Medically hygienic wipes from nonwovens

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ABSTRACT

The application of textile in high performance and specialized fields are increasing day by day and nonwovens share a major part of it. Nonwoven wipes have been used from years in worldwide for varied applications and is serving as a multipurpose commodity in today’s market. This paper focuses on the different types, categories and on the different technologies of nonwoven wipes used and also the market share of these wipes in each category.

1. INTRODUCTION

A nonwoven is an engineered fabric structure made directly from fibers or from the materials that the fibers themselves are made. The term “nonwoven” is often used as a generic description of a fabric that has been produced by a process different from weaving or, more broadly, a fabric that is different from a traditional textile fabric, paper sheet, or plastic film. Like textile fabrics, paper sheets, and plastic films, a nonwoven is a planar structure that can be produced with varying degrees of integrity, surface texture, thickness, flexibility, and porosity. Each of these items of commerce is manufactured by a distinct industry and each is often associated with different, but very basic applications. Specific associations include textile fabrics with clothing and home furnishings, paper sheets with writing and printing, and plastic films with wrapping and packaging. These apparently different commercial items are similar in the sense that each is a fiber-based material, and that many application properties often considered to be unique to textiles, paper, or plastic materials can be met or exceeded by some form of nonwoven fabric. In fact, the technologies used to make nonwoven fabrics are based on the fundamental principles used to produce textiles, papers, and plastics. In this regard, nonwovens are fabrics that are made by (a) mechanically, chemically, or thermally interlocking layers or networks of fibers or filaments or yarns, (b) interlocking fibers or filaments concurrent with their
extrusion, (c) perforating films, or (d) forming porous films concurrent with their extrusion. The American Society for Testing and Materials (ASTM D 1117-80) defines a nonwoven fabric as: A textile structure produced by bonding, interlocking of fibers, or both, accomplished by mechanical, chemical, or solvent means and combinations thereof.

### 1.1. Wipes

Wipes can be a paper, tissue or nonwoven; they are subjected to light rubbing or friction, in order to remove dirt or liquid from the surface. Consumers want wipes to absorb, retain or release dust or liquid on demand. One of the main benefits that wipes provide is convenience – using a wipe is quicker and easier than the alternative of dispensing a liquid and using another cloth/paper towel to clean or remove the liquid.

Wipes are made from tissue paper or nonwoven bonded fabrics, which may be soaked with an antiseptic finish. The wipe may be used to cleanse the body, clean wounds or the skin prior to wound dressing application, or to treat rashes or burn (Horrocks et al., 2000). Nonwoven wipes are used for the purpose of cleansing or disinfecting. They started at the bottom or more precisely, the baby’s bottom. Yet, during the past decade, the category has grown to include hard surface cleaning, makeup applications and removal, dusting and floor cleaning. In fact, applications other than baby care now account for about 50% of sales in the wipes category.

#### 1.1.2. History of wipes

According to Wikipedia the origin of wet wipes came about during the mid 50’s as more people were travelling and needed a way of cleaning up on the go. Wet wipes were also introduced as a quick way of cleaning hands after a take away meal. By the end of 70s the first real baby wipes appeared in the marketplace available to consumers and these were in the form of small thin wipes, which were packaged in a round plastic canister. By the 1990s the expansion of wipes led to more applications on the market and now most large supermarket stores having their own private label branded wipes equivalent. At this stage, the format changed to bigger and thicker wipes. Since then the global wipes market has grown to in excess of £6 billion (based on 2009 figures) and is expected to continue to grow and exceed £7.5 billion by 2014.

#### 1.1.3. Nonwovens for wipes

Nonwovens are the preferred materials for wipes because they are less expensive, more hygienic and more versatile than conventional woven cloths. Additionally, nonwovens are softer, stronger and more amenable to retaining treatments such as soaps and cleaning fluids than paper materials. To compete more effectively with reusable cloth wipes, producers are developing nonwovens with increasingly higher basis weights for greater strength and a more cloth-like texture. Nonwoven wipes are marketed as providing greater convenience and better hygiene compared to reusable cloths. The producers of nonwoven wipes compete on the basis of superior performance and affordability (Magdalena Kondej, April 2010).

