needles to physically entangle the fibers and is particularly well-suited for thicker fabrics. Hydroentanglement employs high-velocity water jets to displace and reorient fibers, creating strong web structures. Stitch-bonding secures fibers and yarns through stitching or knitting. These techniques physically entangle fibers without the use of chemical additives, making them inherently more sustainable and widely applicable in both disposable and durable nonwoven products.

Thermal bonding is widely used, particularly in polymer-laid nonwovens. In this process, thermoplastic fibers such as PET, PP, or PE are softened by heat and then cooled to create inter-fiber bonds. Thermal bonding offers benefits such as reduced water usage, improved energy efficiency, and a smaller environmental footprint. In 2022, PET accounted for 25.5% of all nonwoven fiber consumption, with 35% of its staple fiber derived from recycled bottles. The industry is gradually shifting toward bio-based thermoplastics, with PLA and PLA/coPLA bicomponent fibers representing notable advancements.

Chemical bonding enhances properties like strength, flexibility, and texture by applying binders via techniques such as spraying, immersion, foaming, or printing. Traditional binders are usually based on acrylate or vinyl polymers, but growing sustainability demands are encouraging the development of bio-based and biodegradable binders. One common strategy involves partially replacing fossil-based binders with bio-content sourced from wood bark or food industry waste, enabling a gradual transition while addressing raw material availability and performance consistency. Solvent bonding, which involves partial solvation of fiber surfaces, is also used for specific applications.

A distinct and highly sustainable bonding technique is hydrogen bonding, which allows cellulosic fibers to bond naturally under humidity, temperature, and pressure without the use of chemicals. While this method offers clear environmental benefits, its application is primarily limited to absorbent cores in hygiene products due to lower material strength.

In terms of raw material use, manufactured fibers represent approximately 60% of all nonwoven production, due to their availability, uniformity, and established performance. However, to reduce costs and environmental impact, the industry is increasingly turning to agricultural by-products and waste fibers. According to EDANA, there's a growing trend toward utilising low-cost biomass wastes to produce high-performance nonwovens, supporting broader efforts toward sustainable and renewable materials.

NATURAL FIBERS POWERING SUSTAINABLE NONWOVENS

Natural fibers are increasingly replacing synthetic ones in the nonwovens industry thanks to their renewable, biodegradable, and eco-friendly properties. These fibers are generally classified into three categories: plant-based, animal-based, and mineral-based fibers. Plant-based fibers are the most common in nonwovens, valued for their low cost, low density, and reduced skin and respiratory irritation compared to synthetic alternatives.

Plant fibers come from various parts of the plant and are grouped into six types: Bast fibers (flax, hemp, jute, ramie, kenaf), Leaf fibers (banana, abaca, pineapple, sisal, henequen, agave), Seed fibers (cotton, kapok, coir), Straw fibers (rice, wheat, barley, oats, rye), and Grass fibers (bamboo, bagasse, corn, sabai, canary).

Some of these fibers are cultivated specifically for textile production (e.g., cotton, flax, hemp, kenaf), while others—such as coconut coir, sugarcane, banana, and pineapple—are agricultural by-products.These fibers consist mainly of cellulose, lignin, and hemicellulose. The proportion of these components influences fiber strength and performance.

For instance, bast fibers like hemp and kenaf have high cellulose content, which contributes to their strength and stiffness, making them suitable for construction, automotive, and technical textiles. Bast fibers are characterized by high stiffness, low elongation, and good tensile properties, and are widely used in composites, automotive parts, building materials, and textiles. Leaf fibers are coarse and rigid, and commonly used in mats, ropes, handkerchiefs, insulators, and composites. Fruit and seed fibers, such as coir, are lightweight and tough—ideal for products like ropes, twines, mattresses, doormats, and brushes. Grass fibers are typically extracted through water retting, a simple and cost-effective method. Straw fibers, derived from cereal crops, are used in animal feed, biofuels, construction, packaging, and paper. Though biodegradable, their lower strength and limited availability can restrict applications.

Wood fibers, sourced from trees, are classified as softwood or hardwood. Softwood fibers are longer, while hardwood fibers are shorter and better suited to specific technical needs. Both are widely used in the paper industry.

WOOD FIBERS

Wood fibers have secured a significant position in the nonwovens sector thanks to their versatility and cost-effectiveness. In Europe, wood pulp constitutes approximately 18% of the staple fiber content used for nonwoven production, amounting to about 340 kilotonnes annually. Its appeal lies largely in its affordability, especially when compared to cotton or regenerated cellulosic fibers. However, due to its characteristically short fiber length—typically under 5 mm—wood pulp is rarely used alone and is often blended with man-made or natural fibers to improve fabric performance. This blending is particularly important in airlaid and wetlaid processes, where wood pulp contributes to the absorbent cores of hygiene products such as diapers, adult incontinence products, and feminine care items. In airlaid applications, softwood-based fluff pulp, which contains both long and short fibers, is commonly used to achieve the necessary bulk and absorption capacity. Beyond hygiene, wood pulp also plays a role in hydroentangled nonwovens like wipes and filters, where its high absorbency is valued. However, its relatively low wet strength means it is often combined with fibers such as cotton, bast fibers, or man-made cellulosic fibers to ensure structural integrity during use. In addition to being a more affordable option, wood pulp contributes positively to the functionality of nonwovens, enhancing absorbency and even improving flushability when incorporated at optimal ratios (typically 60–75% when combined with other cellulosic fibers). This combination helps manufacturers strike a balance between performance, cost-efficiency, and sustainability.

AGRICULTURAL WASTE: UNLOCKING NEW OPPORTUNITIES FOR NONWOVENS

Bast Fibers: Strong, Renewable, and Underused

Bast fibers are gaining renewed attention in the nonwovens industry for their environmental benefits. In 2023, global production of bast fibers included approximately 3.4 million tonnes of jute, 400,000 tonnes of flax, and 200,000 tonnes of hemp. These fibers are regarded as a sustainable option, mainly due to their lower water and pesticide requirements compared to cotton.

Flax

Flax, traditionally grown in countries like Canada, France, and Belgium, is a dual-purpose crop used for both fiber production and linseed oil. Flax is one of the oldest known fiber crops in human history and remains relevant today, especially in the nonwovens sector.

Low-grade flax fibers are commonly used for nonwoven production through processes such as needle-punching, hydroentangling, stitch bonding, and adhesive bonding. These methods influence the structure and performance of the resulting fabric. Studies comparing different nonwoven manufacturing techniques have shown that needle-punched flax fabrics typically form slightly curved fiber bundles with a random orientation, while spun-laced fabrics exhibit more fiber splitting and shorter bundles. In contrast, fiber mats produced through paper processing tend to gather Fibers into straight, randomly placed bundles.

Mechanical testing of flax-based composites has revealed that processing can slightly reduce fiber strength. However, spun-laced and mat-reinforced composites show better mechanical properties in the machine direction, while needle-punched composites perform better in the cross direction.

Beyond structural uses, flax fiber waste has also been successfully used to produce multi-layered needle-punched nonwovens for filtration applications.

Jute

Jute is one of the most widely cultivated natural fibers, second only to cotton in global importance. As a bast fiber, jute is a cost-effective and abundant resource, particularly in tropical regions where it is predominantly grown.

Nonwovens made from jute fibers are produced using various technologies, including stitch bonding, adhesive bonding, needle-punching, thermal bonding, and hydroentanglement. Jute nonwovens are valued for their high strength, dimensional stability, and moisture absorption, as well as their ability to be bleached, dyed, and printed. These properties make them suitable for a range of applications from packaging to automotive components.

