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Conference Paper · October 2021

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ABSTRACT

A wet wipe, also known as wet tissue, is a moistened nonwoven cloth mainly used for cleaning purposes. It is a personal hygiene product under the medical textiles arena. Wet wipes are soft and hence widely used as baby wipes, facial wipes, and so on. They are usually made with fibers like cotton, viscose, polyester, polyethylene, etc. The substrate selection for the wet wipe is based on durability and cost. The wet wipes commercially available are either disposable or flushable which make them easy to use. But a major disadvantage is that the synthetic fibers are non-biodegradable and lead to micro plastic pollution. Also, the chemicals used in finishing may be harsh on skin causing irritation, allergies, etc. To overcome this herbal finished eco-friendly wet wipes are preferred. This paper discusses the effects of synthetic wet wipes and the use of natural fibers and herbal extracts in making sustainable wet wipes.
Keywords— Bamboo, Viscose, Eco-friendly, Herbal Oils, Wet wipes

INTRODUCTION

Medical Textiles is one of the fastest growing sectors of the global Technical Textile industry. The Med tech industry had a market size of around 16 to 17 billion US$ in 2019 and is expected to grow @ CAGR of 4.5 to 5.0% with 23 to 24 billion US$ in 2024-25. Healthcare and Hygiene products is an important category of Medical Textiles that includes products like surgical covers, drapes, cloths, blankets, sheets, incontinence diaper, wipes etc. The market segmentation is 15% for woven, 20% for knitted while 65% for non-woven fabrics. Hygiene products remain by far the most important area of application (32%) of nonwovens.

Wipes are disposable cloth treated with a cleaning agent. Wipes are of two types: wet wipes and dry wipes. A wet wipe or a wet towel or a moist towelette is a pre-moistened non-woven fabric used for cleaning purposes like personal hygiene and house hold cleaning One of the main advantages of the wipes is the convenience in using a wipe i.e. quick and easier than alternative dispensing a liquid. Some of the wipes are harmful to skin as they contain alcoholic agent and MCI (methylchloroisothiazolinone). Regular use of wet wipes leads to the problem of dark spots, allergic reaction, pimples, acne, dry skin and rough on the face. The reaction of chemical treated wet wipes on the face is too much that harms the sensitive skin. Another great option is to use eco-friendly biodegradable wet wipes with herbal finishing.

The global wet tissue and wipe market size is projected to reach USD 17980 million by 2026, from USD 16830 million in 2020, at a CAGR of 6.3% during 2021-2026 (1). The global baby wipes market reached a value of US$ 4.1 Billion in 2018. The market value is projected to reach US$ 5.1 Billion by 2024, exhibiting a CAGR of 3.4% during 2019-2024 (2). The global

personal care wipes market is projected to grow at the rate of 5.4% during the forecast period 2018 to 2023 (3).

II COMPONENTS OF WET WIPES

A wet wipe is made of two main components

- Absorbent fabric
- Wetting solution

The absorbent fabric is made of natural or synthetic fibers or their blends. The various substrate materials and their properties are given in Table 1.

TABLE 1

SUBSTRATE MATERIALS FOR WET WIPES

Substrate Material	PROPERTIES
Cotton	Soft on skin, good absorbency add water retention properties
Viscose	Very soft, great absorbency and strength properties, absorbency and strength properties
Polyester	Good strength
Wood Pulp	High surface area and flat ribbon-like morphology which gives them good cleaning and absorbency properties
Polypropylene	Good Strength
Polyamide	Better feel ,softer and more flexible fibers,
Polyethylene	Low-Density, very flexible material
Polyvinylalcohol	Strong, flexible
Blends like Polyester/ viscose, flax/ viscose, *Cotton/ Lyocell, etc.*	The resultant web possesses the properties of both the fibers in the blend.
Bicomponent fibers are also used.	
Fibers like Linen, Jute, Silk, Ramie, and Hemp may also be used.	

A. NON-WOVEN FABRICATION METHODS

The four main types of Non-woven fabrication methods and non-woven fabric properties are shown in Table 2.

TABLE 2 NON WOVEN FABRICATION METHODS

Methods of fabrication	Properties of the non-woven fabric

Spunbond / Spunlace	Melting of raw material, formed in to filaments then laid as a web, to be bound together by using heat rollers and embossing.
Airlaid	Stables fibers, possibly along with certain powers, resins or thermally fusible, low melting fibers. Not involved carding
Drylaid	Utilized for stable fibers, natural and synthetic or blends, relatively slow and more expensive method. Application of pre-moistened wipes.
Wetlaid	Short length, intra and intra fiber cohesiveness or adhesion to form of continuous web. Not recommended for long fibers.

