

**Spunlace Innovation and Hemp-Based Wipe Development**

**Executive Summary**

Industrial hemp is emerging as a high-performance, sustainable fiber for nonwovens. This white paper presents IND HEMP’s groundbreaking development of a hemp-based spunlace wipe, the first of its kind grown, processed, and manufactured entirely in the United States. Focusing exclusively on the spunlace (hydroentangled) nonwoven process, we detail the technical manufacturing steps—from Montana hemp fields to finished wipes—and demonstrate how hemp fiber can be integrated into modern wipes without compromising performance or sustainability. Key trial results show that hemp blends exhibit strong dry and wet tensile strength at typical wipe basis weights, meeting or exceeding industry benchmarks.

Beyond technical performance, this project showcases a *localized supply chain* for nonwovens: fiber cultivation and initial processing in Montana, fiber refinement in the Southeast, and fabric manufacturing at North Carolina State University’s Nonwovens Institute. The result is a more transparent, resilient supply chain and a product with a compelling sustainability profile. Hemp-based nonwovens offer brand owners and converters a “clean label” alternative – a wipe composed of natural, biodegradable fibers, free of plastics or chemical binders. By replacing conventional inputs (often wood pulp or synthetics) with regionally grown hemp, manufacturers can reduce environmental impact while telling a stronger sustainability story.

In summary, IND HEMP’s hemp wipe initiative demonstrates leadership in sustainable nonwoven innovation. It validates that U.S.-grown hemp fiber can deliver premium performance in spunlace wipes, opening the door for wider adoption of agricultural fibers in hygiene and personal care products. This white paper provides a technical overview of the spunlace process, details the hemp wipe development steps and data, and highlights the broader implications for industry stakeholders, brand partners, and sustainability advocates.

**Introduction**

As the nonwovens industry faces increasing pressure to improve sustainability, producers are exploring bio-based fibers to replace synthetics and wood-based inputs. Industrial hemp (Cannabis sativa) fiber has gained attention as a renewable, *regenerative* resource that can meet performance requirements while significantly reducing environmental footprint ( [Hemp: A Sustainable Plant with High Industrial Value in Food Processing - PMC](https://pmc.ncbi.nlm.nih.gov/articles/PMC9913960/#:~:text=fiber%20not%20being%20met%20by,water%20than%20hemp%20per%20unit) ). Hemp is a fast-growing bast fiber crop requiring less water and agrochemicals than cotton, and it sequesters CO₂ efficiently during growth. In fact, hemp cultivation uses roughly *2.5 times less water* than cotton per unit area and can yield the same fiber output on one-third of the land. These advantages make hemp an attractive fiber for sustainable textiles and nonwovens.

**Nonwoven fabrics** are engineered materials made by bonding or entangling fibers into a sheet or web without weaving or knitting. This category includes many everyday products – from baby wipes and medical gauze to air filters and insulation. Among nonwoven production methods, *spunlace hydroentanglement* stands out for producing soft, cloth-like materials suitable for wipes and other disposable hygiene products. Spunlace allows manufacturers to use staple fibers (natural or synthetic) to create fabrics with high absorbency and drape, without any chemical binders. As such, it is an ideal process for integrating natural fibers like hemp into wipe products, enabling plastic-free, biodegradable wipes.

This paper focuses on spunlace nonwoven manufacturing with hemp fiber, using IND HEMP’s recent wipe development as a case study. We begin with a technical overview of the spunlace process, then detail the step-by-step development of the hemp-based wipes – from field to finished product. We present key performance data (basis weight, tensile strength) from the trials, and discuss the implications for sustainability and supply chain localization. The goal is to inform industry stakeholders and brand partners of the potential of hemp in nonwovens, backed by real-world data and process knowledge, in a formal yet accessible manner.

**Spunlace (Hydroentanglement) Process Overview**

Spunlace hydroentanglement is a mechanical bonding process that uses high-pressure water jets to entangle fibers into a cohesive nonwoven fabric. In a typical spunlace line, loose fibers are first carded (combed into a uniform web) and laid onto a conveyor. The dry fiber web then passes under rows of fine water jets directed at pressures that can range from 50 to 300 bar. These jets punch through the fiber web and interlock the fibers by twisting and wrapping them around each other. The result is a strong, flexible fabric formed *entirely by physical fiber entanglement*, without any adhesives or thermal fusing.

