

# **Characterization and Analysis of Sanitary Pads**

By

**Umayal.PI**

**(17PTF021)**

A Thesis Submitted To The  
Avinashilingam Institute For Home Science and Higher  
Education for Women  
Coimbatore-641043

**In partial fulfillment of the requirement for the degree of  
MASTER OF SCIENCE IN TEXTILES AND FASHION APPAREL**

**APRIL, 2019**

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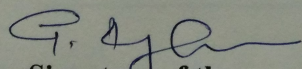
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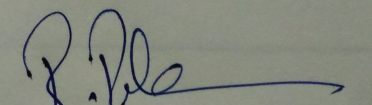
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Certified As Bonafied Research Work

  
Signature of the

**Head of the department**

  
Signature of the supervisor

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# ***Introduction***

# 1. INTRODUCTION

In our day to day life, we all are approaching sustainable way; it has become very important for human beings to live in the world of hygiene and freshness. The awareness of health and hygiene has two functions- one protecting the wearer and another one is biodegradation of the textile materials. An important area of textiles is the healthcare and hygiene sector among other medical applications. The range of the product includes surgical clothing, surgical drape, surgical gown, surgical covers, bedding, incontinence diapers, sanitary napkins and clothes/ wipes. Sanitary pads are designed to absorb and retain menstrual fluid discharges. The main requirements of sanitary pad are stop leak aging; prevent odor, absorbency, comfort and safety. The feminine hygiene napkins have three types' thick sanitary napkins, ultra thin sanitary napkins and panty liners, [Dinakaran.et.al. 2017].

Medical textiles are defined as those textiles that are used in healthcare settings for variety of medical applications. The extent of growth is due to the development and improvement of knowledge in textile as well as medical sector, [Rigby et al, 2009].

An important and growing part of the textile Industry is the medical and related healthcare and hygiene sectors. A textile has always been a part of healthcare. The range of products available is vast but typically they are used in the operator theatre or on the hospital ward for the hygiene, care and safety of staff and patients. The number of applications range from the simple cleaning wipe to the advanced barrier fabrics used for operator rooms. An unorganized sector of manufacturers has been catering largely to the third and the biggest segment of the healthcare and hygiene products.

Manufactures of textiles for medical applications known the challenges and the need to develop new cost-effective ways to protect both hospital staffs and their patients from bacteria; viruses and body fluid invasions in operator room environments have occupied research labs and testing facilities for the last few years, [Anita et al., 1997].

The use of textile materials for medical and health care products can be classified into following main areas: Barrier material, Bandaging and Pressure garment, wound care material, Hygiene material, Implantable material and extra corporal devices etc. The main requirements of textile material for medical applications they are biocompatible, good resistance to alkalis, acids and micro-organisms, good dimensional stability, elasticity free from contamination or impurities, absorption/ repellency and air permeability , [ Anita et al., 1997].

The constituent element of medical textile products for medical applications include materials as fibers, yarns, woven, knitted and non woven etc..., Depending upon the usage, they

are classified into four types: non implantable medical textiles, Implantable medical textile, Extra corporeal medical textiles , healthcare and hygienic medical textiles , [ Akter et al ., 2014].

Non implantable medical textiles constitute one of the most dynamic research field's characteristic of technical textiles and its range of applications. Textiles used in biological systems to estimate, treat, increase or regenerate a tissue, organ or function of the body. These materials used for external applications on the body and may or may not make contact with skin. This includes wound care, bandages, plasters, Pressure garments, orthopedic belts etc.,

Implantable medical textile used inside the body for effecting repair to the body. Types of implantable medical textile vascular grafts, hernia mesh, sutures, heart valves, heart patch, and rotator cuff repair devices and anterior cruciate ligament. Soft tissue implantable :( cartilage, ligaments), orthopedically implants/ Heart tissues: Made of non-woven material, Thickness- 13 to 30 mm, Cable/ braided materials are used and Polyethylene tera sulphate, [Rajendran et al., 2006].

The extra corporeally mounted devices used to support the function of vital organs, such as kidney, liver, lung, heart pacer etc. The extracorporeal devices are mechanical organs that are used for blood purification and include the artificial kidney (dialyser), the artificial liver, and the mechanical lung. The function and performance of these devices benefit from fiber and textile technology, [Rajendran et al., 2006].

The purpose of the protective health-care garments is to protect health care professionals from contamination by blood and other infection fluids. This product includes operating and emergency room textile caps, gowns, barrier products, breathable membranes masks etc... The requirements from medical protective textiles are it should prevent infective material from passing through the skin, last long enough, affordable, comfortable and effective, [Rajendran et al., 2006].

Disposable textiles are textiles used in or as apparel for functional applications, designed to be disposed off after use. They are bound by "use and throw" concept. Disposable nonwovens are those nonwovens for short life applications in single use including hygiene, medical, consumer wipes, industrial wipes and others. Hygiene nonwovens include baby diapers, training pants; adult diapers (adult incontinence) and feminine care products (external and internal). The external feminine care products include sanitary napkins and pads. The internal feminine care products refer to tampons, [Rasigha et al., 2012].

Textile materials are gradually taking on more important. The hygiene textile is one of the fast growing segments in medical textiles. Most of these hygiene products are disposables or single time usable product. These products are mainly made up of nonwoven structure. The

hygiene textile products are used in medical textiles includes in the following: Wipes, Baby diaper, Adult diaper and feminine, [Rasigha et al., 2012].

In this study, sanitary pads characteristics evaluation was taken and compared with the branded sanitary pads available in the market are quality fiber analysis, determination of pH, determination of absorbency and ability to withstand pressure after absorption, flexibility of the sanitary pads, water retention and disposability. Among all the evaluation, determination of pH, FTIR and SEM analysis and liquid strike through characteristics of different commercially available sanitary pads are most important. Since it is directly and indirectly contacts with skin of feminine hygiene pads.

The pH testing Indian standard was adopted by the Indian standards institution on 31 October 1983, after the draft finalized by the chemical methods of test sectional committee had been approved by the textile division council. This standard first published in 1961, has been revised to align it with ISO 3071-1980 'Textiles-Determination of pH of the aqueous extracts' issued by the International organization for standardization.

This standard prescribes methods for determination of pH value of aqueous extracts of textiles. The methods are applicable to textile in any form (fibers, yarns or fabrics) provided, that a small representative sample may be obtained which is in or may be reduced to, a form which permits a ready exchange of liquid between the interior of the material and the water used in preparing the extract, [Textile standards, 1988].

The pH testing there are two methods of preparation of aqueous extracts have been prescribed in this standard. For kier-boiled or scoured and bleached textile materials which have not been finished, pH values of aqueous extracts prepared by the cold method and by the hot method would be the same. Hence pH testing there are any one of the methods may be followed. However, the finished or proofed fabrics; in such cases pH values of cold extract as well as hot extract should be separately determined. pH testing is a process of analyzing the acid, neutral and basic of solution. pH test is the main factor to give comfortable for wearer. pH test should be in acidic or alkaline property of the sanitary napkin leads to severe skin dermatitis. So, all the sanitary napkin should have pH in the range of 6 to 8 suitable to the human skin, [Zhao et al., 2005].

Liquid strike through test is the main factor to keep the skin dry. Poor liquid transport property of the pads leads to severe skin dermatitis. So, the entire pads should have good liquid transport, [Kendall et al., 1974].

This test method measures the strike through time (i.e.) the time taken for a known volume simulated saline solution applied to the surface of a test piece of top sheet, which is in contact

with an underlying absorbent pad, to pass through non-woven and it is measured electronically by liquid strike through time according to EDANA/ INDA standards WSP 70.3 and WSP 70.7, [Textile standards, 2012].

### **Scope and Objectives of project work:**

The scope of the project is to evaluate the performance characteristics of the commercially available sanitary pads.

The objective of the present work is to evaluate and understand the dynamics of the sanitary napkins top layer that determines the amount of the liquid permeation through it and also evaluate the pH of these as separate core and sanitary pad as a whole and understand the properties affecting the same. The detail description of the present project work is as follows

- To select suitable test methods for commercially available sanitary pads for comfortness.
- To study the characteristic spectral analysis of sanitary pads.
- The samples are evaluated by determination of pH, FTIR and SEM analysis and liquid strike through characteristic of different commercially available sanitary pads.

## ***Review of literature***

## **2. REVIEW OF LITERATURE**

Reviews of literature for the present study on “**Characterization and analysis of sanitary pads**” are discussed under the following headings:

### **2.1 Hygiene Textiles**

### **2.2 Sanitary Pads**

2.2.1 History of sanitary pads

2.2.2 The main components of sanitary pads

2.2.3 Characterization of fabrics in sanitary pads

2.2.4 Potential problem of sanitary pads

2.2.5 Structure of sanitary pads

2.2.6 Performance characteristic of sanitary pads

2.2.7 Choice of raw materials

2.2.8 Properties of sanitary pads

2.2.9 Advantages of sanitary pads

2.2.10 Disadvantages of sanitary pads

2.2.11 Uses of sanitary pads

2.2.12 Tests to evaluate performance

### **2.3 pH test**

2.3.1 History of pH test

2.3.2 Skin surface pH

2.3.3 pH testing method

2.3.4 Importance of pH test

2.3.5 Advantage of pH test

2.3.6 Disadvantage of pH test

2.3.7 Characteristic of pH test

2.3.8 Uses of pH test

## **2.4 Liquid strike through test**

2.4.1 History of Liquid strike through test

2.4.2 Reasons to use liquid strike through test

2.4.3 Importance of liquid strike through test

2.4.4 Characteristic of liquid strike through test

2.4.5 Advantage of liquid strike through test

## **2.5 Fourier Transform Infrared Spectroscopy**

2.5.1 History of FTIR spectroscopy

2.5.2 Main components of FTIR spectroscopy

2.5.3 Advantage of FTIR

2.5.4 Disadvantage of FTIR

2.5.5 Application of FTIR in textiles

## **2.6 Scanning Electron Microscope**

2.6.1 History of SEM

2.6.2 Importance of SEM analysis

2.6.3 Advantage of SEM

2.6.4 Disadvantage of SEM

2.6.5 Application of SEM

2.6.6 Uses of SEM analysis

## **2.1 Hygiene textiles:**

The hygiene textile is one of the fast growing segments in medical textiles. Most of these hygiene products are disposables or single time usable product. These products are mainly made up of nonwoven structure. The range of products available for healthcare and hygiene is vast, but they are typically used either in the operating theatre or in the hospital wards for hygiene, care and safety of the staff and patients. They could be washable or disposable, [Ajmer et al., 2006].