### 1.2. Wipes Market by region

The market of wipes in different regions is shown in the figure 1 which convey that the market of wipes has been increasing by year (Freedonia Group, 2007).

#### 1.2.1. Domestic Market for Non woven wipes

The domestic market size for nonwoven wipes in year 2007-2008 is estimated as 1.8 million square metres valued at 10 crore and expected to increase 3.5 million in year 2012-2013 valued at 20 crore (Growing at CAGR of 15%).

#### 1.3. Dry and wet wipes

Cleansing the skin is a personal hygiene problem for which the wipes are well suited. Wipes are of two types viz..., dry wipes and wet wipes.

#### 1.3.1. Dry Wipes

Dry wipes are the most commonly used as cleansing products they are usually referred to as “toilet tissue” or “toilet paper”. Dry wipes are used for cosmetics, floor-glass cleaning, dust wipes, mops, automotive and cleanroom applications (Helen Viazmensky et al. 1994). Nonwoven dry wipes containing spunlaced layers of polyester web and scrim are commercially available. Examples of such dry wipes are Swiffer®, available from The Procter & Gamble Company, Cincinnati, Ohio, and Grab-It®, available from S. C. Johnson & Son, Inc., Racine, Wisconsin, which are generally made by needling round polyester staple fibers into a scrim. These wipes are electrostatically charged to attract dirt and dust, and the three- dimensional structure of the webs used is open so that dirt particles are trapped by the wipes. Another example of a dry dust wipe is Scotch-Brite®, available from Minnesota Mining and
Manufacturing Company, St. Paul, Minnesota, made from spunlaced webs of polyester staple fibers having longitudinal grooves therein. Hydraulically needling a web of staple fibers into an unbonded flash spun web made of continuous filaments to form a spunlaced nonwoven fabric. The flash spun web may optionally be bonded to increase the level of permeability of the nonwoven fabric. Disclosed as end uses for the nonwoven fabric are filtration applications, and bulky, dust proof and barrier liners for garments, sleeping bags, pillows, comforters and the like.

### 1.3.2. Wet wipes

Wet wipes have various applications such as facial wipes, baby wipes, hand and body wipes, cleansing wipes, feminine hygiene wipes medicated wipes and antibacterial wipes. Beside the use of dry wipes, it is becoming increasingly frequent to use wet wipes for the purpose of cleaning. Wiping material of this type is pre-packaged in a moist environment and is commonly used by consumers for cleansing or wiping parts of the body, particularly when wash water is not readily available or cannot be conveniently used. These wipes have been used for applying or removing makeup or in cleansing other parts of the body. Wet wipes have a fibrous structure, generally of thick calliper, impregnated with a composition usually water or oil based.

#### Basic requirements of wet wipes:

- They must have sufficient wet strength to resist tearing and puncturing during use.
- They must have sufficient wet thickness and wet toughness.
- They must easily and readily disintegrate within the disposal systems and preferably, when disintegrated.
- They must be totally biodegradable (Joann et al., 2003).

### 1.3.3. Basic composition of a wet wipe comprises of

- An emollient which improve the glide of the wipe on the skin and to hydrate the residues thus reduce in dryness and irritation.
- A surfactant and / or an emulsifier are employed to emulsify the emollient or any other non water soluble oils present in the composition.
- A rheology modifier which is used to increase the viscosity of the composition at lower temperature as well as at process temperature.
- Preservative in order to reduce the growth of microorganisms and to enable a longer shelf life.
- Soothing agent to reduce the irritation or stinging/burning/itching effect of chemicals (George et al. 2005)

### 1.3.4. In comparison to dry toilet paper, wet wipes have several benefits (Figure 2 & 3)

- The enabling of a better lubrication during the use of wipe, reducing the abrasiveness of the cleansing operation.
- The hydration of the residues, enhancing their removal from the skin.
- The hydration of the skin tissue.
- The ability to deliver a soothing lotion to the skin that can remain on the skin after the cleansing operation (James Joseph et al. 1994)

### 1.4. Global demand for dry/wet wipes

Pre-moistened or wet wipes are normally supplied to the consumer already wet or pre-moistened with a liquid, while the dry wipes are supplied dry, with the understanding that the consumer will add a liquid if needed. In 2009, wet wipes contributed around 71% of the total wipes market. Over time, dry wipes are predicted to gradually gain market share, growing from 29% in 2009 to 30% in 2014 (Pranay Bhaskar Sahu, 2012).

