SYNOPSIS OF Ph.D.

TITLED

DEVLOPMENT OF ECO FRIENDLY SANITARY PRODUCT

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IN
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GUIDE

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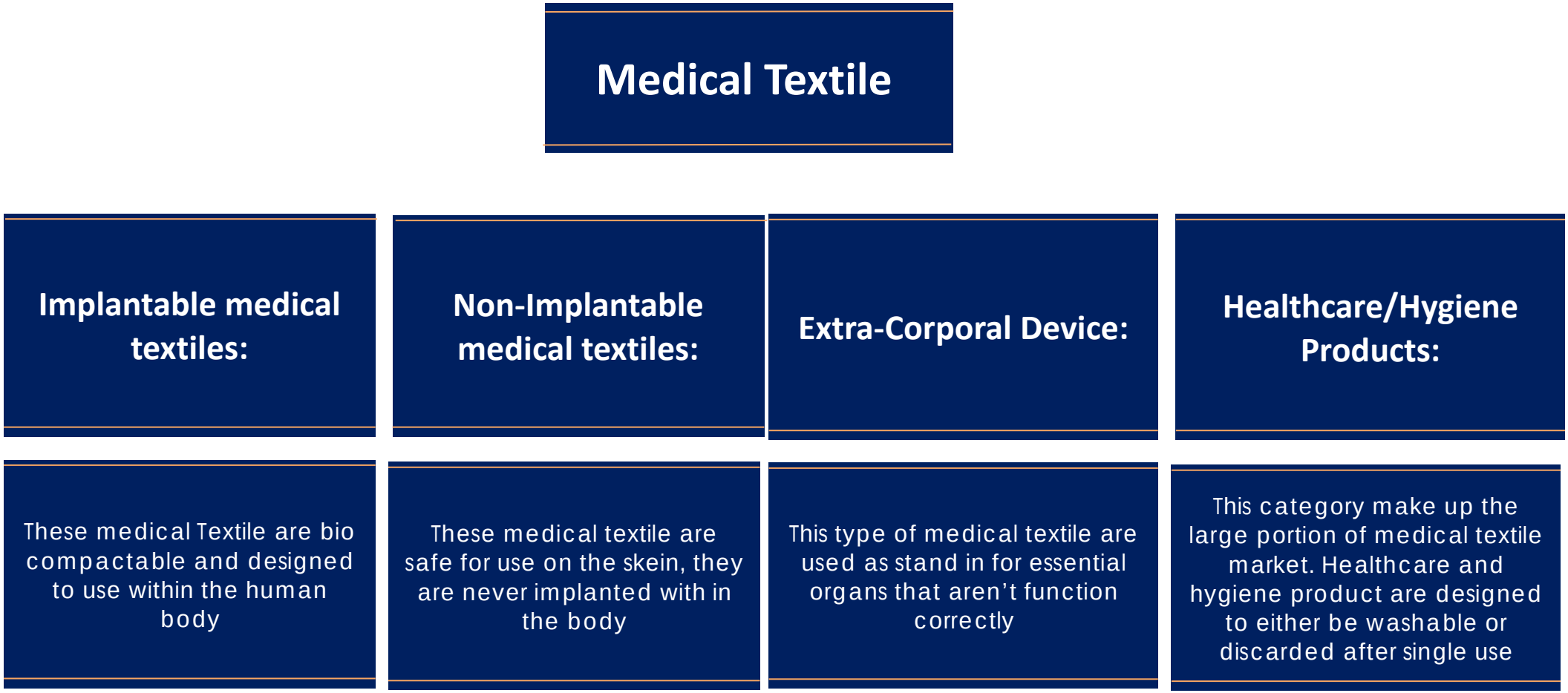
SYNOPSIS

1. Introduction

A textile is a woven or knitted fabric made of yarn. According to the definition of technical textiles, they are materials and goods created primarily for their technical and performance qualities rather than their aesthetic or decorative qualities. One of the segments of the technical textile market that is growing the fastest is medical textiles, which concentrates on fiber-based goods used in health care applications like prevention, care, and hygiene. [1] The medical, healthcare, and hygiene industries constitute a significant and expanding segment of the textile industry. Applications for materials range from basic cleaning wipes to cutting-edge barrier textiles used in operating rooms. In operating room conditions, new, cost-effective methods of preventing bacterial, viral, and bodily fluid intrusions are being developed to safeguard both hospital workers and patients. Medical textiles are defined as, 'the type of technical textiles which offer variety of technical and functional properties having applications in the field of medical and clinical care and are manufactured primarily for their technical performance and functional properties rather than their aesthetic or decorative characteristics'.