The hygiene products include both disposable and non disposable products mainly used in hospitals such as

- Wipes
- Baby diaper
- Adult diaper
- Sanitary pads
- Tampons
- Incontinence products

## **2.2 Sanitary pads:**

In our day to day life, we all are approaching sustainable way; it has become very important for human beings to live in the world of hygiene and freshness. The awareness of health and hygiene has two functions- one protecting the wearer and another one is biodegradation of the textile materials. An important area of textiles is the healthcare and hygiene sector among other medical applications. The range of the product includes surgical clothing, surgical drape, surgical gown, surgical covers, bedding, incontinence diapers, sanitary napkins and clothes/ wipes. Sanitary pads are designed to absorb and retain menstrual fluid discharges, [Kumar, 2007 et.al].

A growth rate of over 18% to 20% is expected in India for the sanitary pads market, which holds a huge potential and excellent profit margin for the manufacturers. Today, the global market for absorbent hygiene products is over US \$ 50 billion. The evolution of hygiene products in Europe and the North America has taken 4 to 5 generations. Feminine care was introduced over 100 years ago. Baby diapers were invented 60 years ago. Adult incontinence products appeared 30 years ago. Feminine hygiene (Lady Napkins) is hygiene absorbent products engineered to absorb and retain body fluid without causing any leakage. The user should always feel dry and comfortable.

The menstrual cycle starts for young women between the ages 11-17, frequently around 12-13 years. On average a woman experiences a period every 28th day, 12-13 times in a year. A menstrual period normally lasts 3-7 days. The loss of fluid in a period is on average half a cup or

65-80 ml. The menstrual pattern is influenced by giving birth and contraceptive methods. Menstruation lasts until menopause at the age 45-55. The feminine hygiene products market has evolved over more than 100 years. The main requirements of sanitary pad are stop leak aging; prevent odor, absorbency, comfort and safety. The feminine hygiene pads have three types' thick sanitary napkins, ultra thin sanitary napkins and panty liners.

Today disposable menstrual pad are dominating the market as they are worn during a woman's period to absorb her menstrual flow and then disposed away. Nowadays incontinence pads have different variation depending on the manufacture and these include.

- a) Panty Liner: Designed to absorb daily vaginal discharge, light menstrual flow, "spotting", slight urinary incontinence, or as a backup for tampon use.
- b) Ultra Thin: A very compact (thin) pad, which may be as absorbent as a regular or maxi/super pad but with less bulk.
- c) Regular: A middle range absorbency pads.
- d) Maxi/Super: A larger absorbency pad, useful for the menstrual cycle when menstruation is often heaviest.
- e) Night: A longer pad to allow for more protection. While the wearer is lying down, with absorbency suitable for overnight use.
- f) Maternity: Usually slightly longer than a maxi/ super pad and are designed to be worn to absorb lochia (bleeding that occurs after childbirth).

The shape, absorbency and length may vary depending on manufacturer, but usually range from the short slender panty liner to the larger and longer overnight and they can either reusable or disposable, [ Nyoni et al, 2011 ].

### **2.2.1 History of sanitary pads:**

Sanitary pads have been in use as early as the 10<sup>th</sup> century. These pads were made of soft material to absorb menstrual discharge. In ancient period women often used a variety of home-made menstrual pads, old cloths, grass, or any other absorbent materials they consider in a specific way to suitable for menstrual management. The very first disposable pads were thought up by nurses, looking for new methods to stop excessive bleeding, particularly on the battlefield. The first pads were made from wood pulp bandages by nurses in France. It was very absorbent, and cheap enough to throw away afterwards. Disposable sanitary pads were first commercially available from around 1896 created by Johnson Company. The Kimberly Clark Company put kotex on the market in 1921. These disposable absorbents were extended front and back so as to fit through loops in a special griddle or belt worn beneath undergarments. [Figure-1]

The first major improvement in disposable sanitary pads came around 50 years later. After the technology developed and started to manufacture thinner pads. It can be made of cotton wool mixed with special polymer crystals designed to absorb liquid. Once liquid enters pads, the

polymer crystals absorb it turning it into a gel-like substance and trapping it inside. The next step was the development of more comfortable and safer products. In the 1990, the industry created a innovations such as wings on maxi pads with wraparound edges that fold under to fit multiple panty style. Nowadays, Women use different methods for menstrual management and these include modern disposable sanitary pads, tampons, cloth menstrual pads and other alternatives, [Nyoni et al., 2011].

### 2.2.2 The main components of sanitary pads:

The main components of a modern sanitary pad include the following:

- i) **Top Layer:** External layer of a sanitary towel and has direct contact with the skin. It is commonly made from a very thin non-woven fabric and the top sheet is designed to transfer fluid quickly from the top sheet to secondary layers, hence maintaining a dry feeling on the body surface.
- ii) **Absorbent core:** Absorbent core and acts as the blood storage layer. It has to absorb the blood as fast as it is received and has to allow distribution of the liquid through the structure so that the whole core is utilized.
- iii) **Barrier sheet:** It protects clothing and surrounding areas from being stained or wetted by fluids retained in a pad or absorbent core. It is typically made of breathable polyethylene film or a non-woven film composite that prevent wetness transfer out of the sanitary napkin, [Nyoni et al., 2011]. [Figure-2]

### 2.2.3 Characterization of fabrics in sanitary pads:

At their core, fabrics are characterized across a number of dimensions. The ASTM lists hundreds of standards ranging from material performance, tolerance, identification of fibers, thermal resistance, and many more, [Textile standards, 1996]. Weaves are defined according to their warp and weft (the longitudinal versus transverse threads), their thread or yarn, and their ends per inch for tightness, [Kawabata, 1988] define 16 standards to characterize the hand, or the “feel “of the fabric. The yarns are further measured according to a set of various units such as the denier (mass density), super S number (fineness of fiber), etc [Collier, 1970]. Given the immense amount of variation possible, this study is restricted to materials that are available in the market for less than the equivalent of 1 USD per meter in rural Zambia. In particular, the material properties that this study seeks to optimize are narrowed to those that would be most relevant to successful pad design. Summarizes the requirements for an effective design, including the need to absorb and retain discharge, be in contact with the user without irritating skin, and a high wicking and fluid-retaining interior with a waterproof exterior. In addition, high porosity, tolerance to salts, low linting, and comfort are necessary. In a reusable design for the Developing

world, this study adds to this list durability (which would influence sustainability and affordability of a final product) as well as rudimentary drying time. The latter is included because a significant problem for the application is that, even if women and use and wash pads, it is inadmissible to dry them in public and therefore materials requiring minimal drying time are optimal. For this study, materials are tested specifically to maximize, affordability, absorbance, durability and reusability, comfort, and drying time, [Gupta, 2014].

### **Absorption:**

Absorption is characterized in both the speed of uptake and the amount of liquid that the material can hold, and is dependent on both material properties and organizational structure. In addition, particle size, relative composition, and orientation may influence a material's absorptive ability, [Gudmundsdottir et al, 2009] measure the average total menstrual flow in the West (substantially lower in developing countries where nutrition levels are much lower) as approximately 51g during a menstruation period. Many studies quantify the absorption of fabrics through different measurements, [Demir et al., 2009]; for example, use the water absorption value (ratio of mass of material when saturated with water over mass of dry material) and drying time to determine the effectiveness of super absorbent fibers. Professor Steven Warner at the University of Massachusetts, Dartmouth [Personal interview, Feb 2014] discusses the rate of vertical wicking as critical to measuring speed of uptake, as well as the contact angle in order to measure wetting.

### **Comfort:**

The measure of fabric quantities comfort as a performance through a series of sixteen measurements that define handle judgment, essentially the "feel" of a fabric. [Kawabata, 1988] These measurements have standardized an objective measure for the "hand" of fabrics. These parameters include include koshi (related to bending stiffness), numeric (smoothness), "fullness and softness", shari (crispness), and hari (anti-drape stiffness), [Behera et al, 1997] and [Radhakrishnan et al, 1993] use Kawabata's fabric evaluation system to measure the tactile and thermal comfort properties of spun yarns and woven fabrics respectively, using a standard Instron tensile tester to measure tenacity and breaking, [Bagherzadeh et al, 2007] measures comfort properties for Spacer fabrics through quantifying air and water permeability, fabric bending, compression, and surface characteristics [Ibrahim et al ,2010] and [ Kane et al ,2007] measure the comfort of cotton fabrics and jerseys, respectively, through assessing air permeability, heat transmittance, hydrophilicity, and water absorbance.

## **2.2.4 Potential problem of sanitary pads:**

### **Hygiene risk:**

Improvisation led to introducing SAP to increase absorbency, they began to be made of Polypropylene (PP)-based perforated top sheet and polyethylene sheet as barrier. This improved its functionality. These products have a particular quality harmless, but they may be laced with dioxins, petrochemicals, GMO (Genetically Modified Organisms) and fragrances. When these

chemicals are contact with the sensitive skin, tissue may get irritated. Dioxins are carcinogenic in nature hence the risk of cancer increases even at very low levels of exposure. Additives such as fragrances, deodorants, absorbency agents, urea and formaldehyde enhance the properties but can cause allergies and skin reactions.

### **Disposability:**

Polymers in sanitary pads are non-biodegradable material. This may create many serious problems. Disposable sanitary pads cause occupational hazards for waste pickers who use their bare hands to sort out garbage. This is a health hazards. The common practice is to use a disposable sanitary pads releases dioxins and furans, creating environmental hazards.

### **Affordability:**

In developing countries, the price of sanitary pads is often prohibitive for most of the population. About 70 per cent of Indian women still cannot afford sanitary pads and use unhygienic rags. In a 2012 study by Cheryl Nakata and Kelly Weidner on diffusion and adaptation of sanitary pads to the target group, it was found that according to the household incomes influence the usage of sanitary napkins. The reason behind its cost is the fact that most of the material used is imported from developed places. This ultimately increases the cost of the product, [Barman et al., 2016].

## **2.2.5 Structure of sanitary pads:**

There are four functional components of a sanitary napkin: (i) fluid acquisition layer (ii) distribution component (iii) absorbent structure (iv) liquid impervious membrane.

(i) Fluid acquisition layer: A lot of R and D have been done to keep the top surface dry so that it does not cling to the body and fits comfortably. This layer is a perforated film which allows liquid to pass through it quickly into the absorbent structure and stays dry, since the fluid is entrapped in the structure. It thus reduces the chance of leakage.

