"NONWOVENS & LIFESTYLE" — SPUNLACED AND AIRLAID NONWOVENS FOR MEDICAL - SURGICAL - HEALTH CARE PERSONAL CARE - HYGIENE

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Introduction

Nonwovens are developed to impart special properties to a product. The advantage of nonwovens, when compared to textiles, is the high economic efficiency of production and their performance capability while at the same time the ability of producing lower weight fabrics.

In order to be competitive today, nonwoven producers must have high productivity at low cost. At the same time, the market demands higher quality. Anyone desiring to meet these requirements must choose suitable processes for web formation, web bonding, and web finishing.

New technologies help to realize this intention. The spunlace technology has made a considerable contribution to the improvement of economic efficiency by a reduction of cost, a higher product quality and with the development of new products (fig 1).

In the medical and sanitary area, the use of appropriate fibers is an important condition for obtaining the required properties. Products free of binder and chemicals are preferred in this particular arena.

Fibers

In the production of products for medical and sanitary, personal and health care and the cosmetic area, mainly 3 types of fibers are used:

- cotton
- rayon
- wood pulp, cotton linters

The importance of wood pulp fibers for these areas is clear. They impart the desired properties to the products and have many advantages over synthetic fibers while the presence of a capillary system is particularly suited for the majority of medical and hygiene nonwovens. (They absorb well)

Since most of these are disposable products, the question of resource must stand at the beginning of our reflections.

Cotton

Cotton is a fiber widely accepted by consumers. Many products consisting of cotton have been made and used by man for a long time. Cotton is the purest form of cellulose that can be found in nature and exceeds the physical and chemical homogeneity of any other vegetable fiber.

Loose bleached cotton has been used for a long time in the sanitary and pharmaceutical area as so called cotton wool.

Cotton is a highly absorbent fiber and therefore suited very well for absorption of body fluids such as urine, blood, and other fluids. It is used for bandages, wound dressings, cosmetic pads, tampons, sponges, swabs, etc.

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Cotton also offers the positive property of being a naturally breathing fiber, i.e. it largely prevents the passage of fluids, but let's gas and water vapor pass. Because of this property cotton is also predestined for surgical gowns and drapes.

In a wet state, cotton has a higher strength (as opposed to viscose) and does not offer the typical slippery touch of synthetic fibers. This is especially favorable for health care applications requiring skin contact.

The quick water absorption by cotton is caused by the structural network of microfibrils; this makes cotton particularly interesting for applications where liquids have to be removed from surfaces. Moreover, cotton offers an excellent resistance to heat as well as dimensional stability and strength even at temperatures of up to 175° C.

Cotton fiber has renewable resources and is bio-degradable. In the past, the use of cotton for the medical industry often failed because of the higher price as compared with viscose. The price of cotton varies depending on quality and crop yield as it is a natural fiber.

It can be assumed, however, that in the long term the market share of cotton will rise because of its advantages.

In summary, cotton is characterized by the following properties:

Absorbency, bio-degradable, breathable, drape, easily sterilized, heat resisting, high wet strength, insulating properties, non allergenic, renewable resources, softness, water retaining capacity.

Usually cotton with a staple length of 7-25 mm is used for nonwovens products, depending on the web forming process used and the intended application. Where mainly volume and absorbency of the products are required, linter and comber noils are used. In most cases bleached cotton is employed which provides the fiber with good absorbency, but makes it more difficult to handle on a card because the fiber can break and neps can form. In many cases viscose or polyester blended with cotton is therefore used.

With all of the above properties, cotton is particularly suitable for wiping cloths that are bonded by spunlacing technology.

Because of its high absorbency, a good fabric-like structure with low linting tendency and its high wet strength, makes cotton highly suitable for the hospital, medical, cosmetics, consumer, and wet wipes.

Special applications in the computer industry, for cleaning of lithographic plates, etc., enlarge the scope of applications.

In addition, spunlaced cotton webs can be dyed, printed, and finished. The repeated washability of cotton spunlaced products is also an advantage. .

