COMPOSITE NONWOVENS FOR HYGIENE AND MEDICAL APPLICATIONS

BY

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Abstract. The paper presents a review relating to the opportunities and technologies to obtain the composite nonwovens for hygiene and medical applications. The liquid absorption characteristics are evaluated for two composite nonwovens.

Key words: composite nonwoven, structure, technology, hygiene, absorption.

1. Introduction to the Composite Nonwovens

The composites in general and composite nonwovens in particularly, are recognized as a macroscopic combination of two or more distinct materials often with a recognizable interface between them.

By comparison, advanced composites are different because they are using only continuous, oriented high performance fibres in polymer, metal and ceramic matrices. A composite is also considered as a multiphase material formed from a combination of materials which differ in composition or form, remain bonded together, and retain their identities and properties.

The composites are maintaining an interface between components that act in concert to provide specific characteristics not obtainable by any of the original components acting alone.

Relating to the textiles, the types of composites are as following:
− Fibrous, that are composed of fibres, and usually in a matrix;
− Laminar made from layers of materials;
− Particulate, with inclusions of particles or flakes, usually in a matrix;
− Hybrid as combinations of any of the above.

The composite nonwovens (CN) are roll goods made from 2 or more layers when the essential part of a composite can be identified as a nonwoven.

In fact a composite nonwoven (CN) is a nonwoven fabric to which
filaments or yarns or particulates are added. The composite nonwovens (CN) are representing a fast growing category of products as the suitable answers to the current trends and are recognized too as engineered fabrics. The structure of the composite nonwovens (CN) is appreciated as:

− A composite nonwoven material may be reinforced with woven fabrics, braided fabrics, knitted fabrics or a 3D structure;
− The matrix is typically polymeric, ceramic, or metallic.

The complex composite nonwovens are representing the combination of different layers of nonwovens together bonded by latex bonding, hydroentangling, needlepunching, thermally bonding, or stitch-bonding process.

The hybrid composites are the composites with two or more types of reinforcing fibres [1] in the form of:

− Interply or tow-by-tow: 2 or more fibre types mixed regularly or randomly;
− Sandwiched hybrids (core-shell): one material is sandwiched between two layers of another;
− Laminated: alternate material layers stacked in a regular manner;
− Intimately mixed hybrids: the constituent fibres are made to mix as randomly as possible;
− Other: reinforced with ribs, pultruded wires, thin fibre veils, combinations.

Why composite nonwovens? The composite nonwovens are often in use because they have many advantages such as following:

− Economical solution by eliminating steps, one product replaces two or more materials;
− Engineering solution by providing a specialized technical solution not possible by single layers.

The composite nonwovens are manufactured in many ways, examples being as following:

− Fibres and filaments;
− Blends of fibres by and from webs (carded, air laid or wet laid webs), variables (fibre type, fibre dimensions or geometry), or homogeneous blends or gradient structures.

The composite nonwovens from homogeneous blends of fibres are observed, as few examples in the following products:

− Acquisition layer in diapers from fibres of 8-12 denier and 2-4 deniers combined for loft and wicking action;
− Blend of cut fibres with melt blown fibres, example CoForm process from KC (wood pulp + MB) or Thinsulate® from 3M (large denier cut + sub-denier fibres) [2];
− Fire protection fabric from P-aramid and melamine spunlaced together;
− Cable-wrap from synthetic fibres + super-absorbent fibres thermally bonded together.
The few examples of composite nonwovens from layered composites can be obtained by:

- Processes with more than one forming section adding different fibres or filaments to a web: multi-card, multi-forming box air laid, multi-beam spunbonding, combinations of various forming processes like SMS, SMMS;
- Processes of gradient Kiara® filtration media by large denier bicomponent fibres over smaller denier bicomponent fibres or improved life at equivalent efficiency vs. webs made from homogeneous blend or made from the smaller bicomponent fibres [3].

Fig. 1 is representing an example of elementary structure of layered composites by carded/air laid/carded layers through-air bonded.

Fig. 1 − Example of elementary structure of layered composite nonwoven.

The composite nonwovens can be made from microfibres and filaments as layered composites, examples being such as SMS or more sections of SMMS, SSMMSS with small, but weak melt blown fibres (M) which are sandwiched between stronger spunbond filaments (S) to form useful breathable barrier fabrics [4].