Among the above types spun lace is the most commonly used method for non-woven making for wet wipes.

B. WETTING SOLUTION FOR WET WIPES

The wetting solution used in wet wipes may consist of chemical like hydro alcohols, emulsions or oils. They may include alcohol, binder, softener, surfactant, pH bu ering material (organic and inorganic acids), emulsifier, silicone oils, perfumes (aleo vera, cinnamon, lemon leaves, lavender, chamomile, etc.), mineral powders, antibacterial agents, and their combinations. Lotions and medicines may also be applied on wet wipes (4).

III. RESEARCH ON WET WIPES

Absorbent Fabric	Wetting Solution	Outcomes	Reference
Spun lace nonwoven 100% Tencel 70/30% Tencel/ Viscose 50/50% Polyester/ Viscose 60/40% Polyester/ Viscose 80/20% Polyester/ Viscose 100% Polyester	Rose water Olive oil Rose water + 3 g/l Sodium alginate + 0.5Molar Geraniol Olive oil + 3 g/l Sodium alginate + 0.5Molar cinnamaldehyde # No preservative has been used.	The highest antibacterial activity was obtained with Olive oil + 3 g/l Sodium alginate + 0.5Molar cinnamaldehyde. 60/40% Polyester/ Viscose fabric was the most preferable one by subjective and objective evaluation.	Kaplan, S et al., 2018

Double layer non-woven with inner elastic web of melt blown ethylene vinyl acetate microfibers and outer non-elastic web of spun bonded polypropylene microfibers	Fragrances, preservatives, soaps, humectants and emollients	Disposable wet wipes which may be utilized for purposes of infant hygiene.	Jackson, D. M et al 1988
100% Bamboo nonwoven fabric	Ocimum tenuiflorum (Tulsi) leaf extract + Syzygium aromaticum (Clove) extract + 2% citric acid and 2% ferrous sulphate + Rose water	The product exhibited antimicrobial and fragrance properties.	Devaki, E et al., 2019
75/25% Cotton/ Lyocell nonwoven fabric	Aloe vera + Lemon grass oil	The product exhibited antimicrobial, moisturizing and deodorizing properties.	Ahmed, H. A. M et al., 2011

IV FLUSHABLE WET WIPES

Flushable wipes, some of the disposable nonwoven products, are used as moist tissues, baby wipes, personal hygiene wipes, adult incontinence wipes, and cleaning wipes. The flushable wipes market is growing rapidly, and it is expected that the worldwide sales will double to $2.7 billion by 2020. Which can be completely disintegrated and dispersed into sewage systems, are some of the disposable nonwoven products. A truly flushable wipe should be biodegradable, dispersible, and compatible with water treatment systems. Flushable wipes can be produced by selecting appropriate materials and production technologies. The flush ability performance of these products is quite important with regard to the environmental pollution (8).

Premoistened, flushable, disposable and biodegradable wet wipes was developed and granted a patent (U.S. Patent No. 5,629,081) the present invention provides a pre–moistened, dispersible, and biodegradable wet wipe comprising a web of non-woven fibers contacted with a PVOH containing binder. The binder contacted web future comprises an aqueous lotion solution comprising from about 0.1 to about 0.9 percent by weight of the lotion of boric acid and from about 5 to about 8 percent by weight of the lotion of an alkali metal bi carbonate. The

resulting wet wipe has a ph between 7 and about 9 and a wet strength between about 8 and about 20 (9)

Flushable hard surface cleaning wet wipe according to the present invention there is provided a wet wipe comprising substrate that has tensile strength of at least 5 N/inch and which is biodegradable. In a further aspect, the present invention provides a flushable wet wipe comprising a Substrate having a loading factor of at least 1.5 grams of cleaning composition per gram of Substrate and which is biodegradable. The wet wipes is suitable for cleaning hard Surfaces, especially lavatories and is flushable (10).