Spunlace fabrics are known for their textile-like qualities: they are soft to the touch, drapable, and can be made highly absorbent. This is why spunlace is widely used for products such as disposable wipes, personal care cloths, and medical gauze, where a cottony handfeel and absorbency are important. For example, cosmetic facial mask sheets and baby wipes are often made of spunlace nonwovens to give a gentle, cloth-like user experience. Despite their softness, spunlace wipes can be quite strong, especially when wet strength enhancers or certain fiber blends are used. Notably, because no binders or plastic fibers are required in hydroentanglement, 100% cellulosic (plant-fiber) spunlace fabrics are possible, enabling fully biodegradable and even compostable products.

From a manufacturing standpoint, spunlace is a relatively versatile process. It can accommodate a variety of fiber types and blends – e.g., cotton, viscose rayon, lyocell (a cellulose filament), polyester, wood pulp, and now hemp. Natural fibers typically need to be of sufficient cleanliness and suitable length (usually staple length ~1 to 2 inches) to be carded and entangled effectively. The entanglement intensity (and thus fabric strength) can be tuned by adjusting water jet pressure, number of passes, and the supporting screen or drum design. After hydroentanglement, the web is dewatered and dried, which is an energy-intensive step (often involving vacuum extraction and through-air drying). Modern spunlace lines therefore include water filtration and recirculation systems to recycle the process water, mitigating the high water usage of the process.

In summary, spunlace nonwovens offer an effective way to create fabric-like sheets from staple fibers using only water and energy. The absence of chemical binders means that if renewable fibers are used, the end product can remain fully bio-based. The trade-off is that hydroentanglement lines have significant capital and operating costs (large pumps, dryers, etc.) and somewhat slower throughput compared to ultrafast processes like spunbond extrusion. However, for applications where softness and natural fiber content are priorities – *such as premium personal wipes* – spunlace is often the technology of choice. These factors set the stage for introducing hemp fiber into spunlace wipes, combining the process’s material flexibility with a sustainable fiber input.

*(For a visual illustration of the hydroentanglement process, see IND HEMP’s video “The Future of Nonwovens is Growing in Montana.”)*

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[The Future of Nonwovens is Growing in Montana - IND HEMP - YouTube](https://www.youtube.com/watch?v=LRUCNREFw6M)

**Hemp-Based Wipe Development Process**

IND HEMP’s hemp wipe project demonstrates how an agricultural fiber can be integrated end-to-end into a nonwoven product. The development required coordination across the supply chain, from farming and fiber processing to nonwoven fabrication and testing. Below we outline the key steps in this process:

1. **Cultivation of Industrial Hemp:** The journey begins on Montana farms, where industrial hemp is cultivated as a fiber crop. IND HEMP works with regional growers and agronomists to produce hemp varieties optimized for fiber quality (tall stalks with strong, low-resin fiber). Grown without the need for intensive pesticides or herbicides, hemp offers a sustainable agricultural feedstock. It also enriches regenerative agriculture systems by improving soil health and biodiversity on rotation farms ( [Hemp: A Sustainable Plant with High Industrial Value in Food Processing - PMC](https://pmc.ncbi.nlm.nih.gov/articles/PMC9913960/#:~:text=fiber%20not%20being%20met%20by,concluded%20that%20in%20terms%20of) ). After a 90–100 day growing season, the hemp is harvested and field-retted (allowed to partially decompose to loosen fibers) before baling.
2. **Decortication and Fiber Refinement:** Baled hemp stalks are transported to IND HEMP’s fiber processing facility in Fort Benton, MT – part of the first industrial hemp “fiber campus” in the U.S. ([About IND HEMP - IND HEMP](https://indhemp.com/about-ind-hemp#facilities#:~:text=Our%20newly%20built%2052%2C000%20sq,Image%203%2F3)). There, the stalks undergo decortication, a mechanical process that separates the outer bast fibers from the inner woody core (hurd). IND HEMP’s decortication line (a 5 ton/hour LAROCHE system) breaks and scutches the stalks, yielding raw hemp fiber bundles. The fiber is then further cleaned and classified: remaining hurds, dust, and short fibers are removed to produce a *cleaner, more uniform bast fiber*. This may involve additional steps like cottonization, where fibers are mechanically softened and shortened to a spinnable length ([Showcasing Hemp Fiber at Techtextil North America](https://indhemp.com/2021-9-3-showcasing-hemp-fiber-at-techtextil-north-america-trade-show/#:~:text=Showcasing%20Hemp%20Fiber%20at%20Techtextil,5%E2%80%9D%20and)). By the end of this stage, IND HEMP has “premium bast fiber” ready for nonwoven applications, typically in a coarse to medium denier similar to other natural textile fibers.
3. **Scouring (Fiber Cleaning & Bleaching):** One of the innovations of this project was to further refine the hemp fiber by scouring. IND HEMP partnered with specialty textile processors in the Southeastern U.S. (notably *Bear Fiber, Inc.* and *Tintoria Piana US* in Georgia) to perform this step. Scouring is a chemical washing process that removes pectins, lignin, and oils from the fiber, and often includes bleaching. The Montana-grown fiber was shipped to Georgia, where it was scoured to enhance its compatibility with other fibers like cotton and lyocell. The result was whiter, softer hemp fiber with minimal non-cellulosic content, closely resembling cotton in feel. This step is crucial because bast fibers like hemp naturally contain ~30% non-cellulosic components (pectin, hemicellulose, etc.) that can affect bonding ([Revolutionizing Sustainable Nonwoven Fabrics: The Potential Use of Agricultural Waste and Natural Fibres for Nonwoven Fabric](https://www.mdpi.com/2673-8783/4/2/18#:~:text=Bast%20fibres%2C%20originating%20from%20hemp%2C,physical%2C%20chemical%20and%2For)). Removing these impurities (a process akin to traditional hemp “degumming”) produces a finer fiber that can blend seamlessly with cotton or regenerated cellulose fibers in downstream processes. *This premium refined hemp fiber is the input material for the spunlace trial.*
4. **Fiber Blending and Web Formation:** With clean fiber in hand, IND HEMP proceeded to create nonwoven webs at North Carolina State University’s The Nonwovens Institute (NWI), a leading research facility with pilot-scale production lines. For this trial, various fiber blends were prepared – combining hemp with natural complements like cotton and lyocell. The blends were chosen to evaluate different compositions and basis weights. For example, prototypes included blends such as 50% hemp / 50% cotton and 50% hemp / 50% lyocell, as well as an 80% hemp / 20% cotton mix at a heavier weight. These fiber mixtures were processed through a carding machine at NWI, which opened and aligned the fibers into a uniform web. Notably, observers reported that the hemp blends showed *“exceptional compatibility”* on standard carding equipment – the fiber opened and mixed well without special modifications. This confirms that properly refined hemp fiber can be handled much like cotton on conventional nonwoven machinery. The carded webs were laid to target basis weights ranging roughly from 50 to 95 grams per square meter (GSM), covering the typical range for light to heavy wipes.
5. **Hydroentanglement (Spunlace Bonding):** The dry fiber webs were then hydroentangled on NWI’s pilot spunlace line, completing the spunlace nonwoven fabrication. Multiple passes under high-pressure water jets bonded the fibers into a coherent fabric ([Innovative Wipes Trial with The Nonwovens Institute, at NC State University - IND HEMP](https://indhemp.com/innovative-wipes-trial-with-the-nonwovens-institute-at-nc-state-university/#:~:text=In%20collaboration%20with%20The%20Nonwovens,manufactured%20in%20the%20United%20States)). No chemical binders or synthetic filaments were added – the integrity of the wipe comes purely from hemp, cotton, and lyocell fibers entangled together by water forces. After entanglement, the wet fabrics were vacuum extracted and oven dried. The outcome was rolls of nonwoven wipe material made entirely of natural fibers (hemp blends). This represents a milestone: one of the first-ever *American-grown, American-made* hemp nonwoven fabrics. The project team literally “took it from Montana fields to finished wipes.” The successful operation also demonstrated that hemp fiber can endure the hydroentangling process. Despite the fiber’s stiffness relative to cotton, the scoured hemp did not clog or break the line, and the resultant fabric had excellent strength and handfeel, described as soft and durable.
6. **Performance Testing:** After manufacturing, samples of the hemp wipe material were sent to an independent lab, *Southeast Nonwovens, Inc.*, for thorough testing. Key performance indicators (KPIs) such as tensile strength (dry and wet), elongation, basis weight, and thickness were measured for each formulation. Wet tensile strength is particularly critical for wipes, which must remain intact during use even when saturated with liquid. The test results were impressive: hemp-containing wipes delivered strong tensile performance, in many cases meeting or exceeding typical benchmarks for cellulose-based wipes. In addition, the data confirmed that adding hemp did not compromise the soft feel or absorbency expected of a wipe. Table 1 summarizes selected results from five prototype formulations.