In the Fig. 2 is given a structure of layered composite, of thickness that can be less than 1.5 µm, with polymeric nanofibres made with fibres of diameters less than 0.5 µm [5].

Fig. 2 − Structure of layered composite with polymeric nanofibres.

The nanofibre layer component placed to the structure top is limiting the mechanical properties of the composites, and is also giving the functional properties such as softness, absorbency, permeability, adherence, suppleness, flexibility, adaptability, etc.

The wet laid cellulose substrate placed to the bottom is increasing the mechanical properties and firmness as well one kind of roughness.
The structure of laminated composite nonwovens consists of at least one nonwoven layer of nonwovens and at least one different layer (film, reinforcement net, etc.).

The following nonwoven processes can be applied as lamination methods to obtain the composite nonwoven structures: thermal bonding, ultrasonic bonding, adhesive bonding, extrusion coating, needlepunching, or spuncaking.

2. Hygiene Products from Composite Nonwovens

2.1. Types of Hygiene Products

With some specifications, the hygiene products could be considered the most useful to consumers and with a production growing as end-uses nonwoven composites [6]...[10].

There are three types of nonwoven based hygiene products as follows:
− Baby care: baby diapers, training pants, pant diapers, dry baby wipes, and wet baby wipes;
− Feminine hygiene: sanitary napkins, panty shields, tampons, interlabial devices, personal wipes, cosmetic removal pads, feminine pads, sanitary towels, and panty liners;
− Adult incontinence: adult diapers, adult pant diapers, under-pads, personal/medicated wipes, nursing pads, disposable underwear, bed pads, bladder control pads, briefs, disposable underwear, guards, insert pad & pant system, liners, nursing pads, personal/medicated wipes, shields, two piece insert system.

The components of the hygiene products, presented in the Fig. 3, are the following: back-sheet, top-sheet, barrier leg cuffs, barrier waist cuffs, elastic components, absorbent core, acquisitions/distribution layers, fastening systems, and recognition label systems.

The components of the hygiene products by type are made from:
− Base: air laid web product of high liquid absorption, soft;
− Additives: modify some of the characteristics (blood absorption, higher absorption, and higher density) etc.; SAPs/SAFs (SA polymer in granulate/fibre form); mono component fibres such as PP–PET–viscose, etc.; odour granulates.
− Laminate with e.g., plastic film (mono or bicomponents) PP/PE, tissue, nonwoven, others.

The hygiene products for example the baby diapers are a complex nonwovens structure based with the components thus: coverstock - nonwoven, acquisition layer - nonwoven, pad - air laid nonwoven, main fluff pad - air laid nonwoven, SA powders or fibres, back-sheet - film, other - elastic, waist elastic band, frontal tape, tape tab, label.

Fig. 3 presents a detailed complex structure for a hygiene product.
Fig. 3 – Complex structure of a hygiene product.

The raw materials for hygiene nonwovens are: fibres (pulp fluff, cotton, polypropylene), SAPs super-absorbent polymer, nonwovens (air laid, composites, melt blown, thermal bonded, spunbonded), tissue, fastening materials, elastomer, film, odour absorbing additives, foam, other (tabs, waistband, hot melt adhesives).

The fibres are providing for hygiene products some advantages by component:
- In top sheet: very good softness, and efficient and fast transportation;
- Acquisition layers: hydrophilic and promptly passage of the liquids into the absorbent core;
- Leg cuffs: hydrophobic by applying a fibre spin finish, carded & thermal bonded web gives a water resistant barrier which prevents leakage and minimizes skin rash;
- Fastening systems: coarse fibre nonwovens are excellent adhesive materials for Velcro tape, offering an easy/affordable/comfortable fastening solution;
- Textile back-sheet: fine fibres with a high softness level and tailored hydrophilic/phobic properties cover the outer layer of the product, and ensure a comfortable surface and textile feeling.

2.2. Production of Hygiene Products

Fig. 4 is presenting the processing steps from cellulose in ball or roll form for hygiene items production [11].

The required properties of the medical and hygiene products are more complicated even if they are considered as being simple. From these properties some are caused by nonwoven content and some specifically are because of content of absorbents, as following: strength, absorption capacity, absorption speed, resiliency, rewet & acquisition time, rewet & acquisition time under load, fluid transport, saps content, saps placement & dispersal, product thickness, density and basis weight, gel lock-up determination, centrifuge retention capacity, fluid run-off quantification, total absorptive capacity, liquid
strike-through time (simulated urine), “simulate active landfill test”, as well the compostability and environmentally.