### 1.5. Classification of wipes categories

Based on applications where the wipes are used it is been classified into three categories viz ;

- Personal Care wipes
- Household and home cleaning wipes.
- Industrial cleaning wipes.
1.5.1. Personal Care wipes

Personal care wipes are the wipes generally used next to skin, they are of baby wipes, cleansing pads, pain relief wipes, personal hygiene wipes and pet care wipes.

i) Baby wipes:
Baby wipes are wet wipes used to cleanse the sensitive skin of infants. These are saturated with solutions anywhere from gentle cleansing ingredients to alcohol-based “cleaners.” Baby wipes are typically sold in plastic tubs that keep the cloths moist and allow for easy dispensing (Figure 4).

ii) Cleansing pads:
Cleansing pads are fibre sponges that have been previously soaked with water, alcohol and other active ingredients for a specific intended use. There are different types of cleansing pads offered by the beauty industry: makeup removing pads, anti-spot treatments and anti-acne pads that usually contain salicylic acid, vitamins, menthol and other treatments. Cleansing pads for preventing infection are usually saturated with alcohol and bundled in sterile package. Hands and instrument may be disinfected with these pads while treating wounds. Disinfecting cleansing pads are often included in first aid kits for this purpose (Figure 5).

iii) Pain relief wipes:
These are pain relief pads sopping with alcohol and benzocaine. These pads are good for treating minor scrapes, burns, and insect bites. They disinfect the injury and also ease pain and itching.

iv) Personal hygiene wipes:
These are usually pre-moistened and come either individually packaged or in one larger container that can be resealed. These kinds of wipes can be useful when you’re doing outdoor activities, especially during warmer weather. The wipes can remove dirt and sweat before they settle into your pores. Some no-rinse wipes can even remove waterproof makeup (Figure 6).

Methods of making personal hygiene wipes:
- Providing a nonwoven wipe, comprising a single fibrous batt where upon the single fibrous batt is entangled by the application of hydraulic energy to form a highly entangled outer surface region and a lightly entangled inner core region; and
- A cleansing composition comprising an effective amount of a cleansing surfactant, said aqueous liquid cleansing composition being coated onto or impregnated into said substrate to the extent of from 50% to 500% by weight of the substrate.

v) Pet care wipes:
Today one can find even wet wipes for pet care, for example eye, ear, or dental cleansing pads (with boric acid, potassium chloride, zinc sulfate, sodium borate) for dogs, cats, horses, and birds.
1.5.2. Household & home cleaning wipes
Household wipes can be of kitchen wipes, bathroom wipes, food service wipes, glass surface cleaning wipes, automotive care wipes etc (Figure 7).

1.5.3. Industrial cleaning wipes
When it comes to industrial applications, choosing the right wipe for the job can make an enormous difference in terms of performance, efficiency and economy. Rags and laundered cloths were once the all-purpose solution for wiping dirt and oils from equipment and hands (Figure 8). Convenient disposable wipes are now widely recognized as the preferred alternative (Pranay Bhaskar Sahu, 2012).

1.6. Category wise Market for wipes
The role of wipes plays a major role in the personal care category as the product fulfills most of the requirement in that particular category. The Market of wipes according to the category is as shown in the figure 9 (www.edana.org).

1.7. Raw materials for wipes
Wood Pulp: It is the main raw material for the wetlaid sector. Wood pulp is also used in spun lace – composite / hybrid processes such as “Spun-Pulp-Spun” SPS or “Spun-Carded-Spun” SPC. It is also favorites for “airlaid paper” (short-fiber based) technologies.