**Performance Results and Discussion**

To evaluate the viability of hemp in spunlace wipes, IND HEMP’s trials covered multiple fiber blends and basis weights. Table 1 below presents the performance data for five prototypes, each made with a different blend and fabric weight. All were produced via carded hydroentanglement under comparable conditions. The metrics shown include basis weight (GSM), thickness, machine-direction (MD) tensile strength, MD tensile elongation at break, and wet MD tensile strength. (All tensile values are measured in pounds-force using standard strip test methods on dry samples and on samples soaked in water.)



**Table 1.** Performance of Hemp-Blend Spunlace Wipe Prototypes
*(All prototypes contain U.S.-grown hemp fiber; cotton and lyocell are also U.S.-sourced.)*

Several important observations can be drawn from these results:

* **High Strength, Even When Wet:** All formulations exhibited robust tensile strength, and notably, the wet tensile values are on par with the dry tensile values (in some cases even slightly higher). For instance, the 50/50 hemp-cotton wipe at 60 GSM achieved ~6.4 lbf dry and 7.3 lbf wet MD tensile. This indicates that hemp fibers contribute strongly to wet integrity, a crucial property for wipes. Cellulose fibers like cotton and hemp tend to retain or increase strength when wet (unlike some viscose rayon fibers which weaken when wet). The data show that a hemp blend wipe can easily exceed the commonly cited requirement of ~5 lbf wet tensile for a premium wipe. In fact, the heavy 95 GSM hemp-lyocell sample reached over 11 lbf wet strength, which is extremely robust for a nonwoven wipe material.
* **Blend and Weight Influence:** The trials compared different hemp ratios and found no processing issues even up to 80% hemp content in the fiber blend. The 80 GSM, 80/20 hemp-cotton sample demonstrates that a high hemp fraction is feasible, yielding ~6.9 lbf dry strength. However, the highest strengths were seen in the heavier and 50/50 blended samples, as expected. The strongest sample (12.5 lbf MD) was the 50/50 hemp-lyocell at 95 GSM, due to its higher basis weight and the intrinsic strength of lyocell. Generally, increasing basis weight improved tensile strength, and using lyocell (a filament fiber known for strength) alongside hemp gave a boost in the heavier grade. The elongation at break for all samples falls in a typical range (around 1.4–2.2 inches extension), with the lighter webs showing a bit more extensibility (the 60 GSM sample elongated 2.2 inches). This suggests the lighter webs were slightly less reinforced, which aligns with their lower tensile force capacity.
* **Comparable to Commercial Wipes:** Although direct benchmarking data is proprietary, these values can be compared to literature or known ranges for spunlace wipes. As a reference, a standard 60 GSM wood pulp/viscose wipe might exhibit on the order of 5–8 lbf MD tensile when dry and somewhat less when wet. The hemp-blend prototypes match or exceed these ranges, demonstrating that hemp can serve as a functional replacement for or addition to traditional fibers. For example, the 50 GSM hemp-lyocell sample at 7.1 lbf dry strength is very respectable for that weight, indicating hemp’s reinforcing effect (hemp fiber’s high cellulose content and toughness contribute to strength ([Revolutionizing Sustainable Nonwoven Fabrics: The Potential Use of Agricultural Waste and Natural Fibres for Nonwoven Fabric](https://www.mdpi.com/2673-8783/4/2/18#:~:text=Bast%20fibres%2C%20originating%20from%20hemp%2C,physical%2C%20chemical%20and%2For))). The fact that even the lightest hemp wipe (50 GSM) held ~7 lbf wet is encouraging for flushable or dispersible wipe considerations (which often aim for a controlled drop in wet strength after use – outside the scope of this paper, but relevant to product design).