The spunlace technology is highly suited for the production of composites with fabric and woven goods or reinforcing scrims.

The main cause for cotton being particularly well spunlaced is the low wet modulus of the fiber allowing it to easily react to the water jets. Moreover cotton does not have a round smooth fiber cross-section. This results in additional frictional resistance which improves fiber adhesion after fiber entanglement.

The use of unbleached cotton for the spunlace process offers advantages:

The fiber is cheaper than a bleached quality and the spunlace process removes substances such as oils or wax from the fiber so that the fiber later can be more easily bleached, dyed or finished.

However the filter system of the spunlace line must be designed accordingly.

Unbleached cotton is hydrophobic because of the oil and wax. Depending on the spunlacing energy used, the behavior of the fiber is changed by spunlacing from hydrophobic to partially or completely hydrophilic because the mentioned components are more or less washed off the fiber.

In addition, the micronaire of cotton is a factor. Spunlaced cotton of a low micronaire obtains a higher tensile strength, but offers a stiffer touch than cotton of a high micronaire.

Cotton treated by the spunlace process is not only used in the medical industry, it is also used with good results for semi-durable bed sheets, napkins and table cloths that can be washed 6 to 10 times without any problems before they are disposed of. The products thus obtained have the appearance of linen and can be provided with optical effects by dyeing and printing.

Spunlace cotton nonwovens are frequently produced in Japan with weights of 30-250 g/m² for wet wipes, medical applications, gauzes and cosmetics.

Fleissner has already worked with cotton as a raw material since the company's foundation in 1848. we have also developed the conception of a continuous bleaching line for cotton with high operational capacities.

Viscose

Viscose consists of cellulose, the same as cotton. Cellulose is obtained from wood and is used for the production of rayon and cellulose acetate fibers. Thus rayon is a synthetic fiber produced from regenerated cellulose. Considering the constantly growing environmental awareness, the possible decomposition of nonwovens gains more and more importance which also promotes the use of rayon.

The product advantages are similar to those of cotton:

Skin tolerance, physiological safety, decomposable, good moisture absorbency and simple finishing. For cotton wool products, mostly blends of viscose and cotton are processed, as for example for the production of tampons. For the use of viscose in hygienic or for medical purposes further advantages can be realized. The webs are lint free as opposed to cotton textiles for surgical gowns.

Also in the field of wiping cloths, viscose is of great importance. It is certainly the essential property of wiping cloths to absorb fluids and accumulate them, i.e. absorption and retaining capacity. Depending on the field of application, it is possible to distinguish particularly between medical and hospital wipes, wet wipes (impregnated with a high share of lotions), refreshing tissues, household wipes and industrial wipes. First of all, spunlaced nonwovens for medical purposes made of viscose staple fiber bleached without chlorine and made without binder bonding should be mentioned here. Because of it's special properties, viscose has shown to be an ideal fiber for the production of medical wipes. In many cases, blends with polyester or polypropolene are used to obtain certain characteristics. In the production of absorbing gauze for medical and surgical applications the advantage of spunlace viscose fiber webs is also obvious. This applies above all to the production of sponges and wound dressings.

Absorbent gauze normally consists of cotton or a blend of cotton and rayon and is characterized as a smooth fabric of open structure with usually 6 - 16 layers placed one above the other. With spunlace technology cost competitive gauze products are produced where the open structure (apertured) is formed by the selection of a wire mesh for spunlacing, i.e. the web takes the form of the wire mesh. However, only 4 instead of 6 - 16 layers are usually required for nonwovens gauze which also adds to cost saving. The spunlace process allows continuous production of nonwovens from the fiber to the finished nonwovens product which can be produced at a much lower cost than woven or knit goods. Although a lot of cotton is used for gauze, blends of 70% rayon and 30% polyester prevail as they can practically imitate the absorbency of cotton. Thus linting problems are mostly avoided.

The market of needled and thermally bonded household wiping cloths made of spun-dyed viscose staple fibers should not be forgotten, nor the technical nonwovens made of modified viscose fiber types having antistatic, flame resistant or gas absorbing properties.