One common source of raw material is jute mill waste, such as broadloom caddis generated during the weaving process, this waste, often combined with other fibers like viscose or woollenized jute, can be processed into nonwovens using air-laying and chemical bonding methods. Mechanically bonded jute nonwovens are already widely used in industrial sectors, particularly for automobile parts and packaging.

Hemp

Hemp is a bast fiber crop cultivated for its strong natural fibers and edible seeds. In recent years, it has gained renewed interest in nonwovens, particularly in sustainability-focused applications. Studies have shown that hemp fibers can contribute to acoustic insulation, with one investigation highlighting their fibrous structure and porosity as effective for sound absorption.

Further research has focused on repurposing hemp fiber waste from textile processing. Using wet-laid technology and thermal bonding, nonwovens with 70–90% hemp content were produced with binder fibers such as PLA and viscose. These materials demonstrated promising structural and environmental performance, though testing revealed low resistance to fungal growth.

In another study, lightweight, absorbent cellulosic structures were produced from waste cannabis fibers using the wet-laid process. Despite their lower pectin content and reduced weight, the resulting nonwovens showed comparable softness, strength, and absorbency to heavier porous fabrics—making them attractive for hygiene and technical applications.applications.

Ramie

Ramie is a bast fiber known for its higher strength and stiffness compared to cotton, while also offering better air and moisture permeability and antibacterial properties. However, it has limitations such as poor elasticity, limited wrinkle recovery, and a rough texture. In Japan, Shiga Ramie Industry Co. produces crimped ramie fiber webs that offer good tactility and moderate extensibility, though their relatively low strength limits their use in practical applications. To improve these properties, researchers have used advanced treatment methods—such as the addition of polyurethane layers—to significantly enhance mechanical performance.

Ramie has also been blended with cotton to produce nonwovens for hygienic applications, such as panty liners. These blends, manufactured using wet-laid techniques, showed that increasing the ramie content improves air permeability, compressive strength, and compression recovery. However, it also reduces surface smoothness, absorption capacity, and tensile strength.

In composite applications, ramie blended with synthetic fibers such as polypropylene (PP) has shown promising mechanical properties. Compared to hemp, kenaf, and bagasse composites, ramie composites demonstrated higher water absorption, largely due to the finer structure of the fibers and their ability to hold moisture.

Kenaf

Kenaf is cultivated mainly in tropical regions for its fiber and seed oil. In one study, kenaf fibers were extracted using a modified chemical degumming method involving alkaline treatment with NaOH and softener to reduce stiffness and coarseness for carding. The treatment was effective in removing impurities and producing finer fibers without negatively affecting strength.

Because of the low strength of 100% kenaf fabric, nonwoven blends with 80% and 50% kenaf were developed using rayon fibers. Kenaf was also embedded into nonwoven samples containing polypropylene (PP) and polyethylene terephthalate (PET), fabricated using the needle-punching process. A high proportion of low-melt PET fibers led to smaller pore sizes, resulting in low air permeability and water absorption.

In another study, kenaf and empty fruit bunch (EFB) fibers were blended with PP to produce needle-punched nonwoven composites, followed by compression moulding. Increasing the natural fiber content resulted in a linear decrease in tensile strength and a linear increase in flexural modulus.

Kenaf/ramie nonwoven fabrics have also been produced via carding, needle punching, and wet bonding, showing excellent strength suitable for automotive interior parts. Finally, cellulosic-based nonwoven composites were fabricated using kenaf, jute, flax, and waste cotton fibers combined with recycled polyester and substandard PP. Among the samples, kenaf/cotton needle-punched composites exhibited superior thermal insulation compared to those made from synthetic fibers.

Roselle

Roselle, native to West Africa and India and now cultivated in China and Thailand, is a bast fiber used as a sustainable substitute for jute. Recent studies have shown that roselle fiber mats can be used to produce lightweight epoxy composites with relatively low density compared to sisal composites. As the roselle content increases, so does the material's capacity for water absorption.

Lotus

Lotus fiber, derived from the lotus root, is increasingly explored for nonwoven applications. Nonwovens made from lotus fiber are produced using wet-laid techniques and offer a variety of desirable properties such as antibacterial, mildew-resistant, moisture-absorbing, and deodorizing capabilities. These fabrics are soft, breathable, waterproof, non-toxic, biodegradable, and recyclable, making them suitable for eco-friendly textile applications.

Bamboo

Bamboo, a fast-growing perennial plant from the grass family, is increasingly valued in nonwoven production due to its natural antibacterial and bacteriostatic properties. Both natural and regenerated bamboo fibers contain Bamboo Kun, a compound responsible for these qualities, making bamboo an attractive material for hygiene-related products.

Bamboo fibers feature a hollow tube structure and a fine micro-scale fiber bundle, contributing to their lightweight and breathable nature. Studies have shown that modifying bamboo nonwoven fabrics through surface treatments, such as oxygen plasma, enhances important characteristics like air and water vapour permeability, wickability, and hydrophilicity, while also slightly reducing thickness and weight.

Bamboo nonwovens can be produced using different techniques. For example, 100% bamboo fibers have been processed by spun-laid technology to produce eco-friendly wet wipes with a soft texture and natural antibacterial and anti-allergy properties. Bamboo is also used in blends with polypropylene (PP) to create needle-punched nonwoven fabrics. Blends with 20% bamboo and 80% PP demonstrated the best mechanical performance, achieving high tensile strength and elongation. Additionally, bamboo fibers bonded with polylactic acid (PLA) have been used to manufacture nonwoven composites. Increasing bamboo content in bamboo/PLA membranes led to a 124% improvement in tensile strength without compromising flexibility, highlighting bamboo's potential in sustainable and high-performance nonwoven products.

Leaf Fibers: Tough and Versatile for Technical Nonwovens

Abaca

Abaca, a member of the banana family, is primarily cultivated in the Philippines, Ecuador, and Costa Rica. It is a valuable natural fiber known for its strength and versatility. Abaca has been used in various nonwoven applications, including blends with polyester to create functional nonwoven fabrics through adhesive bonding and needle-punching processes. One notable application is in the production of tea bag papers, where abaca's long fibers, combined with fibrillated synthetic polymers, contribute to excellent infusion properties and effective retention of fine tea particles.

Sisal

Sisal, mainly grown in Tanzania and Brazil, is another widely used leaf fiber in nonwoven production. Depending on the extraction method, sisal fibers vary in strength, with mechanically extracted fibers providing the highest performance. Nonwovens made from sisal are commonly produced using needle-punch technology. Studies have explored combining sisal with other fibers, such as wool waste or coir, to develop new textile structures. For example, mixing sisal with coir can improve thickness and air permeability, although it may reduce the fabric's bursting strength. On the other hand, pure sisal nonwovens demonstrate superior strength and maintain lower thermal conductivity, making them suitable for applications requiring durability and insulation.

Banana

Banana is a lignocellulosic plant fiber typically harvested from the leaf or pseudostem of banana plants, which grow abundantly in tropical regions. The fibers are extracted from different parts of the plant, such as the bark and midrib, and are usually treated under alkaline conditions to remove surface impurities. This process improves fiber bonding, particularly in wet-laid nonwoven production, with outer bark fibers yielding the best mechanical strength and elongation.

Banana fibers have also been used in reinforced composites. For instance, fibers from the pseudostem of the Nendran variety—a banana commonly grown in southern India—were used to produce needle-punched nonwoven fabrics. When bonded with a polyester matrix in a honeycomb structure, the resulting composites showed improved mechanical strength and effective fiber–matrix bonding.