Overall, the performance testing validated IND HEMP’s claims that hemp fiber “delivers strong wet and dry tensile strength – key performance traits for premium spunlace applications.” The prototypes proved that a properly processed hemp can integrate into a spunlace wipe and meet the rigorous demands of that product category. These data, while preliminary, give confidence to product developers that hemp-containing wipes can achieve the necessary strength, thickness, and softness profiles for commercial use. Further optimization (e.g., adjusting fiber fineness, blend ratios, or entanglement parameters) could improve these properties even more, but the proof of concept is clearly established.

**Sustainable Innovation and Industry Impact**

The success of the hemp wipe development is more than a single product breakthrough; it represents a scalable model for sustainable innovation in the nonwovens industry. Several broader implications emerge from IND HEMP’s project:

* **Demonstrating a Localized Supply Chain:** This project achieved something unprecedented – a *USA-origin supply chain for wipes*. From farm to finished nonwoven, every stage took place domestically, reducing reliance on imported materials. Typically, wipe substrates used in North America might rely on fibers grown or processed overseas (e.g. Asian rayon, European wood pulp) and are often manufactured in large overseas mills. IND HEMP’s model shows a path to “farm-to-product” integration in the United States, which can shorten logistics, improve supply security, and support local economies. A more localized supply chain also means a smaller carbon footprint from transportation. This resonates strongly at a time when brands and retailers are seeking to regionalize production and hedge against global supply disruptions. By coordinating growers, processors, and research institutes, IND HEMP has illustrated how to bring an alternative fiber from field to market within one country – a blueprint that could be replicated or scaled up with commercial partners.
* **Advancing Sustainability and Carbon Reduction:** Hemp’s environmental benefits carry through to the finished product’s sustainability story. Cultivating hemp is itself a carbon-sequestering activity – studies report up to ~9 tons CO₂ equivalent sequestered per acre of hemp during growth. It also enriches soil health and requires fewer pesticides and fertilizers than conventional fiber crops like cotton ( [Hemp: A Sustainable Plant with High Industrial Value in Food Processing - PMC](https://pmc.ncbi.nlm.nih.gov/articles/PMC9913960/#:~:text=fiber%20not%20being%20met%20by,concluded%20that%20in%20terms%20of) ). On the manufacturing side, the hemp wipe contains only plant-based fibers (hemp, cotton, cellulose) and thus is *100% biodegradable*. Unlike petroleum-based synthetic wipes or those with plastic binders, a hemp-based wipe can fully break down at end-of-life, potentially even in composting conditions. This addresses the growing concern over persistent plastic waste from disposable wipes (many of which currently contain polyester). In addition, by avoiding harsh chemical binders or finishes, the product aligns with *“clean label”* principles – it’s made of recognizable natural ingredients. For consumers and regulators increasingly wary of plastics and chemicals in disposables, this is a significant advantage. IND HEMP’s wipe essentially offers a drop-in solution for brands to launch a plastic-free, compostable wipe without sacrificing performance.
* **Material Innovation for Brands:** For brand partners in personal care, this development expands the palette of sustainable materials. IND HEMP has effectively added *hemp fiber* to the list of proven nonwoven inputs for wipes, alongside cotton, wood pulp, and viscose. Hemp brings a unique marketing appeal as well – it is a “regenerative fiber” with an appealing narrative. Companies can tell a story of Montana farmers cultivating a crop that ends up in a baby wipe or disinfecting wipe, emphasizing natural origin and American sourcing. The brand storytelling potential (“American Innovation, Rooted in Hemp” as IND HEMP phrases it) can differentiate products in a crowded marketplace. Moreover, the performance results show that going green doesn’t mean compromising quality: the hemp wipes *perform exceptionally well*, even compared to conventional wipes. In fact, hemp’s high absorbency and moisture management are inherent benefits that could improve wipe functionality. For example, hemp fiber’s porous structure can enhance fluid handling, making for a wipe that cleans effectively yet doesn’t drip excessively. Brand owners focusing on natural and organic product lines are likely to find hemp-based wipes a compelling addition, aligning with trends in clean beauty and eco-friendly baby care.
* **Leadership and Collaboration:** IND HEMP’s initiative also exemplifies industry leadership through collaboration. By working with The Nonwovens Institute (a hub for nonwoven R&D) and other partners, a small company leveraged world-class expertise and facilities to achieve a big result. It signals to the industry that hemp is not just a niche or theoretical fiber, but one that is *ready for integration* with standard manufacturing processes. The project serves as a call to action: *if you’re a converter, wipe manufacturer, or OEM seeking sustainable fiber inputs, hemp is viable and available*. IND HEMP’s team has effectively de-risked the idea by doing the R&D legwork. This kind of public-private partnership and knowledge sharing accelerates innovation industry-wide. As an outcome, we may see more trials and adoption of hemp in other nonwoven sectors – from absorbent cores to insulation felts – now that it’s been proven in spunlace wipes. The company’s willingness to publish data and openly promote the findings (through this paper, conferences, and media) underscores a commitment to advancing sustainable materials as a whole, not just within their own product line.