Wood Pulp

Wood pulp consists of cellulose fibers made from wood. This is the most frequently used fiber worldwide. In the wood pulp works, the cellulose fiber is produced by alcaline cooking or cooking with acid sulfite. The fibers are gained by dissolving of lignin which keeps the fibers together and can then be used for the production of nonwovens.

For this purpose, the fibers are dried to about 10% and sheeted in bales or supplied in rolls of so-called paper-board of various widths and diameters.

Wood fibers being hydrophilic is a decisive factor for use in the production of nonwovens for medical purposes.

Cellulose pulp is used mostly where the corresponding amounts of absorbent fibers are required and where therefore low-priced fibers will be selected.

The main use of pulp is found in the production of absorbent disposables such as diapers, sanitary napkins, and incontinence products. Another application is wiping cloths for the medical industry, in particular for the graphic industry where absorbing properties are desired. Another application is the consumer market with the use of table cloths, napkins, tissue, etc., and in the hospital with surgical drapes, bed sheets, surgical gowns. Often blends with synthetics are used for the latter application.

Pulp, same as cotton and rayon, is a fiber type with renewable resources and excellent bio-degradability. For the production of nonwovens from pulp, the pulp roll is first defibrillated by a hammer mill and then laid down in web form by an airlay machine.

Airlay web formation lines can also form webs from cotton linters. When comparing pulp, cotton linters and blends with regard to their behavior in the hammer mill and the airlay machine as well as their absorbency, a difference in defibrillation energy, fluid absorption and degree of nep formation can logically be established.

Cotton linters can become an alternative for the disposables market. Considering the cost, cotton can certainly not replace pulp, but cotton could make a contribution in the future, for example for feminine hygiene products where the principle holds the "thinner is better".

When producing nonwovens from fibers which are placed on a belt while distributed in the air flow, bicomponent fibers in short staple form can be used in addition to wood pulp and cotton linters. Apart from bonding, these synthetic fibers also have other important features: reduced dust formation, increased tensile strength, matrix build up for increased absorbency, higher bulk and increased softness.

Generally the following bonding processes are used for nonwovens made of pulp fibers:

Thermal Bonding	(TBAL: Thermal bonded Airlaid)
Binder Bonding	(LBAL: Latex bonded Airlaid)
Combined Bonding	(MBAL: Mulit bonded Airlaid)
Spunlace Bonding	(SBAL: Spunlace bonded Airlaid)

LBAL products are usually sprayed with latex from both sides, dried and cured.

Today's market for these products comprises feminine hygiene absorbent cores, pre-moistened wipes, facial tissues, disposable baby washcloths, high-loft kitchen towels. The combination of cards for synthetic fibers and airlaid process and subsequent chemical bonding with foam padder and printing unit allows to produce high quality wipes for household purposes.

TBAL markets with pulp fibers of about 2.7 mm fiber length and 6 mm long bicomponent fibers are feminine hygiene absorbent cores, incontinence absorbent cores, medical disposable products and diaper absorbant cores.

For thermobonding at highly uniform temperatures, thermobonding belt dryers with external air conditioning for a speed of 400 m/min are used.

With the MBAL method the fiber dust formation is strongly reduced by surface binder application and the tensile strength is increased. Possible applications for this still young technology are feminine hygiene products (panty liners) and premium baby wash cloths.

New production lines for new application will come to market in the near future. This applies above all to multi-layer composites where multi-forming stations and multi-bonding stations are comprised in one production line including super absorbant (SAP application). In this way, the required application steps for production of these multi-function nonwovens can be done continuously in this multi-purpose line instead of the usual off-line processing on converting lines. This multi-layer airlaid process allows to build up a considerably more economical and cost effective production of finished goods.

An example of such a product can be a baby diaper or an incontinence diaper where the complete multi-layer composite as absorbent core is produced in one step on an airlaid line. In such a composite, each layer is intended to fulfill one particular task.

The DanWeb and Fleissner team are already working on new and improved larger airlaid forming heads for these high production process lines which operate at high speeds with wider working widths of up to 5000mm.