To improve softness and processing quality, researchers have explored enzyme-based treatments to remove surface residues. While this reduces fiber weight and strength slightly, it significantly enhances flexibility and workability, making the fibers more suitable for nonwoven applications. Banana fibers have also been blended with other natural fibers. Comparative studies show that banana-based nonwovens offer higher air permeability than those made from hemp or sansevieria, making them promising for breathable, lightweight applications.

Pineapple

Pineapple leaf fibers (PALFs) are by-products of pineapple cultivation and are increasingly used in nonwoven and composite applications. Characterized by their ribbon-like structure and vascular bundles, PALFs are extracted and treated to improve their adhesion properties and remove impurities.

Nonwovens made from 100% PALF have been produced using needle-punching. A notable application is Pinatex®, a leather-like material composed of 80% pineapple leaf fiber and 20% polylactic acid. Pinatex® offers qualities similar to animal leather, including flexibility, durability, and water resistance, making it suitable for sustainable fashion and upholstery. Other studies explored PALF nonwovens blended with low-melt polyester using thermal bonding. Increasing the fabric's area density improved thickness, strength, and filtering efficiency while reducing porosity and water permeability.

Curaua

Curaua is cultivated in the Amazon region of Brazil and Venezuela. Known for its mechanical strength, moisture resistance, and favourable thermal behaviour, curaua fibers have been successfully incorporated into nonwoven composites. These composites have been tested as alternatives to synthetic fiber laminates, particularly in ceramic armour systems, where they demonstrated promising impact and tensile strength.

Henequen

Henequen is a lignocellulosic fiber obtained from tropical agave plants. Used without chemical treatment, henequen fibers have been successfully incorporated into epoxy-based composites. The addition of henequen fibers improved tensile and impact strength compared to composites made solely from the resin matrix, highlighting its potential as a sustainable reinforcement material.

> “Natural fibers are renewable, biodegradable, and eco-friendly.”

Tea Leaf

Tea leaf fiber, a by-product of tea processing, presents an interesting sustainable material for nonwoven applications. In one example, konjac paste was combined with hemp and waste tea leaves to create a nonwoven material known as “KAMIKO.” The result showed that paper products containing 10% tea-leaf waste demonstrated excellent deodorizing properties. Additionally, multi-layered structures using industrial tea-leaf fiber waste combined with woven cotton cloth have been successfully used for sound absorption applications.

Cantala

Cantala, mainly cultivated in the dry, rocky regions of Indonesia such as Sumenep and Madura, is valued for its fibers. Finer cantala leaves yield fibers more suitable for spinning compared to sisal. Research has shown that unidirectional cantala fiber mats can be used as reinforcement in epoxy resin composites. Randomly arranged cantala fibers were found to improve flexural strength by distributing applied loads more effectively along the composite structure.

Fique

Fique is an agave species native to South America, commonly harvested for its fibers extracted mechanically from the plant’s leaves. Fique fibers have been used to produce nonwoven fabrics through chemical bonding, where natural rubber latex is applied between fiber layers before pressing. These nonwovens have shown higher density compared to alternatives made from sisal, glass, or polyester fibers.

Recent developments have focused on reinforcing polymer composites with fique fiber mats using compression moulding techniques. When integrated into polyethylene and epoxy resins, fique fibers led to substantial mechanical improvements—such as a 166% increase in tensile modulus and a 36% boost in tensile strength in polyethylene-based biocomposites. In epoxy composites, tensile strength improved by 66%, and stiffness by up to 700%, highlighting fique’s potential in lightweight, high-performance bio-based materials.

Fruit and Seed Fibers: Light, Functional, and Abundant

Husk

Betel nut husk (BNH), an agricultural by-product comprising up to 80% of the betel nut’s volume, shows promising potential for nonwovens. Its fibers have similar tensile strength to kenaf and offer high elongation. However, nonwovens made from randomly arranged ripe BNH fibers can suffer from decreased flexural strength due to fiber irregularities and trapped air during resin processing, leading to internal voids and weaker composite structures.

Coconut husk, or coir, is another abundant agricultural waste used in nonwoven production. Blends of sisal and coir, created through needle-punching, have been evaluated for air permeability, water absorbency, and strength. Coir’s natural crimp improves water absorption and elongation, while sisal contributes to overall tensile strength. A blend of 70% sisal and 30% coir achieved better air permeability than the reverse ratio.

Corn husk, a maize by-product, has been used alongside banana stem waste to produce nonwovens. Treatments with baking soda and cleaning vinegar enhanced fiber quality, with baking soda-treated fibers producing smoother fabrics. Further studies showed that alkali and bleaching treatments improved fiber surface roughness, enhanced adhesion with resins, and resulted in stronger composites.

Kapok

Kapok fiber, obtained from the fruit of the silk cotton tree, is lightweight and naturally hydrophobic due to its waxy surface. Air-laid and needle-punched processes have been used to create blends of kapok with cotton, viscose, polyester, and polypropylene. While kapok’s short fiber length presents processing challenges, blending it with longer fibers helps improve cohesion. The resulting nonwovens display low bulk density and high void content, making them suitable for insulation or filtration applications.

Biduri

Biduri is a wild-growing plant with fibers similar to kapok. Its fibers are light, wax-coated, and suitable for sound insulation and oil absorption. Nonwovens have been created by blending biduri fibers with polyester or polypropylene. Alkaline treatment improves fiber performance by removing lignin, enhancing oil absorption capacity.

Oil Palm

Fibers from oil palm trees can be extracted from various parts of the plant, including empty fruit bunches (EFB), fronds (OPF), and trunks (OPT). These fibers offer good mechanical strength and are increasingly used in nonwoven composites. When blended with polypropylene (PP), they are typically processed using carding and needle punching, followed by compression moulding to form fabric-reinforced composites.

The tensile strength of these materials is primarily influenced by the degree of fiber entanglement, with higher PP content leading to stronger, more compact structures. In contrast, blends with a high proportion of oil palm fibers tend to be bulkier and less rigid, which can reduce tensile performance. For oil palm frond fibers, wet mechanical entanglement has also been used to produce nonwovens, with alkaline treatment applied to improve wettability and water retention—enhancing their compatibility in composite applications.

Okra

Okra stalks can be a source of fibers comparable to traditional bast fibers like flax and hemp. Nonwovens made from okra fibers were produced using needle-punching, with alkali treatment improving tensile strength and surface roughness. Additional processing with degumming and bleaching helped prepare fibers for blending with jute in various ratios. A 50:50 okra-jute blend yielded the best overall fabric appearance and quality.

Luffa

Luffa, commonly found in Asia, provides fibers from the plant’s sponge-like interior. These fibers have a natural cellular structure, which increases fabric bulk and reduces packing density. Luffa has been processed using both needle-punching and dry-laid bonding techniques, creating thick, absorbent nonwoven materials.

Waste Cotton

Cotton fibers removed during ginning and textile manufacturing are classified as waste cotton. Needle-punched nonwovens made from this waste show that slower fiber feed rates and increased layering can improve fiber interlocking, resulting in stronger fabrics. This makes waste cotton a viable material for sustainable nonwoven products.

Straw Fiber

Straw, a by-product of cereal crops like rice and wheat, holds potential as reinforcement in composites. Studies show that blending straw fibers with cotton and treating them with alkali and enzymes can improve surface roughness and fiber quality. Nonwovens made from treated rice straw have demonstrated improved mechanical properties and surface adhesion, especially when combined with cotton in a 90:10 ratio.