(ii) Distribution component: This component spreads out the fluid, especially in the longitudinal direction, for better utilization of the product. By spreading fluid, it increases the probability of more retention of fluid.

(iii) Absorbent structure: One of the main characteristics of sanitary pads is to absorb body fluid and retain it for a long period of time and avoid back flow under pressure.

(iv) Liquid impervious membrane: This is the last layer. It acts as a barrier to prevent fluid from leaking, [Barman et al., 2016].

### **2.2.6 Performance characteristic of sanitary napkin:**

Liquid flow through the interface among these three components (top layer, absorbent layer and barrier film) and mainly within the absorbent component is the key factor in deciding the performance of a sanitary napkin. To understand the working principle of sanitary napkins we have to consider the flow path of fluid through each layer of a sanitary pad.

As fluid comes vertically in contact with the first layer, it moves across the fluid acquisition layer to the absorbent layer without spreading in the facing layer. Once fluid reaches the absorbent layer, it spreads and can be held without reversing flow direction.[Figure-3]

The first problem in sanitary pads is the interface between acquisition layer and absorbent layer. The acquisition layer is mainly made up of hydrophobic fiber and the absorbent layer is composed of hydrophilic fiber so the fluid must get readily transferred from acquisition layer to absorbing medium. Transfer of fluid from one layer to other will fail if there is not enough intimate contact between the two layers. Any gap will alter the pattern of flow and liquid may spill and lead to failure of the product.

Almost all sanitary pads use fluffed cellulosic pulp as the core component of the absorbent material. This fluff is prepared by defibrillation of unopened compressed cellulosic boards. There is always a chance of some amount of unopened board which gives heterogeneity to the absorbent material. Therefore, uneven flow and retention of fluid will be different from the rest of the area.

Performance of sanitary pads can be evaluated on fluid retention capacity or the amount of fluid sustained after applying pressure. One factor which affects fluid retention is density. Modern commercial sanitary pads are made from super absorbent fiber used in compressed and uncompressed form. Density significantly influences the absorption and stability of the product. A highly compressed fiber will expand on absorption whereas in case of lightly compressed fiber, it will collapse as a result of absorption. So compression of absorbent material is necessary to maintain its structural integrity, [Barman et al., 2016].

### **2.2.7 Choice of raw materials:**

i) Fluid transfer layer: Transfer fluid quickly from the top sheet to secondary layer. The fluid transfer layer contains thermoplastic fibers to prevent capillary collapse of this layer. Commercially available top sheet are made up of polypropylene fiber. Organic cotton as top sheet is one the commonly advise raw material for sanitary napkin because of its non irritant, skin friendly and superior liquid. It is soft and breathable which gives comfort and dryness. Recently lenzing have come up with a new fiber called tencel bio soft which is a lyocell fiber.

Fully biodegradable and hydrophobic in nature with extra softness that make it an excellent choice to be used as fluid transfer layer.

ii) Acquisition and distributing layer: Absorbent core cannot absorb fluid immediately, so this layer imbibes the fluid, drawing it away from the point of discharge, distributes it laterally and holds it for the core to absorb. It is generally made up of thermally bonded or air bonded composite non-woven.

iii) Absorbent layer: It is interposed between top sheet and barrier layer main function is to absorb and retain the fluid. Absorbent core need to be thin, soft and pliable. The core layer is made up of wood pulp. Constant effort to replace it by air laid wood pulp and sap to improve its absorption efficiency. SAP turns the absorbed liquid into a jelly like state so that it would not rack back. Bamboo fiber is a novel alternative raw material for absorbent core. Bamboo absorbs wicks water 3-4 times better than cotton and reduces odor to the fiber is filled with multiple micro-holes and micro-gaps. Bamboo is soft to feel as the fiber is naturally round in shape. It does not require any chemical treatment to smoothen it. An additional significant property of bamboo is the anti-microbial agent that is bamboo Kun naturally present in it.

The jute fiber was used to substitute cotton pad. It was found that jute fiber is one of the best replacements for cotton as healthy production of jute in eastern India facilitates this fiber with 65-70% cellulose content and high water affinity. Jute is have low price than cotton fiber and abundant in north-east of India. Banana fiber were developed by she( sustainable health enterprises) a non-profitable NGO, their intention was to make affordable, quality and eco-friendly sanitary napkins available to girls and women to developed country. The studies have been done to replace cotton fillers by flax spinning waste to be used as an absorbent core of sanitary napkin. To further improve the absorbency of sanitary pad cellulose based hydro gel were manufactured to imitate synthetic super absorbent polymer by a sustainable process using a non toxic cross linking agent. Main advantage of cellulose-based hydro gel over current SAP is that they are environmentally friendly, biodegradable and excellent biocompatibility.

iv) Barrier sheet: It seals the fluid from staining or leakages. The barrier sheet is a breathable but fluid impermeable film made up of polyethylene. Polyethylene or polymeric films used as a barrier sheet remain intact as this polymer are inert and are not broke down by bacteria and thus pollutes the environment. Widely used protective film in hygiene products are polyethylene and polyurethane, which are non-biodegradable plastic. Non absorbent fiber such as polypropylene, ethylene etc..., is derived from petroleum resources. Which have high carbon footprint and non-biodegradable in nature. An alternative sustainable replacement of petroleum based fiber is the PLA (poly lactic acid) fiber, which is derived from corn starch using latest biotechnology. The drawback at present is the high cost of synthesis of this high molecular weight PLA that is 5-6 times more than conventional plastic. The use of natural fiber in sanitary pad will reduce the cost of the product will lower accessible to low income group women, [Barman et al., 2017].

### **2.2.8 Properties of sanitary pads:**

- It has good absorbency capacity
- No leakage
- Prevent odor
- Comfortable to wear
- Hygiene
- Stay in place
- No unaesthetic appearance or color

### **2.2.9 Advantages of sanitary pads:**

- It has good absorbency capacity
- Comfortable and safety to wear
- Excellent fineness and softness
- Prevent odor
- It has good breathable characteristic

### **2.2.10 Disadvantages of sanitary pads:**

- Sanitary pad prevents skin from breathing, so they can irritate the skin or deteriorate vaginitis, if used constantly.

### **2.2.11 Uses of sanitary pads:**

- Sanitary pad is used to make an important area of textiles in the healthcare and hygiene sector among other medical applications.
- Sanitary pads are used to absorb and retain menstrual fluid discharges.
- Sanitary pads have been used according to the customer need reusable or disposable pads.

### **2.2.12 Tests to evaluate performance:**

The varieties of sanitary napkins major brand were evaluated in terms of the physical parameter.

#### **1. Quality fiber analysis:**

The fiber analysis of the selected sanitary napkin was done layer wise, using the standard AATCC test methods. Preliminary identification was done using a light Microscope; the longitudinal view of the fibers was viewed under the microscope. Chemical analysis of each layer was done to confirm the nature of fibers. Solubility tests were conducted to identify the

cellulosic fibers and type of synthetic fibers. Melting Point process was used to identify the type of Polyolefin fiber, viz. Polypropylene and Polyethylene.

Scanning Electron Micrographs (SEM) of the pulp fibers of regular type napkins was prepared to ascertain the nature of cellulose fiber used.

## 2. Determination of pH

The pH of sanitary napkins was tested using the aqueous extracts of the samples by the cold method. The ISO 3071-1980/IS1390 specification for sanitary napkins, specifies the test method for testing pH of a sanitary napkin.

## 3. Determination of Absorbency and ability to withstand Pressure after Absorption:

This test was conducted as per the IS: 5405-1981. The time taken for the fluid to get completely absorbed by the napkin and the area of the spread of the fluid was noted. The sides and back of the napkin were observed for any fluid leaking through after placing a one Kg weight on it.

## 4. Water retention:

The measurement of water retention was done by the standard ASTM Centrifuge method. Each prepared specimen was immersed in distilled water at room temperature for 5 minutes to completely wet it out. For ultra thin napkins the immersion time was for 2.5 minutes. The centrifuged specimen was weighed, dried and reweighed. Water retention was calculated and reported as a percentage of the dry mass.

## 5. Liquid strike through test:

A drop of test solution is allowed to fall on the sample and the time taken for the solution to transport from the upper layer of the napkin to the inner layers of the sample. This is measured by observing the drop closely so that the dull wet spot is seen on the wet area of the sample. All samples should be conditioned for 24 hours before the tests, [barman et al, 2016].

## **2.3 pH Test:**

pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water. Water that has more free hydrogen ions is acidic, whereas water that has more free hydroxyl ions is basic since pH can be affected by chemicals in the water, pH is an important indicator of water that is changed chemically. [Plate-1]

The surface pH of healthy skin will vary widely between different body sites, as a good indicator of diverse microenvironments and, for instance, if the skin has been soiled, exposed to sweat, or occluded. The pH may range from 4 to 7, where a pH of 4.6 is normal on the forehead Compared with pH 7 in the interregional skin between the toes. Body regions that are more humid and/or have higher bacteria densities are usually linked to an increased pH. Rigger once pointed out that there is no “normal pH” for the skin because the skin is not an aqueous solution. When measuring the pH of the skin, it is the water-soluble constituents that generate the recorded value. For a correct measurement of skin surface pH, it is recommended to follow certain practical operating procedures. Care must be taken in identifying the skin site, healthy controls, the time of day, and the environmental conditions, [Bo Rune man, 2008].

Absorbent products should firstly be appreciated for their primary functions. If they function well with low adverse effects, they are most likely contributing to good skin health, maintaining a “normal” pH value. There is no doubt that the pH value is fundamental in controlling biochemical and enzymatic activities in the epidermis and is indicative of skin health, but the pH of absorbent products is probably not always as decisive for the skin as some marketers and consumers would like to believe, [Bo Rune man, 2008].

The pH testing there are two methods of preparation of aqueous extracts have been prescribed in this standard. For kier-boiled or scoured and bleached textile materials which have not been finished, pH values of aqueous extracts prepared by the cold method and by the hot method would be the same. Hence pH testing there are any one of the methods may be followed. However, the finished or proofed fabrics; in such cases pH values of cold extract as well as hot extract should be separately determined.

pH testing is a process of analyzing the acid, neutral and basic of solution. pH test is the main factor to give comfortable for wearer. pH test should be in acidic or alkaline property of the sanitary napkin leads to severe skin dermatitis. So, all the sanitary napkin should have pH in the range of 6.5 to 8.5 suitable to the human skin.