One of the main growth markets in the high-performance technical textiles and clothing sector is thought to be medical textiles. It is undeniably influencing the development of novel, enhanced high-tech materials and procedures, which is resulting in fresh technical responses to pressing issues. Technical production procedures, finishing techniques, and a wide variety of technical fibers and polymers are all used in the creation of medical textiles. [1, 2] Due to increasing consumption in Western markets and expanding Asian nations, medical textile growth rates will be above average by 2020. [3] Particularly for non-woven materials and medical textile disposal in the operating room, the future for medical textiles is significantly improved. Therefore, sophisticated and high-performance fiber-based goods and structures produced for use in a range of medical and wound applications are referred to as medical textiles. Medical textiles include items like surgical gowns, bandages, wound dressings, artificial ligaments, liver, kidney, and lung transplants, sutures, vascular grafts, artificial joints, contact lenses, artificial cornea, etc. The use of textiles in the medical, applied healthcare, and hygiene industries is a significant and expanding component of the textile industry. [4, 5]

Classification of medical textiles:



Non-implantable: These products are used as external applications on the body and may or may not be in contact with the skin. This type of medical textile should be non-toxic, non-allergenic and non-carcinogenic. There are many more products such as wound dressing, absorbent pads, wound contact layers, gauze pads, bandages, plasters, lint, etc. used as non-implantable fibrous materials [3,5].

Implantable: These types of products are used in effective repairing of the body whether in wound closure and surgery replacement. Artificial Tendon, Artificial Ligament, Artificial Skin, Artificial Bones/joints, Artificial Cornea, Vascular Grafts, Heart Valves, Artificial Tendon etc. are examples of implantable fibrous materials. [1, 3]

Extracorporeal: These are synthetics organs (i.e., artificial organs), which are designed to replace and support the function of some vital organs such as kidneys, liver, and lungs. They are actually mechanical devices, used for blood purification that incorporate textile technology. The artificial kidney is responsible for filtering the unwanted waste materials as a normal kidney will do. [1, 3]

Healthcare and Hygiene Products: The range of applications of these products is vast and varies from the care and safety of healthcare staff/patients. Protective clothing, PPE, caps, gowns, surgical masks, bed sheets, curtains, baby diapers, sanitary napkins, etc. are examples of healthcare and hygiene products. [4]

Chapter 1: Introduction

Sanitary Napkins:

“Sanitary Napkins” is known as sanitary pads, sanitary pads, sanitary towels, or maxi pads, which form an important part of the gynecological hygiene of every woman. Sanitary Napkins are absorbent disposable single-use products designed to receive, absorb, and retain menstrual fluid and isolate them from the rest of the body. [8] It is worn externally, between the vulva and a woman's undergarment. It is a form of a porous item that has the capability of soaking the flow of blood. Hence, menstruating women wear them during their periods. Some women also prefer using them while recovering from vaginal surgeries, childbirth, or abortion. Sanitary napkins are made by inserting an absorbent pad between fabric sheets. The technical textile component of the sanitary napkin is the non-woven fabric which prevents leakage of menstrual discharge. [10]

The Sanitary napkins market in India has so far been dominated by multinational companies like Procter and Gamble, Johnson and Johnson Ltd., and Kimberly Clark Lever Pvt. Ltd. The last few years have seen Indian manufacturers also entering this space. Brands such as Stayfree and Carefree from Johnson & Johnson Ltd. and Whisper from Procter & Gamble cover close to 85-90% of the sanitary napkins market. The remaining market is shared by Kimberly Clark Lever’s brand Kotex and Gufic Biosciences’ brand

Shapers. Each of the domestic companies such as Royal Hygiene Care, Actifit India Pvt. Ltd., Dima Products Pvt. Ltd., and Kaul Impex. Pvt. Ltd. has a small share of the market. At the global level, some of the major players are Procter & Gamble, Hengan International Group Company Limited, Kimberly-Clark Corporation, Edgewell Personal Care Company, and Kao Corporation. [9]