Grass Fiber: Bagasse

Bagasse is a sugarcane residue left after juice extraction. Despite its short and rigid fibers, it has been used to develop nonwovens through carding, needle-punching, and thermal bonding. However, using more than 70% bagasse is challenging due to processing limitations. LSU researchers have developed methods to overcome these challenges and produce bagasse-based nonwovens and composites. Polylactic acid derived from sugarcane has also been used in nonwoven beverage infusion bags. Bagasse composites with polypropylene show moderate tensile strength and low moisture absorption, though they are not termite-resistant. Additionally, bagasse/cotton blends bonded with biodegradable adhesives have shown potential for sustainable textile products.

> Agri-waste innovation: a game-changer for the nonwovens industry.

EMERGING NATURAL FIBERS

In addition to widely used agricultural fibers, several less common plant-based fibers have found application in nonwoven production, offering unique properties and sustainable potential.

Cotton grass, a by-product of peat excavation in the UK and Ireland, has been processed into nonwovens using hot pressing, with or without binders. Similarly, fibers from tiger nut waste were used to produce a wet-laid nonwoven composite, where the addition of polyamide bicomponent binder fibers significantly improved energy absorption through thermo-bonding.

From New Zealand, muka fiber—traditionally extracted from the leaves of harakeke (New Zealand flax)—has been developed into needle-punched nonwovens. Other recent work has involved blends of yucca and kenaf waste fibers, which showed promising airflow resistance when processed into 3D fibrous structures.

Marine plant waste, such as seagrass from the Mediterranean, has been combined with binders to create wet-laid nonwovens with improved tensile strength. Olive pomace, a by-product of olive oil extraction, was also successfully processed into nonwovens with up to 80% olive content, using wet-laid forming and hot-press moulding with thermoplastic binders.

Several fibers previously considered agricultural waste or invasive plants are also gaining attention. Kudzu has been used to reinforce polypropylene composites, while areca nut leaf sheaths have been converted into needle-punched nonwovens with strong thermal stability and surface roughness confirmed through microscopy.

Research has also highlighted the potential of fibers extracted from sesbania, calabura, and bauhinia, which were blended with flax and jute to form functional nonwoven fabrics. Another plant, dhaincha, was found to produce nonwovens with good bursting strength and air permeability, although with lower tensile and abrasion resistance.

Finally, natural grass fibers from Pennisetum were pre-treated with a mild alkaline solution and processed using air-blowing spinning. This approach improved fiber dissolution while preserving essential biomass components, showing promise for further material development.

EXPANDING APPLICATIONS OF AGRICULTURAL WASTE NONWOVENS

Thermal Insulation

Improving thermal insulation is crucial for reducing energy consumption, especially in buildings where heating and cooling account for a significant share of energy use. In addition to contributing to energy savings, effective insulation also enhances indoor comfort by maintaining stable temperatures. Nonwoven fabrics play a valuable role in addressing this challenge thanks to their combination of lightweight structure, mechanical strength, and excellent insulating capacity. These materials are widely used not only in construction but also in sectors such as automotive and aerospace, where insulation performance is essential.

The effectiveness of nonwovens in thermal insulation stems from their porous structure, which traps stationary air. Since static air has a very low thermal conductivity, it serves as a natural barrier against heat transfer. The amount of trapped air within the nonwoven fabric and the thickness of the air spaces between fibers are critical factors influencing its insulating performance. Simply put, thicker nonwoven materials with more entrapped air reduce heat conduction and radiation, providing better insulation.

Several factors affect the thermal performance of nonwoven fabrics, including fiber arrangement, fiber-to-fiber contact, porosity, and bulk density. Higher porosity, meaning more void space within the fabric, typically lowers both thermal conductivity and density, although this relationship can vary depending on pore size. Additionally, fibers with internal cavities, known as lumens, further enhance insulation by lowering fiber density and creating more air pockets.

Natural fibers are particularly promising for thermal insulation applications due to their intrinsic properties. Their capillary-linked and tortuous porous structure helps create nonwoven fabrics with both strong mechanical performance and high insulating ability. Studies have highlighted the potential of natural fiber wastes—such as coir, hemp, date palm, sisal, bamboo, and jute—to serve as sustainable alternatives for producing nonwoven insulation materials. These fibers offer an eco-friendly solution while maintaining high-performance standards.

Acoustic Insulation

With the steady growth of urbanization and transportation, noise pollution has become a global concern. According to the World Health Organization (WHO), exposure to elevated noise levels contributes to various health issues, both auditory and non-auditory. This growing challenge has made effective noise control strategies increasingly important.

Nonwoven materials are widely used for acoustic insulation thanks to their fibrous, porous structures, which naturally absorb sound waves. Plant-based fibers are particularly suited for sound absorption due to the presence of pores, canals, and cavities that allow sound waves to penetrate and dissipate. As sound passes through the fibrous network, air molecules vibrate within these pores, causing energy loss through friction and heat generation, which effectively reduces noise levels.

The effectiveness of nonwoven acoustic materials depends on several factors, including fiber type, fiber dimensions, fabric density, thickness, porosity, and airflow resistance. Recent studies have shown that nonwovens made from natural fibers such as hemp, coir, bamboo, oil palm, sugarcane, kenaf, date palm, jute, and flax perform well as sound absorbers. Their structure enables efficient sound dissipation while offering additional benefits such as recyclability and a low carbon footprint.

Oil–Water Separation

Oil–water separation is an urgent environmental challenge due to pollution from industrial wastewater and oil spills. Industries such as steel, aluminium, food processing, textiles, petrochemicals, and leather release significant oil residues into water systems. Among the various separation materials developed—such as metallic meshes, porous ceramics, and carbon-based sponges—nonwoven fabrics have received increasing attention for their tensile strength, porous structure, flexibility, liquid absorption capacity, and suitability for large-scale applications.

Research has demonstrated that composite nonwovens made from polypropylene (PP) and natural fibers offer effective oil sorption. Cotton/PP blends, produced through needle punching, benefit from cotton's waxy surface and hollow lumen, while PP/wood pulp nonwovens have shown strong underwater oleophobicity and stability over repeated use. Lignocellulosic fibers such as kapok, milkweed, nettle, and cotton grass have been tested for their oil absorption capacity. Kapok/PP blends have reached over 30 times their weight in oil absorption; milkweed/cotton/PP combinations have achieved up to 40.16 g/g; and nettle/kapok structures have absorbed as much as 28.5 g/g.

Other materials, including Calotropis gigantea, Hybrid Pennisetum grass, and areca nut leaf sheaths, have demonstrated strong oil separation performance, even under challenging conditions such as high salinity or extreme pH. Surface modifications—such as hydrophobic finishes and PVDF coatings—have also been applied to enhance oil–water separation efficiency, durability, and chemical resistance.

Ballistics

The use of natural fibers for ballistic applications is gaining attention as a cost-effective and sustainable alternative to synthetic materials. fibers such as sisal, curaua, bamboo, malva, jute, bagasse, ramie, and coir are increasingly used in flexible fiber mats for body armour. Although the tensile strength and modulus of natural fibers are lower than that of Kevlar, studies suggest they can serve as effective secondary layers in multilayered armour systems. For example, curaua fibers offer a lightweight and affordable option to replace fiber laminates as ceramic backing materials.

Agri-Textiles

Natural fiber-based nonwoven agri-textiles are widely used to improve productivity in agriculture, horticulture, and greenhouse cultivation. Common fibers for these applications include jute, coconut, sisal, flax, and hemp. Jute/polypropylene nonwoven blends have been studied for moisture management, showing that water absorption increases with jute content up to 55%, peaking at 60% when combined with lower needling density and reduced fabric weight. Beyond water retention, these materials support soil health and plant development.