Absorbent, flushable, bio-degradable, medically-safe nonwoven fabric with PVA binding fibers, and process for making the same an absorbent, flushable, bio-degradable, and medically-safe nonwoven fabric suitable for use as wraps, wipes, absorbent pads, etc., is composed of from 2% to 10% by weight of untreated, water-soluble polyvinyl alcohol (PVA) fibers that are heat-bonded to a matrix of absorbent fibers. The use of PVA fibers in low amounts provides softness, while sufficient wet strength is provided by heat bonding the PVA fibers completely to the other fibers in a two-stage heating process. The resulting nonwoven fabric has a high wet-to dry tensile strength ratio, good drape softness, and high fluid absorptive capacity. In a method for producing the non-woven fabric, the PVA fibers are blended with the absorbent fibers, the blended fibers are carded onto a moving web, sufficient water is added to wet the PVA fibers while maintaining web integrity, then the web is heated in two stages, the first with heating cylinders at 40° C. to 80° C., then the second with heating cylinders of 60° C. to 100° C. The fiber web may also be hydroentangled and patterned for enhanced strength and textural properties (11)

Flushable moist wipe or hygiene tissue includes a hydraulically entangled nonwoven material impregnated with a wetting composition. The non-wove material contains at least 70% by fiber weight, pulp fibers and at least 5%, by fiber weight manmade fibers and/or natural fibers with a length of at least 6mm.the moist wipe or hygiene tissues includes at least two plies of the hydraulically entangled nonwoven material, each ply having a basis weight between 30 to 50g/m2 and the plies are held together by frictional forces without additional mechanical bonding like embossing, needling and hydro entangling and without adhesive (12).

V SUSTAINABLE WET WIPES

Nitrogen/sulphur co-doped porous carbon derived from wasted wet wipes as promising anode material for high performance capacitive potassium-ion storage hard carbon as a promising anode material for potassium-ion batteries (PIBs) has attracted growing attention due to its unique structural features and expanded interlayer compared to graphite. Nevertheless, the electrochemical performance of hard carbon for PIBs remains unsatisfying, which will drive the researchers to explore new approaches to enhance the specific capacity and rate capability of hard carbon. Herein, we explore a low-cost, facile and environmentally friendly strategy for the synthesis of N/ S-codoped porous hard carbon (NSPC) via pyrolyzing the wasted wet wipes (13). Confining ferric oxides in porous carbon for efficient lithium storage with the increasing demand for clean and renewable energy, high-energy and power-density energy storage devices with the environmental and sustainable merits are highly needed. Herein, a convenient and sustainable approach was developed to construct 3D porous multi-component composites. The 3D Fe/Fe3O4/carbon composites were successfully derived from daily-used wet wipes.Developing eco-friendly, sustainable, high-performance electrode materials for electrochemical energy storage applications (14).

VI BIODEGRADABLE WET WIPES

Disposable, Biodegradable, Wax-Impregnated Dust Cloth was developed and granted a patent (U.S. Patent No. 5,599,550) the invention to a disposable dust-cloth. The cloth is part of a dry natural fiber material that is a soft open-pored puffy pulp paper, in colours ranging from light to white, with a filler fraction of less than 10%. The biodegradable wax which has hardness that prevents its shearing off from the natural fiber material. The wax is a natural wax of plant or animal origin, preferably carnauba or bee waxes, or a synthetic or a chemically modified wax, preferably paraffin, oxidized polyethylene wax or hydro genized jojoba oil. Wax content 25-50 g/m^2 and wax melting point in range of 60-85 degree C (15)

Biodegradable wipe utilizing bio-based lubricant comprising refined soybean oil was developed and granted a patent (U.S. Patent No. 8,071,524 B2) biodegradable lubricating wipe. The wet wipes typically being fibrous sheet materials, pre-moistened with a solution for improved lubrication and/or protection of an area. In one embodiment the solution is comprised of a bio-based lubricant, a bio-based solvent and water. In one embodiment, the Solution is comprised of mineral spirits and refined soybean oil. In another embodiment the solution is comprised of Soy methyl ester and refined soybean oil. In yet another embodiment, the fibrous sheet material of the invention is biodegrade able and the solution portion breaks down into a vaporizing component and a biodegradable carrier portion (16)

Studies on the Properties of Biodegradable Wipes made by the Hydro entanglement Bonding Technique Nonwoven fabrics for household wipe applications were produced using the hydro entanglement bonding technique. Polyester/viscose and flax/viscose fibers are blends. Four ratios of blending PET/ flax fibers (0%, 10%, 30%, 50%) The wipes were compared their physical and mechanical properties, Tensile strength and elongation properties, both in the dry and the wet states, the liquid absorption characteristics of wipes were tested. The flax fibers can be successfully utilized for developing household wipes due to their good absorption characteristics and higher tensile strength and satisfactory durability (17).

VII CONCLUSION

Most of the wet wipes commercially available and abundantly used by people today are made of synthetic fibers moistened with chemicals. Only few brands use biodegradable fibers and some are flushable wet wipes that degrades in the water. Wet wipes finished with pure herbal extracts are only at the research stage and not being commercialized. Both the manufacturers and consumers need to be made aware of the necessity for sustainable wet wipes for the benefit of the current consumers and the future environment.

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