### **2.3.1 History of pH test:**

The pH testing Indian standard was adopted by the Indian standards institution on 31 October 1983, after the draft finalized by the chemical methods of test sectional committee had been approved by the textile division council.

This standard first published in 1961, has been revised to align it with ISO 3071-1980 ‘Textiles-Determination of PH of the aqueous extracts’ issued by the International organization for standardization.

This standard prescribes methods for determination of pH value of aqueous extracts of textiles. The methods are applicable to textile in any form (fibers, yarns or fabrics) provided, that a small representative sample may be obtained which is in or may be reduced to, a form which permits a ready exchange of liquid between the interior of the material and the water used in preparing the extract , [Textile standards, 1988].

### **2.3.2 Skin surface pH:**

The pH 900 pH meter was used with a Mettler- Toledo 304 flat electrode. The probe was cleansed with de-ionized water before each measurement and the last drops were kept on the electrode to provide a wet state on the skin during measurements. A waiting period of approximately 30 sec was maintained before the reading was recorded. Accuracy of the pH meter is 0.1 units. The instrument was calibrated each day with buffer of pH 4 and 7. Between subjects, the electrode were cleansed with alcohol, [Bo Rune man et al., 2003].

### **2.3.3 pH testing method:**

The pH testing there are two methods of preparation of aqueous extracts have been prescribed in this standard. For kier-boiled or scoured and bleached textile materials which have not been finished, pH values of aqueous extracts prepared by the cold method and by the hot method would be the same. Hence pH testing there are any one of the methods may be followed. However, the finished or proofed fabrics; in such cases pH values of cold extract as well as hot extract should be separately determined ,[Textile standards, 1988].

### **2.3.4 Importance of pH test:**

The care and maintenance of the pH meter general electrode and handling procedures are very important in your lab because pH measurements will only be as good as the condition of your electrodes. For greater accuracy in your measurements and longer electrode life.

### **2.3.6 Advantage of pH test:**

- Digital pH meter consist of a probe that is connected by a wire to a meter that gives you the readout of the pH automatically.
- Using a pH meter time and energy will be saving.

### **2.3.7 Disadvantage of pH test:**

- The pH meter are a little more difficult to use because they must be calibrate and maintained to give accurate measurement.
- Digital pH meter is very costly compare.

### **2.3.8 Characteristic of pH test:**

- Maintain hygiene and freshness
- Eliminates the chance of transmission of disease
- Controls or eliminates skin irritation
- Improves comfort and safety to use sanitary napkins ,[ Harry et al., 2002]

### **2.3.9 Uses of pH test**

The pH measurement is used in a wide variety of applications: agriculture, waste water treatment, industrial processes, environmental monitoring and in research and development. pH is a measure of the acidity or alkalinity of a solution. A standard pH measuring system consists of three elements: pH electrode, Temperature compensation element and pH meter or controller. The pH level of water measures how acidic it is 7 is a balance pH for water. Anything below 7 indicates the water is acidic and if it's above 7 it is alkaline...This is important because the human body has a natural pH of 7.4. There are enzymes and chemical substances called the hormones also present. The hormones are used for coordination between the various functions in the human body and for a better balancing of these chemicals the advent of pH are very important. There is lot of importance of pH uses in everyday life of a human being, [Bonstein et al., 2003].

### **2.4 Liquid strike through test:**

A drop of test solution was allowed to fall on the sample and the time taken for the solution to transport from the upper layer of the pad to the inner layer was noted. The measurement was done by closely observing the drop, such that a dull wet spot is seen on the wet area of the sample, [Shanmugasundaram et.al, 2010]. [Plate-2]

In general, a more hydrophobic top sheet provide spoorer strike-through characteristics but better surface dryness, while a less hydrophobic top sheet provides better strike-through characteristics but poorer surface dryness. Thus to a certain extent there has been a balancing in prior art structures between favorable strikethrough characteristics and favorable surface dryness characteristics. Strike-through is a measure of how long it takes for an absorbent structure to completely absorb a specified quantity of liquid deposited on its surface. Strike-through values are normally expressed in seconds. Low strike-through values are indicative of high absorbency rates, and are, therefore, generally preferred in absorbent bandages and the like. Surface wetness, on the other hand, is a measure of the degree to which absorbed moisture can be caused to emerge from an absorbing matrix, under pressure, to appear as moisture at the surface of the

structure where it originally entered the absorbing matrix. Surface wetness values are normally expressed in grams of reemerging liquid absorbed on a standard filter paper superposed on the absorbing matrix. Low surface wetness values are indicative of a greater ability of the absorbent structure to retain an aqueous solution once it has been absorbed, i.e., improved surface dryness, [Gellert et al., 1975].

This test method measures the strike through time (i.e.) the time taken for a known volume simulated saline solution applied to the surface of a test piece of top sheet, which is in contact with an underlying absorbent pad, to pass through non-woven and it is measured electronically by liquid strike through time according to EDANA/ INDA standards WSP 70.3 and WSP 70.7. Liquid strike through test is the main factor to keep the skin dry. Poor liquid transport property of the pads leads to severe skin dermatitis. So, the entire pads should have good liquid transport.

#### **2.4.1 History of liquid strike through test:**

This part of ISO9073 specifies a method for measuring the time of liquid strike through for nonwoven cover stocks. The method is suitable for making comparisons between different nonwoven cover stocks. It does not simulate in-use conditions for finished products. All standards are subject to revision, and parties to agreements based on this part of ISO 9073 are encouraged to investigate the possibility of applying the most recent editions of the Standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

#### **2.4.2 Reasons to use liquid strike through test:**

Measuring the time required for a specific quantity of liquid (synthetic urine) to pass through a nonwoven material and thereafter be absorbed by an absorbent core. The time was measured five times in Sequence on one and the same on woven Sample, but with a change of filter paper between each measuring occasion. Liquid strike through test is the main factor to keep the skin dry, [Thamichihani et al., 1999].

#### **2.4.3 Importance of liquid strike through test:**

The liquid strike through test important goal of sanitary napkin top sheet development is fabric comfort at the skin/top sheet interface. Various modeling methods involving both human subjects and instrumentation have examined the fabric–skin interaction in terms of friction (tribology), shear, and pressure for both woven and nonwovens have described improved methodologies for modeling friction, pressure and shear at the skin–fabric interface with care sheets and incontinence pads.

Liquid acquisition, strikethrough, and rewet tests were performed by Marketing Technology Service, Inc. Kalamazoo, Michigan. According to EDANA/INDA WSP 70.3 and WSP 70.7, the liquid strikethrough time involves determining the time taken for a known volume of test liquid (simulated urine) applied to the surface of a test piece of nonwoven top sheet, which is in contact with underlying standard absorbent pads to pass through the fabric.

Diapers, catamenial products, adult incontinence garments, and related disposable absorbent products typically comprise a liquid pervious body Side liner, which is atop sheet, a liquid impervious backing sheet, and an absorbent material disposed between the top sheet and the back Sheet for Storing liquid. The absorbent material typically is a pulp having particles of Superabsorbent powders distributed in the pulp. The top sheet separates the wearer's skin

From the absorbent material and from the liquid that is stored in the absorbent material. It is desirable that the top sheet have rapid Strikethrough So that urine, menses, water associated with feces, or other exudates of the body are rapidly brought into contact with the absorbent material and out of contact with the wearer's skin. It is also desirable that the top sheet have low rewet so that these liquids do not migrate from the absorbent layer through the top sheet and back into contact with the skin, [Thomas et al., 2002].

The top sheet is normally a nonwoven fabric prepared from relatively coarse fibers. The structure of the nonwoven fabric is controlled to provide the balance of properties Desired in the top sheet of rapid Strikethrough and low rewet. Typically, the nonwoven is a lightweight Spun bond cover Stock made from continuous filaments; usually mono component continuous filaments that are of sufficient denier to substantially preclude wicking of liquids Stored in the absorbent core and consequent rewet. The Synthetic polymeric filaments from which the top sheet is made normally are hydrophobic. Surfactants sometimes are added to the fabric to promote fluid transport for rapid Strikethrough, [Thomas et al., 2002].

#### **2.4.4 Characteristic of liquid strike through test:**

- Maintain hygiene and freshness
- Improve surface dryness
- Improve more rapid strike through of fluids deposited on the surface of pads.
- To reduce the amount of moisture in contact with the wearer's skin and thus reduce maceration, rash or other unpleasantness.
- To improve strength and softness to enhance their absorbency and containment characteristics in addition to wearer comfort, [Gellert et al., 1975].

#### **2.4.5 Advantages of liquid strike through test:**

- Fast Measurement
- Easy handling
- Using a liquid strike through test time and energy will be saving.

## **2.5 Fourier Transform Infrared Spectroscopy:**

Fourier Transform Infrared spectroscopy is a technique used to obtain an infrared spectrum of absorption or emission of a solid, liquid or gas. An FTIR spectrometer simultaneously collects high spectral resolution data over a wide spectral range. FTIR is a sensitive technique particularly for identifying organic chemicals in a whole range of applications although it can also characterize some inorganics. It is particularly useful tool in isolating and characterizing organic contamination. [Plate-3]

The fiber analysis of the selected sanitary napkin was done layer wise, using the standard AATCC test methods. Preliminary identification was done using a light Microscope; the longitudinal view of the fibers was viewed under the microscope. Chemical analysis of each layer was done to confirm the nature of fibers. Solubility tests were conducted to identify the cellulosic fibers and type of synthetic fibers. Melting Point process was used to identify the type of Polyolefin fiber, viz. Polypropylene and Polyethylene.

Fourier transform infrared spectroscopy, also known as FTIR analysis or FTIR spectroscopy, is an analytical technique used to identify organic, polymeric and in some cases, inorganic materials. This technique measures the absorption of infrared radiation by the sample material versus wavelength. The infrared absorption bands identify molecular components and structure for sanitary pads. The frequency ranges are measured as wave numbers typically over the range  $650\text{-}4000\text{ cm}^{-1}$ , in transmission mode, [Pholmann, 2016].

### **2.5.1 History of FTIR spectroscopy:**

Chemical infrared spectroscopy emerged as a science in the 1880s. In the 1890s, A. A. Michelson, to further his studies of the speed of light, invented the interferometer. In the early 1940s, chemical infrared spectroscopy was still an immature scientific field. But with commercial development of the optical null dispersive spectrophotometer, later that decade, chemical infrared spectroscopy came into widespread use. Dispersive instruments proved the tremendous value of infrared analysis, and soon became the mainstay of organic characterization laboratories.