Field trials using jute-based nonwoven mulches demonstrated improvements in soil moisture, organic carbon, nutrients, and microbial activity—ultimately boosting broccoli yields. Flax and hemp biopolymer mulches, produced via hydroentanglement, benefit from enhanced tensile strength and biodegradability. Pigment treatments, such as carbon black spray on hemp fabrics, have proven effective in weed suppression, matching the performance of conventional polyethylene mulch.

The degradation behaviour of nonwoven agri-textiles has also been widely studied. For example, hemp, flax, and jute-based sanitary mats lost up to 90% of their tensile strength after 12 months of exposure. Similarly, a starch-based ramie nonwoven film used for rice seedling cultivation degraded at approximately 4% per day.

Hygiene

Nonwoven materials have become essential in the hygiene and medical sectors thanks to their flexibility, cost-effectiveness, and suitability for disposable products. Their shorter production cycles and adaptability make them ideal for various medical applications. Air-laid and wet-laid nonwoven structures incorporating flax fibers and their blends are used to manufacture disposable medical items.

Bamboo, in particular, is widely recognized in the hygiene sector and is commonly used in sanitary wipes and baby diapers. Research has also explored the enhancement of bamboo nonwovens for medical use. For example, treating bamboo spun-laced nonwoven fabrics with glow discharge oxygen plasma significantly improves their hydrophilic properties, making them suitable for medical textiles. Further studies have demonstrated that combining regenerated bamboo fiber with aloe vera creates anti-microbial sanitary napkins, with bamboo showing superior resistance to E. coli and S. aureus, as well as better liquid absorption performance. Bamboo nonwovens have also been successfully treated with herbal extracts to produce eco-friendly antibacterial wet wipes.

Apparel Textile

Advancements in nonwoven technologies and materials have led to the development of innovative fabrics with acceptable aesthetic and comfort properties for fashion applications. As the fashion industry moves toward more sustainable and plant-based materials, there has been growing interest in agri-derived fibers for the production of eco-friendly garments, footwear, and accessories.

One notable example is Piñatex, a nonwoven material made by the Spanish company Ananas Anam using waste pineapple leaf fibers—an agricultural by-product sourced from the Philippines. Piñatex has been widely adopted in the fashion industry for use in footwear, bags, and textiles.

In recent research, nettle-based needle-punched nonwoven fabrics were developed for apparel use. These fabrics demonstrated good water absorbency, air permeability, and thermal comfort, making them suitable for clothing applications. Similarly, bamboo fibers have been used to manufacture nonwoven fabrics designed for shoe insoles, including those intended for work and specialty footwear.

Filtration

Nonwoven filters are increasingly used in industrial and environmental applications due to their advantages over woven filters. They offer higher permeability, better filtration efficiency, enhanced temperature resistance, and reduced pressure drops at similar performance levels. For instance, pineapple-based nonwoven fabrics have been tested for air filtration, demonstrating that key factors such as fabric thickness, density, tensile strength, and filtering efficiency play a greater role than air permeability and pore size. This highlights the potential of natural fiber-based nonwovens to serve as sustainable alternatives in filtration systems without compromising performance.

THE PATH AHEAD: FROM WASTE TO HIGH-VALUE NONWOVENS

The management of agricultural waste has become one of today's most pressing environmental challenges, with increasing attention given to finding innovative ways to repurpose agricultural by-products and residues. Issues such as limited landfill capacity and greenhouse gas emissions are driving the search for alternative waste management strategies. The combination of agricultural waste fibers and nonwoven technology offers a promising solution, enabling the production of fully biodegradable nonwoven materials. Thanks to the abundance of agricultural waste fibers and advances in dry-laid and wet-laid nonwoven processes, these natural fibers can now be transformed into fabrics with properties comparable to those of conventional synthetic nonwovens. While nonwoven fabrics made from waste fibers offer advantages such as inherent hydrophilicity and thermal insulation—both important for comfort—they currently face limitations in tensile strength. However, fiber modifications and reinforcement techniques show great promise for overcoming these limitations. The growing demand for sustainable materials derived from renewable resources is expected to accelerate research and innovation in this area. Applications for these new-generation nonwovens are already expanding across multiple sectors, including geotextiles, filtration, automotive components, household goods, agriculture and horticulture, acoustic and thermal insulation, fashion and apparel, and hygiene products. The development of nonwovens using agricultural waste fibers—enhanced through fiber modifications and optimized production methods—has the potential to become a game-changer for the nonwovens industry. Overall, the trend in the nonwovens industry is clearly moving towards reducing reliance on petroleum-based materials and embracing more sustainable, natural alternatives to improve product performance while addressing environmental concerns.

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THE REGULATORY FRAMEWORK SHAPING EUROPE'S NONWOVENS INDUSTRY

The European nonwovens industry is facing growing regulatory pressures, particularly in the areas of sustainability, waste management, and product safety. As production volumes and technological capabilities expand, EU regulators are placing the nonwovens industry under growing scrutiny to ensure alignment with circular economy and environmental goals.

Sanitary waste — which includes menstrual products, baby nappies, and wet wipes — accounts for between 2.9% and 12.4% of the non-recycled waste stream in the EU, depending on the region. This results in an estimated 7.8 million tonnes of waste being landfilled or incinerated each year, underscoring the urgency of addressing single-use nonwoven products through regulatory measures.

Understanding and adapting to this evolving regulatory landscape is now essential for manufacturers. Those who align their operations with upcoming EU requirements — from eco-design and chemical compliance to labeling and end-of-life responsibility — will not only ensure compliance but also strengthen their position in an increasingly sustainability-conscious market.

EXISTING EU LEGISLATION IMPACTING NONWOVENS

Waste Framework Directive (2008/98/EC)

The Waste Framework Directive sets the basic concepts and definitions related to waste management, including definitions of waste, recycling, and recovery. It establishes the waste hierarchy — prioritizing prevention, reuse, recycling, and energy recovery before disposal. For nonwovens producers, this directive influences production processes, waste management during manufacturing, and post-consumer waste strategies. Specifically, it means prioritizing the reduction of waste generation, promoting the reuse of nonwoven materials where possible, and ensuring that recycling and energy recovery options are optimized before disposal. It also requires extended producer responsibility (EPR) schemes in certain sectors, pushing producers to design more recyclable and sustainable products.

Single-Use Plastics (SUP) Directive (2019/904)

The SUP Directive targets the reduction of the impact of certain plastic products on the environment, particularly on marine ecosystems. Nonwoven products that contain plastic and are considered single-use, such as wet wipes, feminine hygiene products, and lightweight plastic bags, fall under this directive. Specifically, these items contribute to landfill waste due to their plastic and non-biodegradable components. Key provisions include mandatory labeling requirements, awareness-raising measures, and product design obligations. It aims to reduce consumption, improve waste collection, and minimize littering of plastic-containing nonwovens. The directive also mandates Extended Producer Responsibility (EPR) schemes, requiring producers to finance the collection, treatment, and disposal of these products.

Regulations on Flushable Wipes

Although there is currently no standalone EU regulation specifically for flushable wipes, they are indirectly addressed under several legislative instruments, including the SUP Directive and Waste Framework Directive. Furthermore, the development of harmonized standards and best practices for labeling and testing is ongoing. These standards aim to define what constitutes "flushable" in terms of disintegration, settling, and biodegradability. The focus is on ensuring that products labeled as "flushable" do not contribute to blockages and pollution in wastewater systems. Many Member States also have national guidelines or restrictions related to flushable wipes.