Airlaid / Spunlace combination (SBAL): In the production of wiping cloths (baby wipes, wet wipes, industrial wipes and surgical gowns and drapes) the nonwovens producer has good chances to obtain a product at low production cost.

Since the raw material cost represents the highest share of the production cost, it is obvious to find ways to save here. The use of pulp instead of viscose in a PES/pulp material offers such an opportunity.

The nonwovens produced on such a line can have either 2 or 3 layers and are characterized by high tensile strength and good absorbency.

The various production lines will be described in the next part of the paper.

As examples of the various methods for producing products for use in the medical and hygiene area, item 3.1 will describe a typical Spunlace line which allows to produce nonwovens for personal care such as cosmetic pads, for the medical area such as wipes, gowns and sponges, and item 3.2 will describe the production of carded airlaid nonwovens made up of pulp, PES, PP, and rayon for baby wipes, wet wipes, and industrial wipes.

Production Lines

Aquajet Spunlace Process for Cotton Pads and Other Products

In the medical and hygiene industry, especially in respect to pads for cosmetic use and other tasks, cotton has always been the main fiber for this product.

The reason is the ecological harmlessness of cotton. It is a recyclable raw material that saves resources and is bio-degradable.

Prior to using the spunlacing technology for bonding of cotton fibrous web formations, the following methods were used:

- Impregnation of the surface with a binder
- Thermal bonding with bonding fibers (bicomponent fibers)
- Embossing of pads with engraved patterning rollers

All three systems, however, have disadvantages when compared to the spunlacing process:

Apart from the natural cotton, the products contain 'foreign matters' (synthetic fibers, polymer binder) which comes into contact with the skin. Thus these products can not be identified as 100% cotton. But it is just this pureness which is preferred by many consumers.

The embossed pads do not offer good abrasion resistance at the surface. Therefore fibers remain on the skin after cleaning.

With the spunlace process, these disadvantages have been eliminated. Bonding is done by pure water and the surface - and only the surface - is bonded by water jets. The inside remains absorbent for fluid, cream, etc.

Generally the Spunlace process can follow any type of web formation system:

- Nonwoven card with cross-lapper
- Airlaid web forming lines
- Cotton cards requiring several cards arranged one after the other where they are layered to achieve a weight of 200-250 g/m².
- It is also possible to combine web formation systems.

The spunlacing technology system bonds the fibrous web structures mechanically where the individual fibers by means of water being pressed through fine nozzles at high pressure.

These water jets penetrate the web, entangle the fibers and thus achieve the bonding and condensing effect.

The water jets, their impulse force in particular, together with the web support, influence the degree of fiber entanglement, the orientation of the fiber compound and the properties which are achieved.

The design of a **FLEISSNER AQUAJET** system basically consists of the following elements:

COMPACTING UNIT:
Compacting of the web between two belts for optimum pre-treatment before bonding.

SPUNLACING UNIT:
This unit comprises all constructional elements which belong to the bonding process itself and are mounted into or onto the AquaJet frame such as jet heads, drums, suction systems, transport belts and drives.

FINAL DEWATERING:
Intergraded dewatering of the finished web on the belt unit by vacuum.

WATER CIRCULATION:
Comprising all components required for recycling of the circulated water such as suction fans, separators, sutcion pumps, filter systems, water tank, feed pump, and high-pressure pumps.

ELECTRIC SYSTEM / LINE CONTROL:
Apart from the electrical components such as frequency inverters, regulating systems, monitoring devices, and control panels, this group also comprises the line control system and the Fleissner PCS (process control system) with PLC and PC including operating desk.

ACCESSORIES:
Systems for cleaning of soiled jet strips and high pressure filters complete with scope of delivery and ensure a long term and trouble free operation of the line.

Cotton pads are produced by using only a two-stage unit.

After the web formation processes as mentioned before, the unbonded fibrous web is fed into the AquaJet on the intake conveyor. It is safely held in place by the compacting belt arranged above and transported to the first spunlacing stage.