According to a new report published by ResearchAndMarkets, "Global Feminine Hygiene Products Market (2021 to 2027) " the global feminine hygiene products market is expected to garner revenue of US$ 38.9 billion in 2020. Therefore, for this analysis, the estimated global sale of feminine hygiene products will be US$ 68.7 billion in 2030. Registering the CAGR of 6.1% from 2021 to 2030. [11]

Chapter 2: Literature survey

3.1 History of Sanitary Napkins:

Menstrual pads have been mentioned in history as early as the 10th century in Ancient Greece, where a woman is said to have thrown one of her used menstrual rags at an admirer in an attempt to get rid of him. Before the disposable pad was invented, most women used rags, cotton, or sheep's wool in their underwear to stem the flow of menstrual blood. Knitted pads, rabbit fur, and even grass were all used by women to handle their periods. [12]

Mid of the 18th century, Intrepid creates much wide variety of products patented like catamenial sacks, bandages as well as flaps, elastic straps, valves, and girdles. In 1873, the Comstock act was passed in the United States, and for birth control industry coined the term "feminine hygiene". By the end of the 18th century, 1896, Lister's Towels, the first commercial sanitary pad manufactured by J&J went for sale. During the world war, nurses in France realized that the cellulose bandages used soldiers, and absorbed blood much better than plain old cotton. Now they state their flow the first pads were made from wood pulp bandages by nurses in France. It was highly absorbent and cheap, thrown away after use. [13, 15]

Beginning of the Nineteen century, KCC invented the combination of cotton and texture, preparing the disposable pads. Kimberly Clark mentioned the Kotex on their head. This thing for consumers not to use the word "menstruation". Similar products introduced by J&J developed Medess in 1927. Modess Print campaign was released and turned into Menstrual advertising into a showcase for high couture and fashion photography in 1940. Early Twentieth Century, Countless American women used homemade pads, often rigged out of "bird's eye," the same absorbent cotton material used for baby diapers. They would pin these cloths, or rags, to their underwear or homemade muslin belts. In the year 2003, FDA approved the first continuous birth control pill, which both suppresses periods and provides birth control. Women taking Seasonale have just four menstrual periods a year. [15,16]

2007: Lybrel is approved by the FDA, the first birth control pill to eliminate periods. That being said, the

Web site freely admits that women may experience “menstrual cramps and vaginal bleeding.”

Even sanitary napkins were available at an earlier time but are expensive for the majority of women and they continued with the earlier old-style method. When they would be afforded it, women were allowed to put place money in the box so that they would not speak to the person and take napkin box KOTEX pad from the reception counter themselves. These things require several years for disposable sanitary pads to become commonplace. [15]

Earlier disposable sanitary napkins were made from cotton, wool, or the same fibrous rectangle covered with an absorbent liner. Form front and back sides of the pad are extending so fit through in the loops in a special belt worn beneath undergarments. This design was infamous for moving forward and backward in the future position. [18]

Later on, an adhesive strip was placed on the back side of the sanitary pad for easy sticking with panties and this become the preferred method with women. The belted sanitary napkins readily disappeared in 1980, thank goodness

In form, the past two decades, the sanitary napkin manufacturing industry has done much-advanced research by leaps and bounds. Long belts and thickness pad days are gone. With the invention of highly absorbent materials and improved designs, sanitary napkins are more comfortable and practical than ever. The invention of “wings” keep the pad in place in the underwear, and the prepared “scented pads” reduce the odors. Sanitary napkins are the most widely used form of the menstrual cycle, particularly in developing countries. [23]

Chapter 3: MATERIALS AND METHODS

The different types of fibers and other components that go into creating liquid-sorbent nonwoven fabric are covered in this chapter. Additionally, preparation methods for spunbond, air-through, and spunlace nonwoven fabrics without functional change are covered. Additionally, a thorough description of evaluation methods for each material is provided. [25,26]

This chapter goes into detail about the various materials used for sanitary napkins, the methods for processing fibers, the techniques for converting processed fibers into nonwoven structures, the techniques for processing nonwovens to add eco-friendly and value-added functionalities to improve the comfort of sanitary napkins, the methods for preparing sanitary napkins, and the techniques for fabricating a performance analysis tester for sanitary napkins. [17,18]

Top Sheet:

- Spunbond-type of nonwoven fabric is processed as follows: extrude and stretch the polymer to form a continuous filament, laid the filament into web, then process the web into nonwoven fabric through their own bonding, thermal bonding, chemical bonding or mechanical reinforcement

methods.