EU Ecolabel

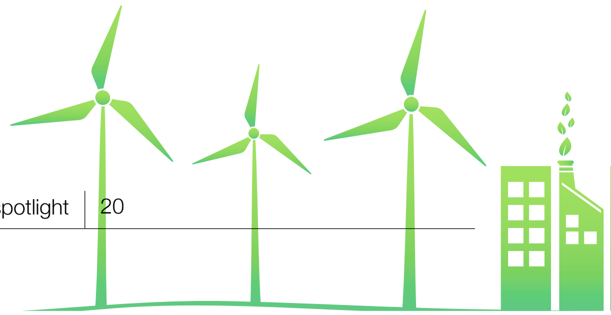
The EU Ecolabel is a voluntary scheme that certifies products meeting high environmental performance standards. For nonwovens, particularly in hygiene, personal care, and cleaning products, the label promotes reduced environmental impact throughout the product lifecycle — from raw material selection to end-of-life disposal. Specifically, the Ecolabel sets limits on hazardous substances, promotes sustainable sourcing, and establishes performance standards to ensure both functionality and sustainability.

Circular Economy Action Plan (CEAP)

The Circular Economy Action Plan is a cornerstone of the European Green Deal. It aims to transition Europe from a linear to a circular economy. For nonwovens, CEAP promotes product design for longevity, reuse, and recyclability. It supports initiatives that foster secondary raw material markets and minimize waste. Nonwoven producers are encouraged to innovate and invest in sustainable materials, recycling technologies, and circular business models. This is particularly relevant for disposable hygiene products, where innovations in biodegradable materials and designs that facilitate recycling are crucial. For example, manufacturers are exploring designs that allow for easier separation of components for recycling or composting.

REACH Regulation (EC 1907/2006)

REACH (Registration, Evaluation, Authorisation, and Restriction of Chemicals) governs the production and use of chemical substances within the EU. Nonwoven manufacturers must ensure that all chemicals used, including binders, coatings, and additives, comply with REACH provisions. It directly affects product formulation, safety data sheets, and the ability to market products in the EU. REACH also enables restrictions or bans on harmful substances, promoting safer alternatives. For instance, certain flame retardants or PFAS chemicals used in nonwovens might be restricted or require authorization under REACH.



THE CHALLENGE OF DISPOSABLE HYGIENE PRODUCTS

Disposable hygiene products such as diapers, menstrual items, and incontinence pads pose unique challenges within the nonwovens sector. These products, while essential for hygiene and health, contribute significantly to waste streams. An estimated 7.8 million tons of such waste is generated annually in the EU, most of which ends up in landfills or incinerators, leading to substantial environmental and economic costs. There is currently no specific EU regulation governing the end-of-life management of these products, presenting a significant hurdle to circularity. Addressing this hurdle requires targeted strategies that consider the entire lifecycle of these products.

Proposed Measures for Disposable Hygiene Products

To mitigate the environmental impact of disposable hygiene products, several measures can be considered:

- Extended Producer Responsibility (EPR) Schemes: Expanding EPR schemes to fully cover the costs of collection, sorting, and recycling of these products.
- Eco-Design Principles: Encouraging the use of sustainable materials, such as bio-based or compostable polymers, and designs that facilitate disassembly and recycling.
- Consumer Awareness Campaigns: Promoting the use of reusable alternatives and educating consumers on proper disposal methods.
- Selective Collection and Recycling Systems: Implementing dedicated collection programs to divert these products from landfills and facilitate recycling.
- Mandatory Labelling Standards: Establish clear and standardized labelling requirements to provide consumers with accurate information on the environmental impact and disposal options of these products.

Effective implementation of these measures requires collaboration between industry, governments, and consumers to create a more sustainable future for disposable hygiene products.

FUTURE OUTLOOK: WHAT'S NEXT FOR NONWOVENS IN EU LEGISLATION

Several upcoming legislative developments will have a significant impact on the nonwovens sector, especially as the EU advances its circular economy and sustainability agenda. The following initiatives are expected to shape product design, marketing, and end-of-life management for nonwoven products in the coming years:

Green Claims Directive

The Green Claims Directive (still under discussion as of early 2025) aims to prevent greenwashing by setting clear rules on how companies substantiate and communicate environmental claims. For nonwovens, this means that environmental benefits such as biodegradability, compostability, recyclability, or reduced carbon footprint must be backed by scientific evidence and verified by independent assessors. This will have a significant impact on product marketing and communication strategies. The directive will also outline penalties for companies found to be making unsubstantiated green claims.

Ecodesign for Sustainable Products Regulation (ESPR)

The proposed Ecodesign for Sustainable Products Regulation (ESPR) will expand eco-design requirements to a broader range of products, including textiles and possibly nonwoven-based goods. The regulation will set minimum sustainability requirements for products placed on the EU market, covering durability, reusability, repairability, recyclability, and the use of recycled content. Digital Product Passports (DPPs) are expected to be introduced, providing traceability and transparency throughout the value chain. These requirements may include minimum thresholds for recycled content, restrictions on certain chemicals, and standards for product lifetime and repairability.

Digital Product Passport (DPP)

The DPP will be a digital tool that provides standardized and accessible information about a product's composition, environmental footprint, recyclability, and sustainability. This passport will enable full traceability across the supply chain and will likely become mandatory for textile and nonwoven products, facilitating responsible sourcing and end-of-life management.

EU Strategy for Sustainable and Circular Textiles

This strategy directly addresses the textile ecosystem, including nonwoven textiles. It aims to make textile products more durable, repairable, reusable, and recyclable, reducing fast consumption and promoting sustainable business models. Nonwovens used in both disposable and durable applications will need to align with requirements regarding eco-design, transparency, and sustainable material choices. The strategy also supports recycling innovation and addresses the environmental challenges associated with synthetic fibers.

TOP TIPS FOR NONWOVEN PRODUCERS TO PREPARE FOR UPCOMING EU REGULATIONS

- ➔ Start Early with Eco-Design
  Incorporate durability, recyclability, and use of recycled content into product development today to meet future ESPR requirements.
- ➔ Review and Verify Environmental Claims
  Make sure all product claims (biodegradable, compostable, recyclable) are backed by scientific evidence ahead of the Green Claims Directive enforcement.
- ➔ Prepare for Digital Product Passports
  Map your supply chain data and product composition now to be ready for DPP requirements.
- ➔ Monitor Evolving Textiles Strategy
  Follow the implementation of the EU Sustainable Textiles Strategy, especially if you supply nonwovens for textile applications.
- ➔ Engage in Industry Collaboration
  Participate in industry groups and standardization initiatives to stay ahead of regulatory developments and share best practices.

Optimizing Vacuum Systems for Energy Savings

Pierre Strauch, VAKUO GmbH

VAKUO GMBH, A LEADING MANUFACTURER OF VACUUM RING PUMPS AND VACUUM SYSTEMS FOR THE PAPER INDUSTRY, SPECIALIZES IN OPTIMIZING EXISTING VACUUM SYSTEMS TO ENHANCE EFFICIENCY AND REDUCE ENERGY CONSUMPTION.

Unlocking Energy Saving Up to 70%

Reducing the power absorbed of vacuum systems is often achievable: Dewatering technologies using Liquid ring, Roots or Turbo all share a global specific consumption of approx. 1 KW per m³/min. VAKUO GmbH provides a proven set of optimization strategies that yield energy savings of at least 30% and up to 70%, ensuring a more efficient and reliable vacuum system.