In 1949 astrophysicist Peter Fellgett used an interferometer to measure light from celestial bodies and produced the first Fourier transform infrared spectrum. But for many years, only a few advanced research groups with access to large, expensive computers and with

personnel able to wait up to 12 hours to transform an interferogram into a spectrum used Fourier transform infrared (FTIR) spectroscopy. For two decades more, FTIR spectrometers were limited to studying problems not solvable with dispersive techniques.

In the late 1960s when microcomputers able to do the Fourier transform became available, commercial FTIR spectrometers appeared. The 1966 development of the Cooley-Tukey algorithm, which quickly does a Fourier transform (the Fast Fourier Transform or FFT), was also instrumental in the commercialization of FTIR spectrometers. However, the first FTIR spectrometers were large and expensive, and were found primarily in a few well-to-do research labs. Gradually, technology reduced the cost, increased the availability, and enhanced the capabilities of FTIR spectroscopy systems. The performance-to-price ratio provided by FTIR spectrometers today was unthinkable only a decade ago, [Hsieh, 2008].

### **2.5.2 Main components of FTIR spectroscopy:**

**The Source:** Infrared energy is emitted from a glowing black body source. This beam passes through an aperture which controls the amount of energy presented to the sample (and, ultimately, to the detector).

**The Interferometer:** The beam enters the interferometer where the “spectral encoding” takes place. The resulting interferogram signal then exits the interferometer.

**The Sample:** The beam enters the sample compartment where it is transmitted through or reflected off of the surface of the sample, depending on the type of analysis being accomplished. This is where specific frequencies of energy, which are uniquely characteristic of the sample, are absorbed.

**The Detector:** The beam finally passes to the detector for final measurement. The detectors used are specially designed to measure the special interferogram signal.

**The Computer:** The measured signal is digitized and sent to the computer where the Fourier transformation takes place. The final infrared spectrum is then presented to the user for interpretation and any further manipulation.

### **2.5.3 Advantages of FTIR:**

- Simpler mechanical design
- Elimination of stray light and emission contribution
- Powerful data station
- Majority of molecules in the universe absorb
- Universal technique
- Sensitive, fast and easy
- Relatively inexpensive and provides rich information.
- Sensitive to “molecules”-anything that contains chemical bonds.

#### **2.5.4 Disadvantages of FTIR:**

- Cannot detect atoms or monatomic ions- Single atomic entities contain no chemical bonds.
- Cannot detect molecules comprised of two identical atoms symmetric- such as N<sub>2</sub> or O<sub>2</sub>.
- Aqueous solutions are very difficult to analyze water is a strong IR absorber.
- Complex mixture- Samples give rise to complex spectra.

#### **2.5.5 Application of FTIR in textiles:**

The speed and sensitivity of the FTIR spectroscopy allows rapid analysis of micro-samples down to the nano gram level in some cases, making the FTIR unmatched as a problem-solving tool in organic analysis. The FTIR microscope accessory allows spectra from a few nano gram of material to be obtained quickly, with little sample preparation, resulting in more data at lower cost. In some cases, thin films of residue are identified with a sensitivity that rivals or even exceeds electron or ion beam-based surface analysis techniques. This has enabled a wider use of this in textile field, [Shaikh et al., 2014].

#### **2.6 Scanning electron microscope:**

The characterization of textile materials has employed many microscopic techniques such as optical and electron microscopy. Scanning electron microscopy (SEM) uses electrons rather than light to form an image. The top sheets morphological analysis was performed using a Fe-scanning electron microscope (care zeiss) the magnified images allowed the analysis of the structure of samples, [Pohlmann, 2016]. [ Plate-4]

An SEM can produce high resolution and depth of field of images, and provides useful tools for examining structural and surface characteristics of textile materials. But in the conventional SEM, samples normally have to be clean, dry, vacuum compatible and electrically conductive in order to produce useable and easily obtained results. The column of an SEM is normally under a high vacuum to minimize beam-scattering effects. The high vacuum and the imaging process in an SEM impose special requirements for specimen preparation. The specimen to be observed in the SEM must remain at a constant potential during examination. A specimen that conducts electricity can bleed off any charge imposed by the incident electron beam. Specimens that are not naturally conductive have to be coated with a thin layer of a conductive material.

A development in electron microscopy in the form of an ESEM opens up new possibilities for textile research. The ESEM extends the use of the SEM to not only being a tool for studying normal SEM samples, but it also allows the

direct observation of unprepared specimens, and is also able to examine wet, oily and out gassing samples and dynamic processes taking place on a microscopic level .[ Wang et al ., 2004]

### **2.6.1 History of SEM:**

In the early 1930s history of SEM had been scientifically desire to see the fine details of the interior structures of organic cells (nucleus, mitochondria.....etc). Although Max Knoll developed the transmission electron microscope to be patterned exactly on the light transmission microscope except that a focused beam of electrons is used instead of light to “see through” the specimen, [Knoll, 1935] and then true microscope was invented in 1937 by Manfred Von Ardenne .The true microscope with high magnification by scanning a very small raster with a demagnetized and finely focused electron beam. The first scanning electron microscope (SEM) detected in 1938 [Von Ardenne, 1938]. Further work was reported by Zworykin’s group in 1942 followed by the Cambridge groups in the 1950s and early 1960s. Its late development finally led to the marketing of the first commercial instrument by Cambridge scientific instrument company as the “stereos can” in 1965, [choudharya et al., 2017].

### **2.6.2 Importance of SEM analysis:**

Microscopy enables a “direct” imaging of organisms, tissues, cells, organelles, molecular assemblies and even individual proteins. Analytical techniques was used in molecular biology provide a data set has been represents cellular processes in an abstract way. Therefore, microscopy was still is an important, complementary technique to visualize the macro and microscopic structure and to assign structure to function and vice versa.

The most important part of electron microscopy is the biological material of preparation procedure. With every preparation step artifacts are introduced. Electron microscopes have put a lot of effort in the preparation of the specimens to reduce the artifacts to a minimum and to image the specimens in a more lifelike state. The image of the specimen can never be better than the entity of the introduced artifacts during preparation, [Kaech, 2013].

### **2.6.3 Advantage of SEM:**

- The SEM has a large depth of field, which allows a large amount of the sample to be in focus at once and produces a good representation of the three-dimensional sample images.
- The advantages of a scanning electron microscope include its wide-array of applications are three dimensional and topographical imaging and the versatile information garnered from different detectors.

- The SEMs are also easy to handling and advances in computer technology.
- This instrument works fast, often completing SEI, BSE and EDS analyses in less than five minutes
- The modern technology SEMs allow for the generation of data in digital form, [choundharya et al., 2017].

#### **2.6.4 Disadvantage of SEM:**

- The disadvantages of a scanning electron microscope start with the size and cost.
- The SEMs are expensive compare to other test.
- Difficult to maintain the steady voltage, currents to electromagnetic coils and circulation of cool water.
- The SEM carry a small risk of radiation exposure associated with the electrons that scatter from beneath the sample surface.
- The negative impact can be minimized with knowledgeable experience researchers being able to identify artifacts from actual data as well as preparation skill.
- There is no absolute way to eliminate or identify all potential artifacts.

#### **2.6.5 Application of SEM:**

The SEMs have a wide variety of applications in a number of scientific and industry-related fields, especially where characterizations of solid materials is beneficial. In addition to topographical, morphological and compositional information, a Scanning Electron Microscope can detect and analyze surface fractures, provide information in microstructures, examine surface contaminations, reveal spatial variations in chemical compositions, provide qualitative chemical analyses and identify crystalline structures. SEMs can be as essential research tool in fields such as life science, biology, gemology, medical and forensic science and metallurgy. In addition, SEMs have practical industrial and technological applications such as semiconductor inspection, production line of miniscule products and assembly of microchips for computers, [choundharya et al., 2017].

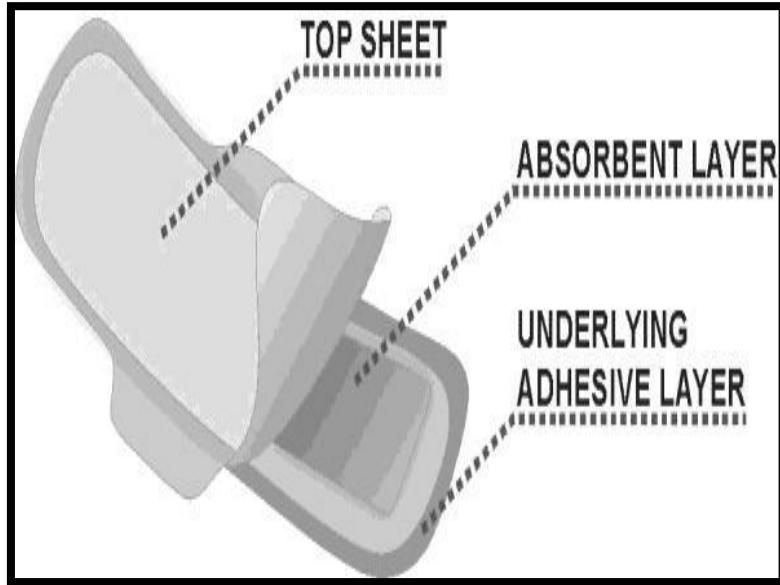
#### **2.6.6 Uses of SEM analysis:**

Scanning Electron Microscopes (SEMs) are used across a number of industrial, commercial, and research applications. From cutting edge fabrication processes to forensic applications, there's a diverse range of practical applications. [Plate-4]

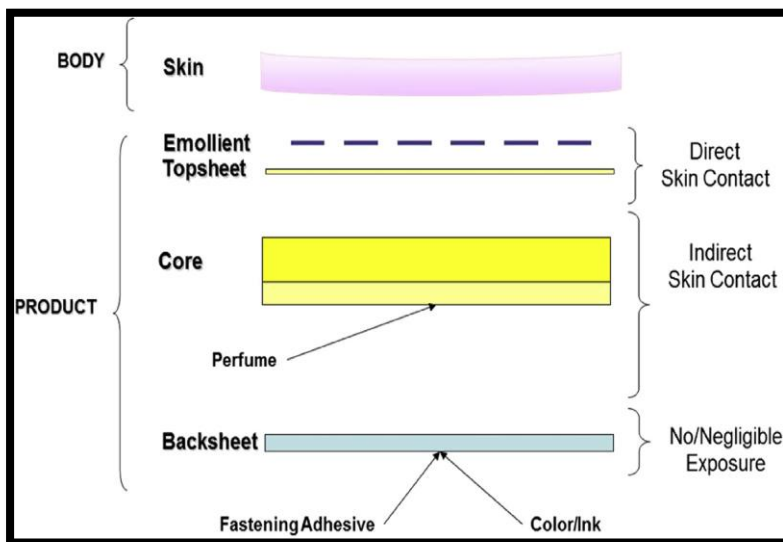
A Scanning Electron Microscope (SEM) uses focused beams of electrons to render high resolution, three-dimensional images. These images provide information on: Topography, Morphology and composition .Electrons are generated at the top of the column by the **electron source**. They are then accelerated down the column that is under vacuum, which helps to prevent

any atoms and molecules present in the column from interacting with the electron beam and ensures good quality imaging.