In short, the IND HEMP hemp wipe project validates a new sustainable option and paves the way for broader change. It addresses the three pillars that industry stakeholders care about today: performance, sustainability, and supply chain resilience. The hemp wipe hits all three – performing on par with traditional wipes, delivering a significantly improved environmental profile, and fostering a domestic supply chain.

**Conclusion and Outlook**

The development of a hemp-based spunlace wipe entirely on U.S. soil marks a significant milestone in nonwoven innovation. It provides a compelling proof of concept for a more responsible future in nonwovens, wherein product performance and sustainability go hand-in-hand. Through this case study, we have seen that *an ancient fiber crop (hemp) can meet modern material needs*, when guided by smart process engineering and cross-industry collaboration.

For industry stakeholders, this white paper offers evidence that integrating agricultural fibers into existing nonwoven lines is feasible. Technical challenges such as fiber consistency, cleanliness, and compatibility with equipment can be overcome through proper upstream processing (e.g., decortication and scouring). The resulting materials can satisfy the stringent requirements of personal care products. We encourage nonwoven manufacturers to consider pilot trials with hemp fiber in their own processes – whether it be in wipes, automotive interiors, filtration media, or beyond. The work at IND HEMP and NWI can serve as a template, and IND HEMP stands ready as a supplier of refined hemp fiber to interested partners.

For brand owners and product developers, the message is that hemp enables truly sustainable product innovation. A wipe made with hemp embodies the principles of a circular, bio-based economy: it is sourced from regenerative agriculture, manufactured with minimal synthetic chemistry, and returns safely to the earth at end-of-life. Adopting such materials can strengthen brand reputation among eco-conscious consumers and meet emerging regulatory demands (for plastics reduction, etc.). IND HEMP’s project also illustrates the storytelling value – linking the product in a consumer’s hand back to family farms in Montana and a vision for positive change. As the tagline emerging from this effort suggests, *“we’re not just supplying fiber; we’re growing the future of nonwovens.”*

Looking ahead, continued innovation in hemp fiber processing and nonwoven technology will further enhance what’s possible. On the fiber side, advancements in degumming, enzymatic processing, and fiber modification could yield even finer hemp fibers suitable for lightweight spunlace or other fabric-like nonwovens. Blends with other natural fibers or novel lyocell-type fibers (e.g., orange fiber, bamboo lyocell) could open new performance attributes. On the product side, one could envision hemp-based wipes that are not only compostable but also formulated for specific uses (antimicrobial finishes using hemp’s antimicrobial properties, perhaps, or superabsorbent particle integration for medical wipes). There is also the intriguing possibility of integrating local industrial hemp fiber with local pulps or cotton waste to create region-specific sustainable wipe products, further closing loops and utilizing waste streams.

*Spunlace Innovation and Hemp-Based Wipe Development* showcases a timely convergence of technology and sustainability. It underscores IND HEMP’s role as a pioneer in this space, yet the outcomes are highly relevant to any organization seeking greener materials. The hope is that this success inspires more collaboration between fiber producers, researchers, and nonwoven manufacturers to bring forth the next generation of sustainable nonwoven products. The future of nonwovens is growing – literally – in fields of hemp, and now we have a tangible example of that future made real.

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