Key Factors for Maximum Efficiency

Optimal system design, correct pump sizing, well-maintained equipment, and intelligent control of the vacuum system's operating point are essential for the paper machine's reliability and energy efficiency.

One of the most effective ways to achieve significant energy savings is by adjusting the vacuum pump's rotational speed. Reducing the speed by 30% (to 70% of the original RPM) can cut power consumption by 50% (since 0.7 × 0.7 = 0.49). As suction flow is proportional to speed, while absorbed power changes exponentially, this adjustment delivers substantial cost reductions.

The Impact of Upgrading Vacuum Pumps

VAKUO has successfully reduced energy consumption by 50% by replacing outdated liquid ring pumps—often over 25 years old and originally sized for outdated requirements—with modern, appropriately sized models. In today's energy-conscious market, such savings are more relevant than ever.

10 Essential Questions for Optimizing Your Vacuum System

Asking the right questions leads to sustainable energy savings and increased system reliability. Below are 10 frequently asked questions that help paper manufacturers make informed decisions:

1. When should a vacuum pump be replaced?

Regular performance testing, ideally conducted annually, is essential: VAKUO offers audits with on-site performance tests and endoscopies. Measurement and analysis of results are the first essential steps toward optimization.

2. Should a pump be repaired or replaced?

A poorly sized pump can waste up to 30 kW. The potential savings are significant: 30 kW × 12.5 ct/kWh × 8,000 h/a = €30,000/ year—a sum equivalent to the cost of a new pump. Given these savings, the cost of repairing or replacing a pump is negligible in comparison.

3. Why does pump efficiency decline over time?

Wear from corrosion and abrasion affects critical clearances, leading to reduced flow. Increasing pump speed to compensate the loss of capacity is inefficient. Additionally, deposits of fibers, scale, or limestone clog the inner channels, resulting in pressure drops and increase electrical consumption.

4. What is the expected efficiency of a pump?

Properly sized and well-maintained pumps should achieve a benchmark for dewatering of 1 kW per m^3/min. Liquid ring pumps utilizing the condensation effect can easily reach this efficiency.

5. Centralized system or dedicated pumps?

A system with dedicated pumps for different areas is often more adaptable and efficient, preventing performance losses due to expansion.

6. Should a pre-separator be used?

Vacuum pumps are compressors, designed to pump air or steam rather than liquids. Liquid ring pumps are robust but inefficient when handling liquid. A pre-separator improves both efficiency and maintenance intervals.

7. Can energy be saved with cooler water?

Indirectly, yes. Colder water increases the suction capacity of the pump, allowing for a reduction in rotational speed. However, using cold water alone is not sufficient adjustments such as installing a frequency converter or modifying the motor pulley are necessary.

8. Port plates (axial) or cones (radial)?

Both designs have advantages, VAKUO offers both: Cone pumps are robust and offer greater efficiency when utilizing larger ports for water recycling, resulting in lower temperatures and improved performance. Distributor disc pumps are more versatile and adapt better to various vacuum levels.

9. Can liquid ring pumps operate at variable speeds?

Yes. Liquid ring pumps achieve substantial energy savings when rotational speed is adjusted, as power consumption changes exponentially.

10. What is the first step toward optimization?

Every day, VAKUO analyzes vacuum systems in the paper industry. By combining your process expertise with our vacuum system knowledge, we can optimize your system for maximum efficiency and cost savings.

Take the First Step Toward Optimization!

With rising energy costs and increasing sustainability demands, optimizing your vacuum system is more important than ever. Contact VAKUO GmbH today to assess your system and unlock significant savings.

www.vakuo.com

SUSTAINABLE AND SMART

VALMET'S MODULAR INNOVATIONS TRANSFORM TISSUE CONVERTING AND PACKAGING

SMARTER, FASTER, GREENER: VALMET SETS NEW STANDARDS WITH PERINI MYGO

With the Perini MyGo line, Valmet achieves new milestones in Tissue Converting efficiency, while offering performance, and sustainability. The line is designed as a plug & play solution, pre-configured with the most in-demand standard settings in the market, offering maximum flexibility to meet various production needs. This approach minimizes installation and start-up costs and times, enabling clients to become operational quickly. The significant reduction in start-up times allows companies to accelerate the introduction of their products to the market, swiftly seizing new opportunities.

Perini MyGo is modular and ready to use: Excellence in simplicity

One of the distinguishing features of the Perini MyGo is its modularity: each unit of the line is equipped with integrated electrical panels, and perimetral guardings optimizing disassembly and reassembly without the need to reconnect the cables. This advantage can also become useful in any future line relocations from one plant to another.

Perini MyGo features functional design for enhanced maintenance and process supervision. Thanks to the perimeter protections of the line made of black mesh closer to the machine, it has been possible to significantly improve visibility inside the line along its entire perimeter, in particular the transmission area. This solution not only facilitates the monitoring of production processes but also allows natural light to penetrate, eliminating the need for additional lighting. This represents an advantage in terms of safety, as it enables easy visibility of anyone inside the machine, and also contributes to energy savings.

Furthermore, the on-board electrical panels made it possible to eliminate the electrical junction boxes and to move all the PLC I/Os inside the electrical panel accessible from outside the line, reducing the risk of malfunctions over time and simplifying troubleshooting.

Reliability without boundaries

Perini MyGo produces toilet and kitchen paper rolls with diameters up to 200 mm, at a speed of 600 m/min. Certified CE or UL, the line perfectly meets the needs of global markets. Additionally, MyGo integrates advanced and proven technological solutions from Valmet, such as the "Sincro" exchange system, as well as core pick-up and tail sealing systems with blade gluing.

Cutting-edge technologies

With the Perini MyGo, Valmet achieves new milestones in Tissue Converting efficiency, while offering performance, and sustainability. The line is designed as a plug-and-play solution, pre-configurated according to market standards, offering maximum flexibility to meet various production needs. This allows for minimal installation and start-up costs and times, enabling clients to become operational quickly. The significant reduction in start-up times enables companies to accelerate the introduction of their products to the market and swiftly seize new opportunities. Furthermore, sustainability is a central element of the new Perini MyGo.

The line includes solutions such as Aquabond, that replaces glue with water during the lamination process, minimizing the negative environmental impact of these substances. Additionally, in case of lamination with glue, the innovative Mo.Se system, which allows the filtering of impurities from the glue and the automatic washing of the entire gluing circuit, promotes responsible water resource management and reduces glue waste. For the embossers engraving, the latest SKEEN systems technology eliminates the use of hard chrome plating in roller production and Potentially eliminates the need for lubrication oil. In conclusion, Perini MyGo represents a, technologically advanced and efficient solution ideal for companies that recognize eco-responsible production as a competitive lever to meet future challenges.

Innovative embossing and real-time control

Perini MyGo can include a versatile laminator embosser that ensures quality with its 409mm diameter steel rollers and can produce embossed, decorated or DESL products. It can use rollers with the most advanced engraving technologies, including the GHOST system. This allows for a significant increase in bulk while ensuring unparalleled production versatility. Additionally, the embossing and perforation parameters can be easily adjusted via the HMI, providing precise control over the process. Furthermore, MyGo integrates the most advanced safety systems, utilizing "fail-safe" modules in the PLC to optimize diagnostics and ensure the highest level of protection.