![Diagram](Image)

Fig. 4 – The technological process for nonwoven hygiene products.

3. Results on Speed of Liquid Absorption

Special devices and a 0.9% NaCl solution of 5.5.2 pH value were used to determine the liquid absorption speed. Two types of hygiene products, Item A and Item L as main types used by consumers are analysed. The specimens are immersed, during 12 min time, into an adequate liquid simulating the body liquid. Absorption height was measured at every 3 min.

The absorption speed is calculated on the base of height values and time data. The experimentally data are given in Table 1 for Item A and in and Table 2 for Item L. The variations of the absorption speed are shown in the Fig. 5 for Item A and in Fig. 6 for Item L.

<table>
<thead>
<tr>
<th>Item A, Specimen</th>
<th>Height of absorption [cm] to the time [min] of</th>
<th>Speed of absorption [cm/min] the time [min] of</th>
<th>Average speed of absorption [cm/min]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3’   6’  9’  12’</td>
<td>3’   6’  9’  12’</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>4.5  5.5 6.2 7</td>
<td>1.5  0.92 0.69 0.58</td>
<td>0.92</td>
</tr>
<tr>
<td>2</td>
<td>4.7  5.8 6.5 7.3</td>
<td>1.6  0.96 0.72 0.60</td>
<td>0.97</td>
</tr>
<tr>
<td>3</td>
<td>5.1  6.0 6.7 7.7</td>
<td>1.7  1.0 0.74 0.64</td>
<td>1.02</td>
</tr>
<tr>
<td>4</td>
<td>4.3  5.0 6.4 7.3</td>
<td>1.43 0.83 0.71 0.60</td>
<td>0.89</td>
</tr>
<tr>
<td>5</td>
<td>4.6  5.3 6.5 7.1</td>
<td>1.53 0.88 0.72 0.59</td>
<td>0.93</td>
</tr>
</tbody>
</table>

Table 1

Experimental Data for Item A
**Table 2**  
Experimental Data for Item L

<table>
<thead>
<tr>
<th>Item L, Specimen</th>
<th>Height of absorption [cm] to the time [min] of</th>
<th>Speed of absorption [cm/min] the time [min] of</th>
<th>Average speed of absorption [cm/min]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3’   6’ 9’ 12’</td>
<td>3’   6’ 9’ 12’</td>
<td></td>
</tr>
<tr>
<td>1</td>
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<tr>
<td>2</td>
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<td>0.56 0.31 0.25 0.22</td>
<td>0.33</td>
</tr>
<tr>
<td>3</td>
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<td>0.63 0.35 0.28 0.24</td>
<td>0.37</td>
</tr>
<tr>
<td>4</td>
<td>2.0  2.3 2.8 3.0</td>
<td>0.66 0.38 0.31 0.25</td>
<td>0.4</td>
</tr>
<tr>
<td>5</td>
<td>1.5  1.8 2.2 2.8</td>
<td>0.5  0.3 0.24 0.23</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Fig. 5 – Variation of the absorption speed with time for Item A.
Fig. 6 – Variation of the absorption speed with time for Item L.

4. Conclusions

One can remark that “Without composites we could be lost”. The comparative analysis of the two hygiene products, Item A and Item L, is showing that even if the Item A is less bulky, slender and very thin, still is offering a better protection because is containing two layers and therefore the speed of liquid absorption is higher. The economical conditions are determining to obtain the hygiene products with only one layer such item L.

Unfortunately for the item L, the absorption capacity is less valuable as well the speed of liquid absorption. As a perspective, the developing of the hygiene products from nonwovens must be seen by two points of view perspectives: of the consumers, who are wishing more aesthetic products, and of the producers who are wishing the less production cost and less production wastes. Also it must be reconsidered the consumers’ wishes who wants products made from natural raw materials as cotton fibres even if they will pay more, but unfortunately the producers are close-mouthed for these products because of higher production cost.

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2. http://www.3m.com/index.jhtml

**NEȚESUTE COMPOZITE PENTRU UTILIZĂRI MEDICALE ȘI IGIENĂ**

(Rezumat)

Lucrarea prezintă o informație cu privire la oportunități și tehnologii pentru pentru a obține nețesute compozite pentru utilizări în igienă și medicale. Două nețesute compozite sunt evaluate prin caracteristica de absorbție a lichidelor.