Polyester: It is by far the most common fibre for carded technologies. As per the application and wipes categories the blend percentage varies. Normally the Industrial wipes are made from 100% Polyester. It is estimated at nearly 43% of the fiber consumed in spun lace.

Viscose: It is another common fiber for wipes, especially for personal care. Personal care wipes are used on very sensitive parts – baby care, facial wipes etc. It has to be very soft, smooth and silky. Viscose fiber has all these properties and because of these properties viscose fiber is referred as “art silk” in the textile industry. Nonwovens industry producers have been working on developing wipes that will flush. To create a flushable nonwoven product, the right combination of strength, easy break up and dispersion is required. To be considered truly flushable the wipe must also be biodegradable. Wipes made from viscose fibers have all these properties and thus can be categorized has flushable products. Household wipes are generally made up of polyester and viscose blended fibers, polyester being the major component.

Cotton: Environmental consciousness combined with price increases and shortages in competing materials have created a strong market opportunity for cotton in the nonwoven industry during the past two years, particularly in the wipes market where the addition of cotton can boost absorbency and strength. Cotton has been enjoying a place in the private label baby wipes market, viscose continues to be a dominant fiber in most spunlace applications, despite a global supply shortage that has driven up prices (Ravishankar Gopal, 2005).

Nonwoven fabrics used as wipes also contain blends of rayon as the absorbent component, and hydrophobic fibres made of synthetic polymers, such as polyester, polypropylene, acrylic and/or nylon. Fibres with 4DG (deep-grooved) geometry have excellent absorption properties due to their three times higher specific surface area in comparison with conventional circular fibres; therefore, they are used in medical wipes and other applications requiring higher levels of liquid absorption.
The possibility of utilizing needlepunched as well as spunlaced fabrics in wipe applications has been explored in a number of studies. The performance of 100% cotton open-end spun and ring spun yarns in conventional towels demonstrated the possibility of employing both for wipe applications. The majority of nonwoven wipes are manufactured from the blends of viscose, polyester fibres or other fibres using different bonding techniques, such as needlepunching, stitch bonding, chemical and thermal (Vera Soukupova et al., 2007).

1.8. Fabric Technologies for wipes
Many nonwoven technologies are employed to produce wipes such as spunlaid, wet laid, airlaid, needle punch technology, carded wipes and spunlace technology. The world wide wipe production and consumption based on the technology is shown in the figure 10.

- 74% of all roll goods for wipes are produced by spunlace or airlaid technology.
- At the converting level, lotion is added and now a wet product is produced
- Given the high transportation cost of wet wipes, the industry is still present in the main geographies in Europe, Asia and US and is predicted to stay regional (www.inda.org).

Commercially, hydro-entangled fabrics or spunlaced fabrics are used for wipes have been produced for a long time. The soft, strong, flexible and in most cases, absorbent characteristics of the fabrics combined with increasingly attractive economics and a textile like handle have brought hydro-entanglement to the fore in this sector (Chellamani et al. 2013). One of the earliest applications was replacements for woven gauze in products such as laparatomy and x-ray detectable sponges. The wipes industry is now remarkably diverse encompassing hygiene (e.g., baby wipes), personal care, facial cleansing and make-up removal, food service, industrial and household cleaning products. In last five years air-laid thermal bonded wipes have been increasingly substituted by hydro-entangled fabrics because of their softer handle, good strength and low thickness (Russell, 2006). Initially, wet wipe products were made of traditional non-woven materials based on paper making technology (pulp based products). These products were well accepted but deficient in softness of the fabric material. The introduction of the ‘spunlace’ non-woven technology offered products that, compared to traditional paper based products, were superior in terms of softness. This is mainly due to;
- The use of long soft fibres (most frequently rayon and polyethylene terephthalate/polypropylene or a mixture of these fibres) in the spunlace process.
- The fact that during the spunlace process no binder is added to the fabric (Harry, 1984).