- Through air bonding is a type of thermal bonding that involves the application of heated air to the surface of the nonwoven fabric. During the through air bonding process, heated air flows through holes in a plenum above the nonwoven material. Bulky, Open, Soft, Strong, Extensible, Breathable, Absorbent.
- Polyethylene – Perforated poly top sheet, special for the Dry comfort type of sanitary napkins.
- Laminated top sheet: PE – Perforated Poly and nonwoven are laminate to gather and making sanitary napkins.

Cake Material:

- Untreated Fluff Pulp
- Bamboo pulp
- Banana Fibre

Back Sheet:

- PE – Poly ethylene Back sheet
- Breathable back
- Super breathable back sheet
- Biodegradable Natural corn polylactic acid fiber

SAP

- Japanese SAP Powder.
- Biodegradable SAP Powder.

• In the next phase, the outer coverstock of the sanitary napkins was subjected to various eco-friendly finishes to improve its comfort and performance. This phase includes a novel feature of thermal bonded non-woven preparation. [27]

• The third phase involves the preparation of super absorbent polymers from agro-waste fibers.

• In the fourth phase, a novel sanitary napkin performance tester was designed and fabricated.

Further to this, the components prepared in the first three phases of the research were assembled together to develop sanitary napkins. The fabricated performance tester was used to analyses the performance of the developed sanitary napkins.[32,33]

Chapter 4: Preparation of Different type of Sanitary napkins

1) PP spun bond top sheet, Sanitary Napkins with PE back sheet [27,37]
2) PP air through nonwoven Top sheet, sanitary napkin with PE back sheet – cottenly feeling[28]
3) PE – Perforated Poly – Top sheet, Sanitary napkin with PE back sheet – Dry type
4) PE- Perorated Poly – Top sheet, ULTRA napkins with PE back sheet – ULTRA DRY
5) PLA – corn type top sheet – with White biodegradable corn PLA back sheet [29]
6) Organic cotton top sheet – with biodegradable back sheet – fluff pulp [30,31]
7) Etc…..

Chapter 5: Method of testing the Napkins (LAB Practical Testing)

- TESTING METHOD TO MEASURE ABSORBTION TIME AND REWET OF FEMPAD ABSORBENCY TEST [Absorbency Rate (Sec)] & REWET TEST [Rewet (gm)]
- TESTING METHOD TO MEASURE ADHESIVE RESIDUE OF FEMPAD
- TESTING METHOD FOR pH TESTING
- TESTING METHOD TO MEASURE SEAL STRENGTH OF FEM PAD [Seal Strength (gf) (Front, Back, OS & DS)]
- PEEL ADHESION (gf)

Testing of Parameters

The primed napkins after UV Sterilization were tested by the researchers who developed the product and the results were good and then the samples were distributed to others.
Parameters Observation
Absorbance capacity 25 ml of goat blood was absorbed when flowed on the center of the napkin.

- To measure the absorbency of sanitary napkins

Tests are conducted on absorbents by subjecting them to liquids. If they can soak adequately without leaking, they are accepted to be good.

IS 5405 (1980)

- To measure the peel adhesion of sanitary napkins [34]

Peel adhesion measures the force required to remove a pressure sensitive adhesive from a testing plate or its own backing material. One industry standardized test to take these measurements is ASTM D1876: Standard Test Method for Peel Resistance of Adhesives (T-Peel Test).
There are other tests and modifications of those tests. The critical thing to remember is that it's possible to quantify the relative peel resistance of adhesive bonds in a way that is repeatable.
To measure the seal strength of sanitary napkins.

ASTM F88/F88M-15

- To measure the adhesive residue of sanitary napkins.