> **Our mission is clear: to constantly innovate, respect the environment, and offer solutions that create real value for our customers.**

DESIGN MEETS SUSTAINABILITY: VALMET'S SKEEN, PIXEL, 4D AND GHOST ENGRAVING SOLUTIONS

Valmet Engraving Solutions provides several benefits to clients with its advanced technologies and embossing services that ensure superior product quality and customization. The innovative approach optimizes production processes, improves energy efficiency, and reduces environmental impact, thus meeting the growing market demands for more sustainable and high-performing solutions. Among the flagships of Engraving Solutions are the patented Skeen, Pixel, 4D, and Ghost technologies, which take the embossing of rolled and folded products to a level of quality and detail beyond traditional technological limits.

The Skeen technology offers clients an innovative solution to meet the growing demand for sustainable alternatives. A crucial aspect is the elimination of chromium plating, a significant step towards a more eco-friendly future. This advanced coating, applied to the rollers through an innovative ultra-high temperature system that deposits a specific metal alloy on the surface, creates a matte finish that is easily distinguishable from chromium, endowing the embossing roller with superior properties. Skeen provides more efficient protection for steel, as the hardness of the new material is twice that of chromium. Another advantage is the reduced surface adhesiveness, which helps keep the rollers cleaner with less effort. In practical terms, this results in lower costs and reduced downtime for customers, leading to more efficient Tissue Converting lines.

Pixel, 4D, and Ghost: the new frontiers of engraving

The Pixel technology represents a significant advancement in tissue products, offering tangible benefits for customers. Based on engravings that create micro-protrusions, it enables the creation of unique, modern designs in terms of shapes and shades, allowing products to stand out in the market. The aesthetic aspect is just one of the advantages. Pixel also reduces the use of glue, making laminated products softer and more pleasant to the touch - qualities highly valued in the hygiene sector. Additionally, the ability to design and engineer custom design solutions, and quickly visualize them through simulations or prototypes created via 3D printing, allows customers to test and refine their ideas efficiently. This shortens development times, ensuring a fast return on investment.

The 4D technology introduces an innovative approach to engraving, designed to reduce stress on the paper, resulting in less degradation or raw material savings while maintaining the same quality. Customers can therefore produce more sustainable and cost-effective products, benefiting from increased flexibility in their production processes. The versatility of this technology makes it suitable for all applications, from paper towels to hygiene products, demonstrating how innovation can effectively address new market challenges and enhance competitiveness.

Finally, Ghost represents the latest achievement in "micro" engravings achieved through a hybrid process made possible by a unique technology available on the market. It is characterized by its unique rounded truncated pyramid tip shape, which allows for the shaping of paper fibers without damaging them. The result is greater resistance to embossing compression, making it ideal for producing bulky and firm products. Ghost is particularly valued by customers for the perfect balance it provides between softness and bulkyness in the final products - two qualities that have always been the most demanded by the market.

"*Our mission is clear: to constantly innovate, respect the environment, and offer solutions that create real value for our customers. The availability of two pilot lines - one small for quick, investigative tests, and one large, for products 100% comparable to actual high-speed converting lines - perfectly defines our role as a trusted partner.*" states Flavio Sabbioni, Area Sales Manager at Valmet Engraving Solutions who concludes "*With over thirty years of experience, patented technologies,* *and unique solutions, Engraving Solutions once again confirms its position at the forefront of innovation in creating and developing solutions that enable customers to refine their products in a shorter time, while ensuring low environmental impact and reduced time-to-market.*"

Casmatic B23 has been designed with a strong focus on sustainability, even though polyethylene is still the most widely used material in secondary packaging today.

VALMET'S CASMATIC B23: REDEFINING SECONDARY PACKAGING FOR A SUSTAINABLE FUTURE

Casmatic B23, an evolution of the best-selling CMB 202, is designed for secondary packaging of roll products such as toilet paper and paper towels. Although it does not replace the primary packaging, the solution creates an outer bag that isolates and preserves the packages, ensuring superior safety during transport and storage. The new model features high performance, a modular design that allows customers to significantly reduce installation time, and sustainability. In this regard, thanks to the TOSS longitudinal sealing system, the Casmatic B23 reduces energy consumption by approximately 20% and pneumatic air consumption by 50%.

Modular design

The Casmatic B23 revolutionises the design of packaging machines by introducing modularity for the first time. This approach reduces installation time at the customer's site by 45%, marking a true paradigm shift in the industry. In particular, the solution can be installed quickly and easily, allowing production to start in just four days with the support of two technicians. In the future, the aim is to further halve this time and complete the process with just one technician, saving significant resources and time. Capable of producing 23 high quality transparent polyethylene bags per minute, the Casmatic B23 is designed to adapt to a wide range of pack sizes, with an estimated format changeover time of just 25 minutes. This flexibility, much appreciated by customers, increases productivity and enables a quick response to different market needs. So far, customer feedback from field tests of the machine has been very positive due to the simplicity of the format change, which translates into a significant increase in production. Valmet is committed to developing solutions that not only optimise operational efficiency, but also promote the energy transition and contribute to a more responsible and environmentally friendly industrial future.

A Future-Proof Automation System

Another strength is the adoption of Siemens S7 1500 as the standard controller, representing the latest generation of PLCs, ensuring superior operational longevity. This aspect is particularly relevant as the solution is already ready for future technologies, with components and devices that are not expected to become obsolete in the short term. Additionally, the machine, thanks to the proprietary IoT system TDS, is designed to share PLC data through the most widely used protocols available on the market, for integration with a wide range of tools, including third-party ones. This allows for data collection and processing, offering the customer the ability to monitor and optimize machine performance, even in real-time. This feature not only improves efficiency but also enables predictive maintenance functionalities to anticipate potential anomalies and minimize downtime, ensuring greater production continuity and constant monitoring of the plant's operating conditions. Completing the innovations is the significant improvement of the HMI, now more intuitive and optimized, to facilitate machine use and improve the operator's experience. This standardized interface not only simplifies daily operations but also contributes to increased customer satisfaction. The first prototype of the solution was successfully installed at an Italian company, which expressed full satisfaction with the machine's performance.

Cristiano Casale, Valmet's Global Packaging Technical Director, explains: "*Casmatic B23 has been designed with a strong focus on sustainability, even though polyethylene is still the most widely used material in secondary packaging today*," and concludes, "*This approach ensures that the machine is ready to meet the growing demand for more environmentally friendly and future-oriented solutions*."

A combination of technological innovation, reduced consumption and modularity, the Casmatic B23 represents an important step towards a more sustainable and digitally integrated future to meet the upcoming challenges of the packaging industry.

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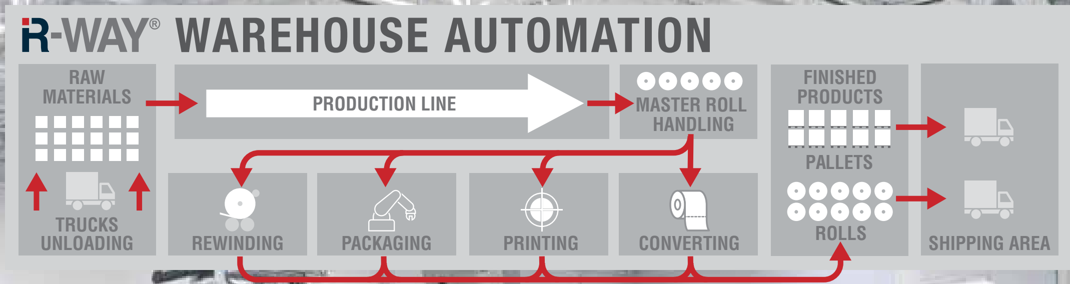

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