1.9. Recent advancement
The following gives a detailed description of recent advancement in wipes

1.9.1. Novel Nonwoven Decontamination Wipe
A well-integrated design of a non-particulate and non-irritant decontamination system and barrier protective and breathable chemical protective fabrics can provide necessary individual protection against toxic chemicals and chemical warfare agents. The Institute of Environmental and Human Health, Texas Tech University have developed a cotton-based non-particulate decontamination wipe that can effectively absorb the bulk toxic chemical agent as well as retain the off gassing vapours. In order to maximize the chemical absorptive and adsorptive capabilities of the decontamination wipe and to ensure next-to-skin comfort, they have designed the protective composite substrate so that the material is composed of at least three layers
1. Top layer (cotton)
2. Middle adsorbent layer
3. Next-to-skin layer (cotton)

The manufacturing of the three layered cotton-based composite material was carried out using H1 needlepunching technology in the Nonwovens and Advanced Materials Laboratory at The Institute of Environmental and Human Health, Texas Tech University. H1 needlepunching technology from Fehrer®, now known as Oerlikon Neumag Austria GmbH, has a contoured needle zone. This technology has been effectively used to develop value-added needlepunched nonwoven products from natural fibers and its blends (Figure 11).

Fabrication of Nonwoven decontamination wipes
For the manufacturing of the above nonwoven composite fabric, the nonwoven ACN-K (Nonwoven Activated Carbon Fabric K) was placed between the two nonwoven bleached cotton fabric layers manually. The base substrate fabrics constitute the top and the bottom layers of the three layered composite protective fabric, whereas the ACN-K forms
the middle adsorbent layer. This arrangement of ACN-K sandwiched between two nonwoven bleached cotton fabrics was needlepunched to a single composite fabric using the contoured needlezone needlepunching machine while maintaining the same machine parameters as the base substrate. This process resulted in fiber entanglement between the nonwoven cotton fabrics and the ACN-K fabric. Thus the final product was a structurally, well integrated, three layered fabric material with the ACN-K layer covered by two nonwoven bleached cotton layers.

**Novel Features and Superior Characteristics of Nonwoven Decontamination Wipes**

- The three-layered decontamination wipe will be flexible, drapable and soft.
- The decontamination wipe will be “next-to-skin” friendly, which is extremely important for personnel/human body decontamination.
- The decontamination wipe due to its flexibility will be able to follow the shapes and contours of intricate parts of human body and equipments.
- The top and bottom layers of the decontamination wipe provides the necessary structural coherence and enhanced strength
- The nonwoven adsorption wipes will have improved adsorption characteristics due to needle-punching which will also increase the overall porosity of the wipe
- The active adsorbing sites of the middle activated carbon adsorbent layers are not masked by the top and bottom layers as the three layers are needle-punched together which basically will enhance the porosity and surface area.
- The use of needle-punched top and bottom layers enhances the adsorption and filtration efficiencies due to the availability of pores and free fibers
- This is an important difference between the currently available rigid wipes that use polymer films that mask the active adsorption sites of the middle activated carbon
- The decontamination wipe has phenolic resin based activated carbon as the middle adsorbent layer that has superior properties such as flame retardancy than the cellulosic activated carbons
- The three-layered decon wipe will have improved mechanical strength and abrasion resistance
- The nonwoven technology is highly productive that enables the mass production of wipes at reduced production costs (Seshadri et al., 2013)

**2. CONCLUSION**

Nonwovens are heart of the medical and hygiene sector and it is a part of medical textiles, which find applications predominantly in disposable and health care sectors and it will be playing vital role in coming decades in technical textiles. Nonwoven wipes plays a tremendous role in this scenario as they serve multi-purposes such as house hold wipes, industrial wipes and other personal hygiene care and also fulfil the needful required in each category. Spunlaced wipes being the major constituents of wipes while viscose and polyester fibres being the most common fibres used worldwide as discussed in the paper. There will be an increasing role of wipes in future.

**REFERENCES**

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