The first spunlacing stage comprises 2 jet heads mounted above a spunlace drum. The first jet head is used for pre-wetting and operates at a low water pressure. The following jet head operates at a corresponding higher pressure for entangling the fibers.

In a further spunlacing step, the second stage, the back of the web is compacted. This is done by another jet head mounted above the drum.

Compacting of the web takes place only on the surface because of the low pressures of approx. 40 bar ,resulting in a low specific compacting energy (less than .01 kW/kg of fiber). Once fiber compaction is complete, the web is transported over a belt unit where it is optimally de-watered by the final suction system to minimize the amount of water to be evaporated at the thru-air dryer..

The web is then fed to the perforated drum dryer for drying and then to a winder. It is also possible to produce thoroughly compacted plain webs for gowns and drapes (viscose, cotton, PES, PP) at higher water jet pressures with additional jet heads on the drums and/or final conveyor.

Other products for the medical industry can also be produced on the same line. For example, wiping cloths for hospital, household, and industry use which are impregnated and printed (on-line or off-line) after web formation and spunlacing to improve strength and appearance .

This requires higher pressures and more jet heads. In these products, not only the surface is bonded, but the web is bonded throughout by the water jets.

When in-line chemical bonding is required, a foam padder can be used to reduce the amount of moisture. Printing can be done by means of a surface printing unit.

By using special patterned wire meshes, apertured products can be made by spunlacing. For instance wipes, sponges, gauze, etc.can be made on the same line where the open structure of the web is determined by the wire mesh structure. For some nonwoven products a web is produced by reduced spunlacing energy with 1 - 2 jet heads. The subsequent in-line or off-line impregnation with application of 2 - 5% binder allows to obtain special properties such as increased strength and reduced surface piling together with optimum abrasion resistance.

Aquajet Spunlace Process Including
Combinations with Wood Pulp for Wipes

As already mentioned, nonwovens obtained by the SBAL process (Airlaid/Spunlace combination) are products offering properties which are harmonized with the requirements in an optimum manner which at the same time causing low raw material cost.

Such a processing line will be discussed in the following.

A carded web pre-bonded by spunlacing in a first processing stage is sprayed with wood pulp according to the airlaid technology.

The airlaid layer is produced by defibrillation of wood pulp rolls in one or more hammer mills where the throughput is controlled by the addition of wood pulp rolls.

The supply of the very short wood pulp fibers from the hammer mills to the forming heads consisting of 2 forming drums is done by means of pneumatic conveyance. The fiber flow is split prior to reaching the drums and is supplied from opposite sides of the two drums.

The two drums rotate in opposite directions above a web formation belt under which a vacuum is created in a suction chamber to suck off the air. The fibers fall like snow flakes and lie down on the belt or (in the case described) on the carded PES web.

Rotating pin or needle rollers inside the drums and also the division of the fiber flow ensure a uniform distribution across the entire working width.

The amount of fibers supplied to the web formation conveyor in conjunction with the conveyor speed determines the uniformity and thickness of the airlaid web.

Fibers and particles passing by the belt are returned to the system after filtering the air flow in an air filter.

Once the carded web has passed the airlaid unit, the 2-layer composite (carded, PES/airlaid pulp) is fed to the subsequent spunlacing unit where the pulp layer is bonded to the PES web.

By adding another fiber layer from a second card installed before the above mentioned spunlacing unit, 3-layer composites (carded PES/airlaid pulp/carded PES) can be produced.

We have initiated a very interesting development which allows to create new product generations by the combination of the spunlacing process with an airlaid machine.

As all 3 processes (spunbonded, airlaid, and spunlacing) can operate with high speeds (500 m/min) it is possible to produce wipes and hygiene products in the form of various multi-layer composites in very cost effective manner.

Naturally, viscose or PP fibers can also be used instead of PES.

Summary

The development shows that the market demands high performance lines for the cost effective and non-polluting production of nonwovens for the medical and hygiene industry.

The spunlace technology in combination with the airlaid technology provides the opportunity to do so and at the same time offers the advantage of saving energy and resources while also increasing the profit. **WHAT COULD BE BETTER THAN THAT.**