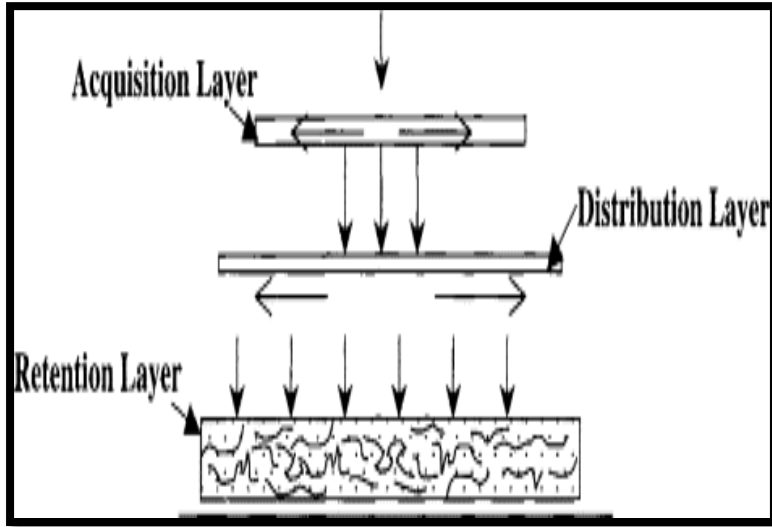
A Scanning Electron Microscope (SEM) is used in materials science for research, quality control and failure analysis. In modern materials science, investigations into nano tubes and nanofibres, high temperature superconductors, mesoporous architectures and alloy strength, all rely heavily on the use of SEMs for research and investigation. The recent development of researchers is exploring new ways nanowires can be used as gas sensors by improving existing fabrication methods, [Joy et al., 1997].



**Figure -1**  
**Basic structure of sanitary pads**

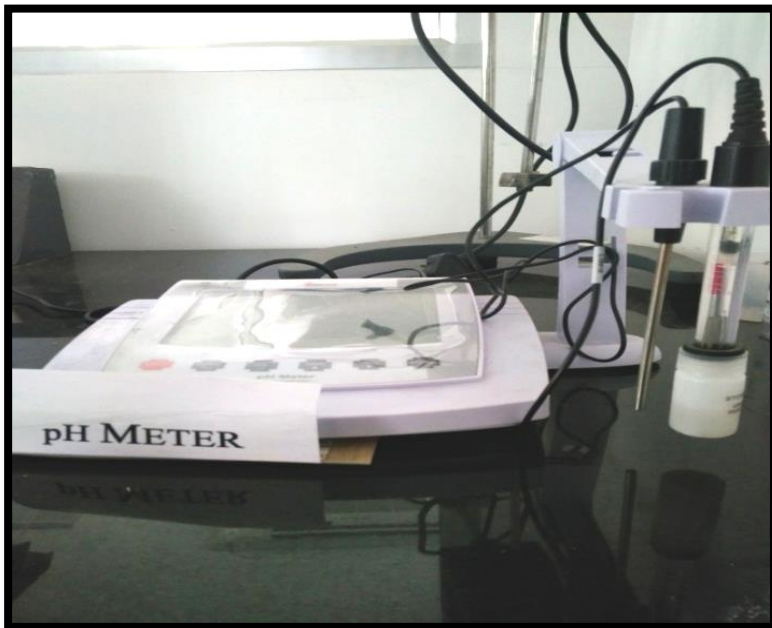


**Figure-2**  
**Main components of sanitary pads**



**Figure-3**

**Characteristic of sanitary pads**



**Plate -1**

**Digital pH meter**



**Plate-2**  
**Liquid strikes through test**



**Plate-3**  
**Fourier transforms infrared spectroscopy**



**Plate-4**

**Scanning electron microscope**

# **Methodology**

### **3. METHODOLOGY**

Methodologies pertaining to the study on “**Characterization and Analysis of Sanitary pads**” are discussed under the following headings:

#### **3.1 Characteristic of Sanitary Pad Pilot Study**

#### **3.2 Selection of pH Test**

3.2.1 Selection of sample

3.2.2 Preparation of test specimens

3.2.3 Amount of sample weight

3.2.4 Preparation of the application method

#### **3.3 Selection of Liquid strike through test**

3.3.1 Selection of sample

3.3.2 Preparation of test specimens

3.3.3 Preparation of the application method

#### **3.4 Analysis of Fourier Transform Infrared Spectroscopy**

#### **3.5 Analysis of Scanning Electron Microscope**

### **3.1 Characteristic of sanitary pad pilot study:**

### **3.2 Selection of pH testing method:**

pH testing method is important to test the process of analyzing acid, neutral and basic of solutions. pH test should be in acid or alkaline property of the sanitary pad leads to severe skin dermatitis. The main factor of pH testing is to give comfortable for wearer. So, all the sanitary pads should have pH range of 6.5 to 8.5 as per ISO 3071-1980.

#### **3.2.1 Selection of sample:**

The sample is prepared to evaluate pH value of the aqueous extract of the sanitary pads shall be held to be representative of the lot.

#### **3.2.2 Preparation of test specimens:**

The preparation of test specimens should be taken into separate core (absorbent) and sanitary pad as a whole and the sample in triplicates or of dimensions such that the test samples will rapidly wet out. Manipulate the material as little as possible.

#### **3.2.3 Amount of sample weight:**

The test specimen of separate core and whole pad can be taken weighing  $2 \pm 0.05\text{g}$ . And the sample measurement can give reading automatically by using digital weighing balance.

#### **3.2.4 Preparation of the application method:**

##### **pH test:**

Two methods of preparation of aqueous extracts methods can be used to test pH. For kier-boiled or scoured and bleached textile materials which have not been finished, pH values of aqueous extracts prepared by the cold method and by the hot method. In this experiment we can use cold method. However for finished or proofed fabrics the two values may differ depending upon the nature of finish or proofing of the fabrics. In such cases pH values of cold extract should be separately determined.

The test specimen can be taken separate core and sanitary pad as a whole and the sample can be swatches into 6 pieces and prepare the extract in triplicate at the temperature of laboratory by taking a test specimen weighing  $2 \pm 0.05\text{g}$  and 100 ml of the distilled water into a Stoppard glass flask agitate the flask for 20-30 min by hand to ensure that the specimen is properly wetted out, then shake it mechanically for 20-30 minutes and then pH value can be measured by using pH meter.

### **3.3 Selection of liquid strike through test:**

The liquid strike through test important goal of sanitary pads top sheet development is fabric comfort at the skin/ top sheet interface. Liquid strike through test is the main factor to keep the skin dry. Poor liquid transport property of the pads leads to severe skin dermatitis. So, the entire pads should have good liquid transport as per ISO 9073.

### **3.3.1 Selection of sample:**

The sample is prepared to evaluate Liquid strike through test for sanitary pad top sheet according to the ISO 186, ensuring that the areas from which the samples are taken have no visible flaws and are not creased.

### **3.3.2 Preparation of test specimens:**

The preparation of test specimen can be swatches into 10 pieces measuring 125mm\*125mm. The test piece should be in condition and filter papers in one of the atmospheres specified in ISO 1390.

### **3.3.3 Preparation of the application method:**

Liquid strike through test first set up the ring stand holding the funnel and positions the burette with the tip inside the funnel. Place one nonwoven test piece on top of one set of five filter paper on the base plate. Place the nonwoven on the filter paper in such a way that the side of the nonwoven which is intended to be in contact with the user's skin is upper most. Ensure that the electrodes in the strike-through plate are clean.

Place the strike-through plate on top of the non woven, with the center of the plate over the center of the test piece. Center the burette and the funnel over the plate. Adjust the height of the funnel so that it is (  $5 \pm 0.5$ )mm above the top of the cavity in the plate . Ensure the electrodes are connected to the timer activate the timer and set the clock to zero.

Fill the burette with simulated saline solution. Keep the discharge valve of the funnel closed and run 5.0ml of liquid from the burette into the funnel. Open the magnetic discharge valve of the funnel to discharge 5.0 ml of liquid. The initial flow of liquid will complete the electrical circuit and start timer. It will stop when all the liquid has penetrated into the nonwoven and fallen below the level of the electrodes in the strike-through plate. Record the time indicated on the electronic timer. Repeat for the required number of test pieces.

## **3.4 Analysis of Fourier Transform Infrared Spectroscopy:**

The Fourier transform infrared spectroscopy is an analytical technique used to identify the top film material in commercially available sanitary pads. This technique measures the absorption of infrared radiation by the sample material versus wave length. The infrared

absorption bands identify molecular components and structure for sanitary pads. The frequency range of FTIR is measured as wave numbers typically over the range 650-4000  $\text{cm}^{-1}$  in transmission mode.

### **3.5 Analysis of Scanning Electron Microscope:**

The sanitary pads (top film) was taken separately to identify the surface morphological analysis was performed using a Scanning electron microscope (care zeiss) the magnified images allowed the analysis of the structure of sample.