When a tape is removed from a temporary application, the goal is to leave the surface as clean as possible. For instance, when a protective film is applied to an automobile part, it should pull up without leaving any ghosting or adhesive left behind. Aesthetics are vitally important.
In a medical application, let's say pressure sensitive tape that's applied to skin, what's important is both how well it resists falling off and how little trauma to the skin will occur when it is removed. If there's a slight residue left, it's not important; it's simply washed off.
If the goal of the application is simply to create a permanent or even semi-permanent bond, the residue isn't as important because these surfaces aren't meant to be separated. Peel adhesion provides insight

into the amount of residue left behind once the adhesive is removed.
Factors that determine if residue is left behind:

• Type of adhesive used (and its strength)
• Cohesive strength; is it stronger than the adhesion?
• What substrates you're sticking to
• Application temperatures

- To lay down the procedure for perform pH testing.

(Clause 7.1 of IS 5405:2019) (IS 1390 (cold method) [34]
Sanitary napkins should have neutral pH values; they should neither be acidic nor alkaline. For that, they are tested to determine their pH value. Testing sanitary napkins on these parameters according to IS 5405 can ensure they fulfil their purpose without leaking and without causing any discomfort or irritation.

Chapter 6: Physical testing

Varieties of Sanitary Napkins Prepared and Performance analysis of prepared for the sanitary napkins.

Prepared the result table with physical testing as well as practical testing of the product by above given methods and prepared the testing table for the respective sanitary napkins.

Physical Testing

Pad Weight (gm)

Bulk Thickness (mm)

Pad length Center

Pad Width (Front & Back)

Core Length

Core Width Center

Core Width (mm) (Front & Back)

Wing Release Paper (width) (mm)

Wing Release Paper (Length) (mm)

Mid Release Paper Length & width (mm)

SAP Paper (mm)

MRP Adhesive (Length & Width) (mm)

Wing Adhesive Length (mm)

LAB Practical Testing

- TESTING METHOD TO MEASURE ABSORBTION TIME AND REWET OF FEMPAD ABSORBENCY TEST [Absorbency Rate (Sec)] & REWET TEST [Rewet (gm)]
- TESTING METHOD TO MEASURE ADHESIVE RESIDUE OF FEMPAD
- TESTING METHOD FOR pH TESTING
- TESTING METHOD TO MEASURE SEAL STRENGTH OF FEM PAD [Seal Strength (gf) (Front, Back, OS & DS)]

- PEEL ADHESION (gf)

Chapter 6: Result & Discussion

According to the findings of the sanitary pad usage survey, a woman generally uses at least 3 pads every day. Every four weeks, an average menstruation lasts between 3 and 7 days. Average usage per year is equal to 3 x 5 x 12 (daily usage times average period of time times months). Since there are 7 pads in a packet, the total is 180, or 25 packets yearly
According to current government data. 689,791,917 total girl's population in India. There are total 64.9% are come in the age between 15-65 age ranges. From which 44,76,74,954 are thought to be reproductively active. It is found that a pad normally weighs roughly 7gm when the dry weights of tested popular pads are used to calculate the average weight. Consequently, a lady would consume at least 1260 grammes (1.26 kilograms) of sanitary napkins in a year. [24]

One regular sanitary pad can take up to 500 to 800 years to decompose, whereas these natural biodegradable pads start decomposing within the year of use. Here we prepared the 3 different type of sanitary napkins with natural biodegradable materials, which was decompose in soil in one year. The physical and mechanical properties of prepared Sanitary Napkins structure were evaluated. The properties of Absorbency Rate (Sec) & Rewet (gm), Adhesive residue test, pH test and seal strength and peel adhesion test carried out with respective sanitary napkins composition.

Chapter 8: Conclusion

Every solution is contained inside nature.

The usage of natural fibres in hygiene products will make them more environmentally friendly. Here in my research paper comparison between old types of Sanitary Napkins which was made by me in 2019 and comparison with updated raw material for the sanitary napkins 2022 which was prepared by me and guidance by my guide.

In Earlier Sanitary Napkins manufacturing process, more than 50% raw materials are non-biodegradable like it will take around 250 to 800 years to decompose. Top sheet - (PP nonwoven), Back sheet – (Polyethylene), glue - (Hot melt), easy tape - (PET base), SAP powder (Sodium polyacrylate). Now a day's majority all Raw materials are biodegradable and environment friendly. Easy to degrade with soil and sun rays once contact with them.

Sanitary pads made of natural fiber will add on the value and be more sue free for the environment. In order to leave the next generation with a better society, we as technologists need to develop a sustainable solution.

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