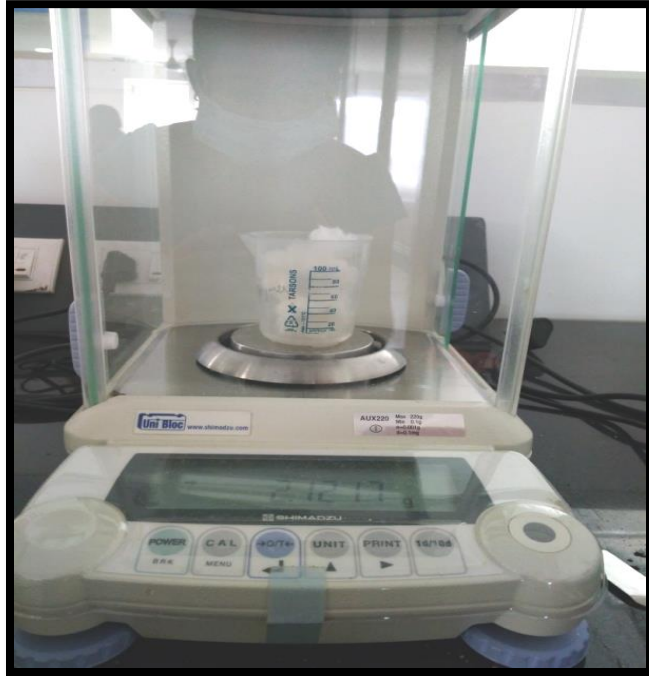
**Plate-5**

**Maxi pad**

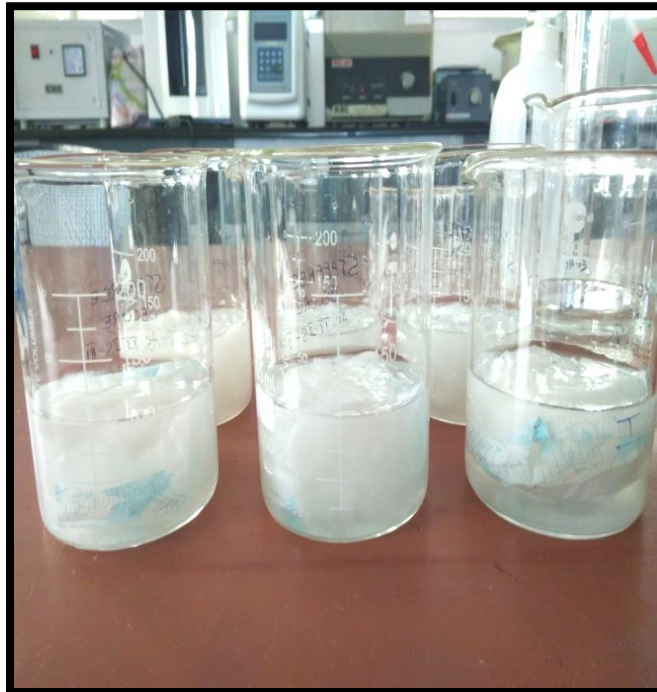


**Plate-6**

**Core layer**



**Plate-7**  
**Weighing balance**



**Plate-8**  
**Aqueous extracts**



**Plate-9**

**Magnetic stirrer**



**Plate-10**

**Magnetic bead**



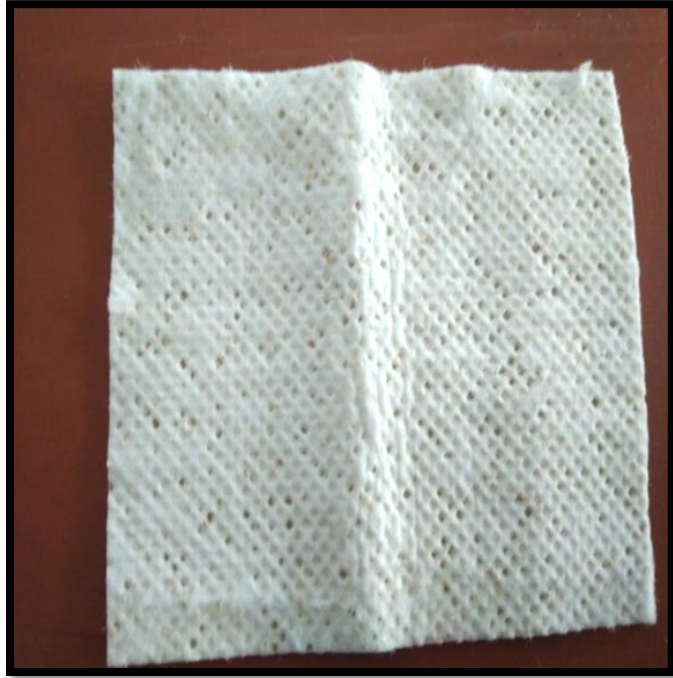
**Plate-11**

**Filtration**



**Plate-12**

**Sample**



**Plate-13**

**SAP film**



**Plate-14**

**SAP inner surface**



**Plate-15**

**SAP outer surface**



**Plate-16**

**Ultra thin pad**



**Plate-17**  
**Gel**



**Plate-18**  
**Sustainable sanitary pad**



**Plate-19**

**Core layer**



**Plate-20**

**Whole pad**



**Plate-21**

**Aqueous extracts**

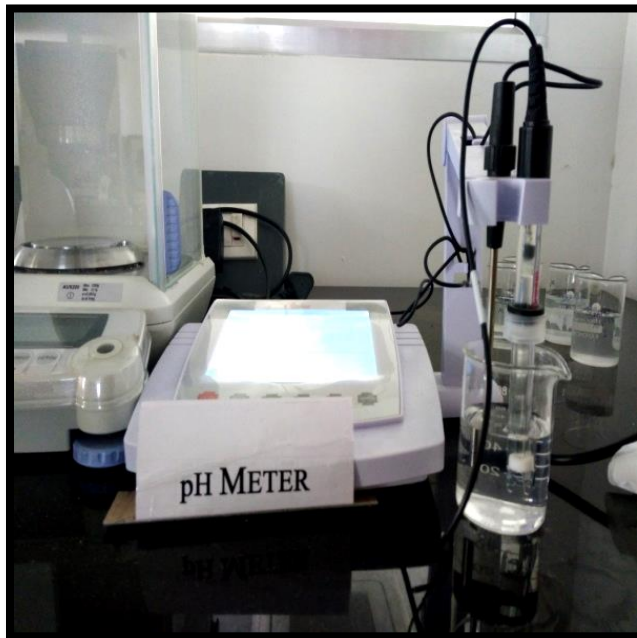


**Plate--22**

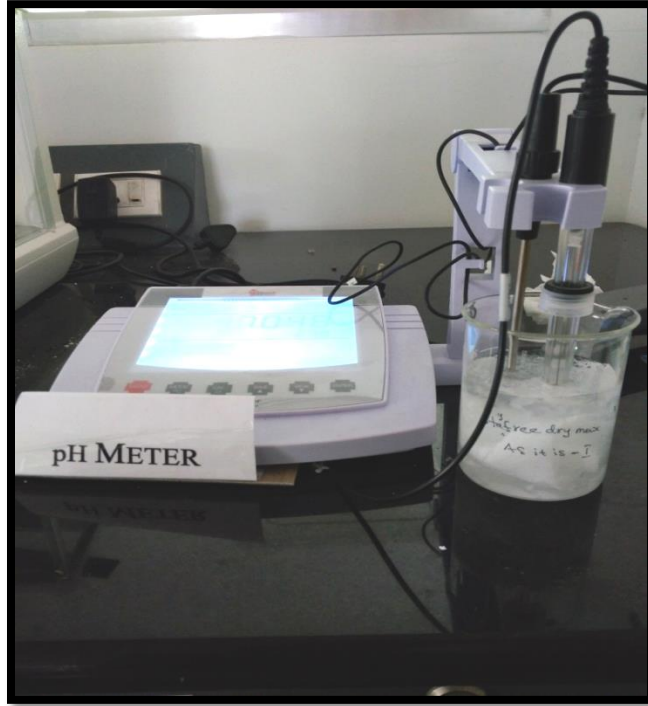
**Core aqueous extract**



**Plate-23**  
**Whole pad aqueous extract**



**Plate-24**  
**pH Test**



**Plate--25**

**Direct pH Test**

## ***Result and discussion***

## **4. RESULT AND DISCUSSION**

The result of the study on “**Characterization and Analysis of Sanitary pads**”, presented in result and discussion are discussed as follows.

### **4.1 pH test**

### **4.2 Liquid strike through test**

### **4.3 FTIR Analysis**

4.3.1 Anion herbal organic cotton

4.3.2 Kotex

4.3.3 Sofy antibacterial

4.3.4 Stayfree secure cotton

4.3.5 Whisper choice aloe vera

4.3.6 Whisper ultra soft

### **4.4 SEM Analysis**

4.4.1 Stayfree secure cotton

4.4.2 Anion herbal organic cotton

4.4.3 Anion organic cotton

4.4.4 Kotex

4.4.5 Whisper choice aloe vera

4.4.6 Saathi

4.4.7 Whisper ultra soft

4.4.8 Stayfree dry max all night

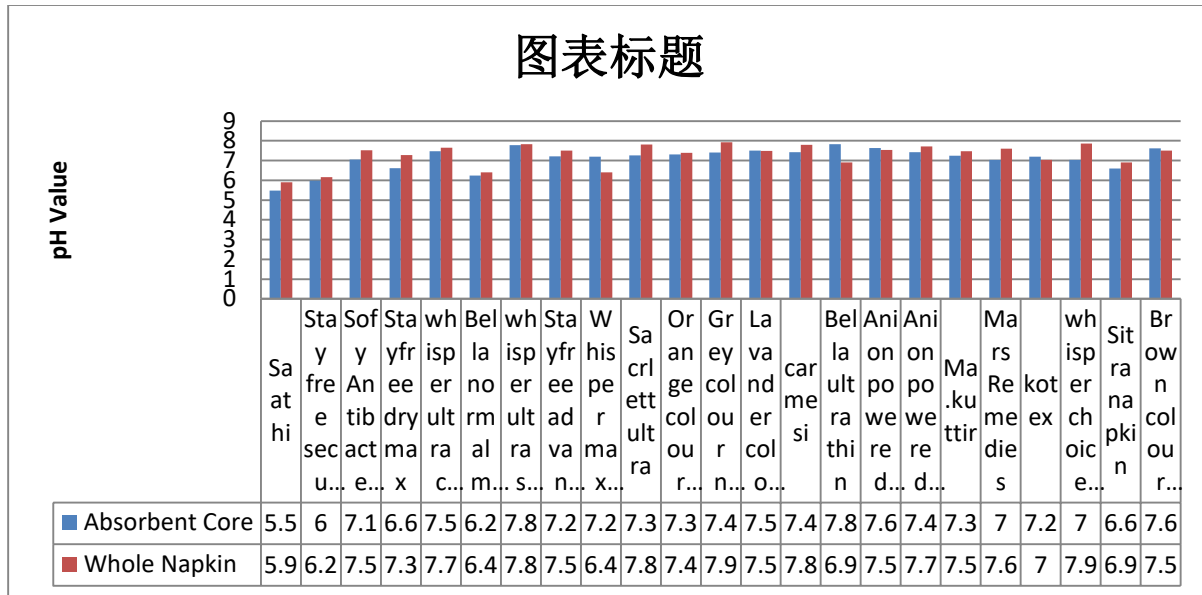
4.4.9 O-Sample

4.4.10 Scarlett ultra

4.4.11 Bella normal maxi

4.4.12 Sofy antibacterial

## 4.1 pH Test:



**Figure-4**

### pH Test

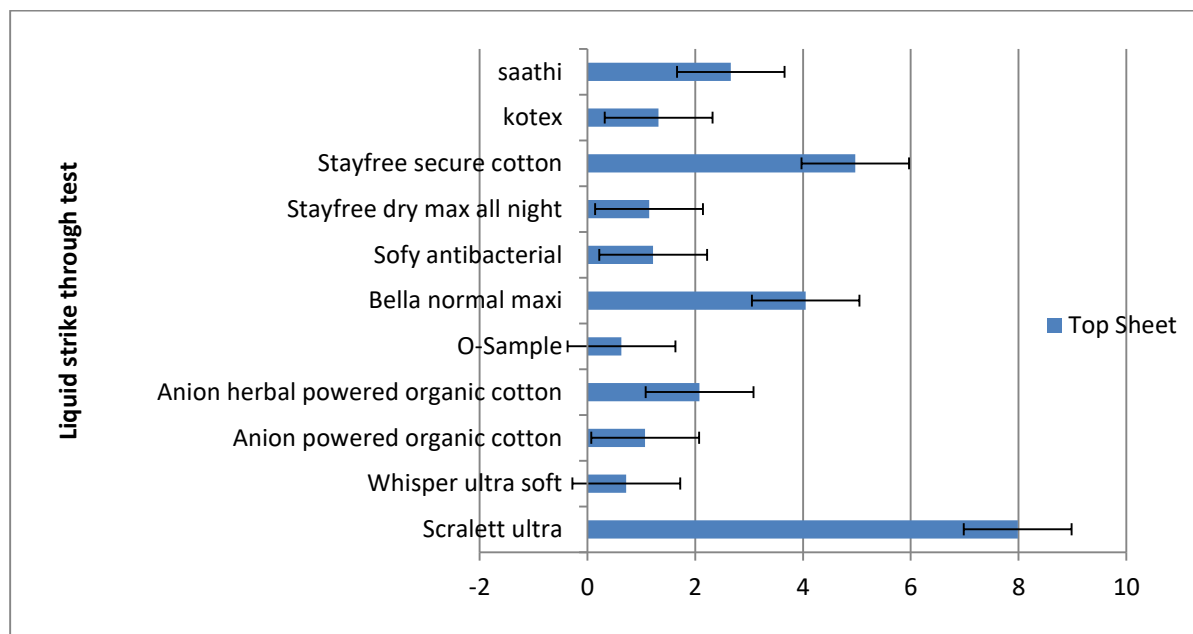
For sanitary pad, it was necessary to check the pH for comfortability to use. Variation in the pH is caused by the choice of raw materials that are used for making sanitary napkins. A series of 23 commercial samples were taken for study and their pH were checked with the core layer and whole napkin. The results obtained from the experiments were compared and checked in triplicates. The inferences showed that is no discrete change in the core layer as well as the whole pad. Statistical analysis using a t-test at a confidence level of 0.05 showed no significant difference between the core and the whole napkin. This indicates that the raw materials used in the sanitary napkin such as glue, top layer and bottom layer didn't contribute much difference in pH. As per IS standard for sanitary napkin, the pH should fall between 6.5-8.5 as shown in above graph except first one, most of the commercial samples when tested were within this range.

## 4.2 Liquid strike through test:

S.No	BRAND	LIQUID STRIKE THROUGH TEST	THICKNESS	MATERIAL	GSM
1	Scralett ultra	7.985	0.158	Polyolefin	22
2	Whisper ultra soft	0.72	0.192	polyethylene	41
3	Anion powered organic cotton	1.07	0.23	Polyolefin	35
4	Anion herbal powered organic cotton	2.08	0.244	polyethylene	35
5	O-Sample	0.63	0.244	Polyolefin	31
6	Bella normal maxi	4.05	0.252	Polyolefin	29
7	Sofy antibacterial	1.22	0.256	cellulose	39
8	Whisper choice aloe vera freshness	--	0.29	cellulose	34
9	Stayfree dry max all night	1.145	0.3	polyolefin	26
10	Stayfree secure cotton	4.97	0.32	polypropylene	43
11	kotex	1.32	0.402	cellulose	77
12	Saathi	2.66	0.458	polyolefin	46

**Table-1**

**Liquid strike through test**



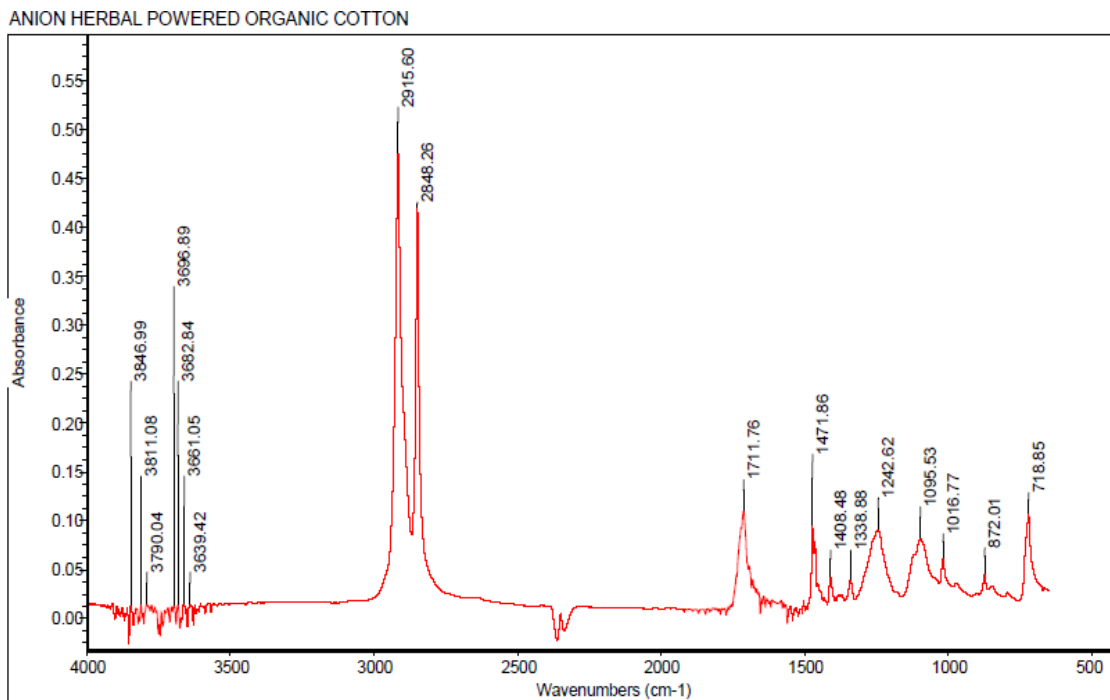
**Figure-5**

**Liquid strike through test**

Liquid strike through test is basically performed to evaluate the time taken for the liquid to pass through the top layer onto absorbent core. Lesser the time needed for the strike, better the

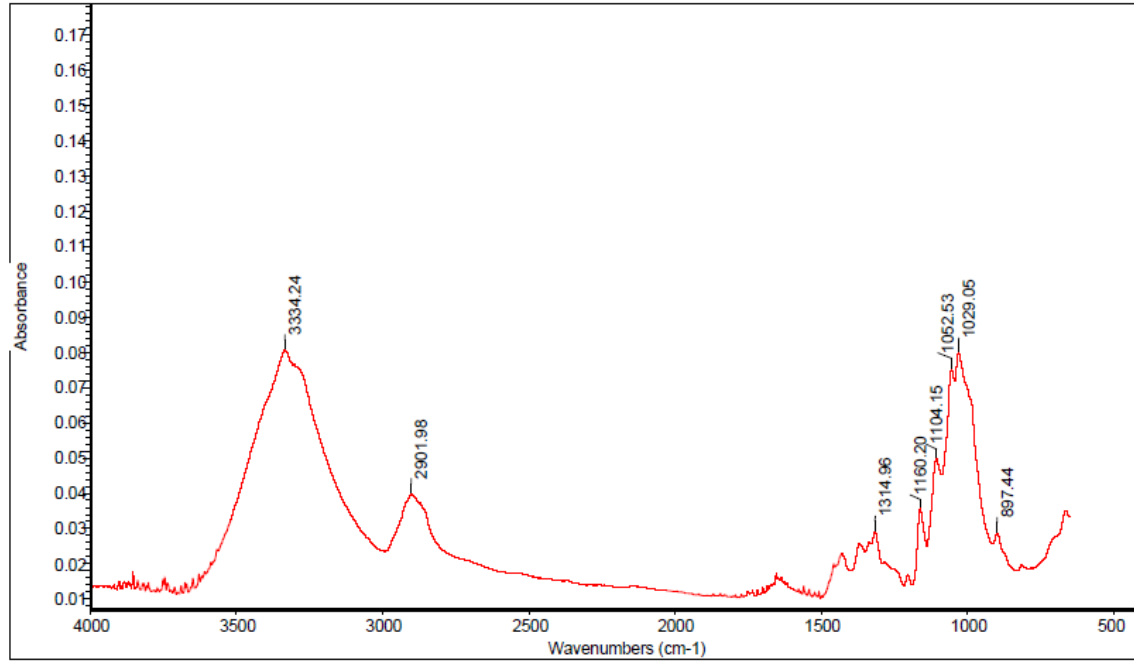
absorbency and drier the material. Many factors influence this property such as porosity, type of material, thickness, testing liquid and GSM. We could observe that all the commercial samples would allow the liquid within a range of 0.6-7 secs. However, we could not correlate between the time and thickness as it was independent and also the type of test liquid also has an effect due to the surface tension, the surface topography and the porosity was influencing the liquid strike through properties in sanitary pads. The SEM indicates that o-sample has more openings when compared with any sample. The maximum time was observed in Scarlett ultra which has minimal openings despite being thinner. Different structures and porosity contribute a lot for the liquid penetration through the top layer.

### 4.3 FTIR Test:



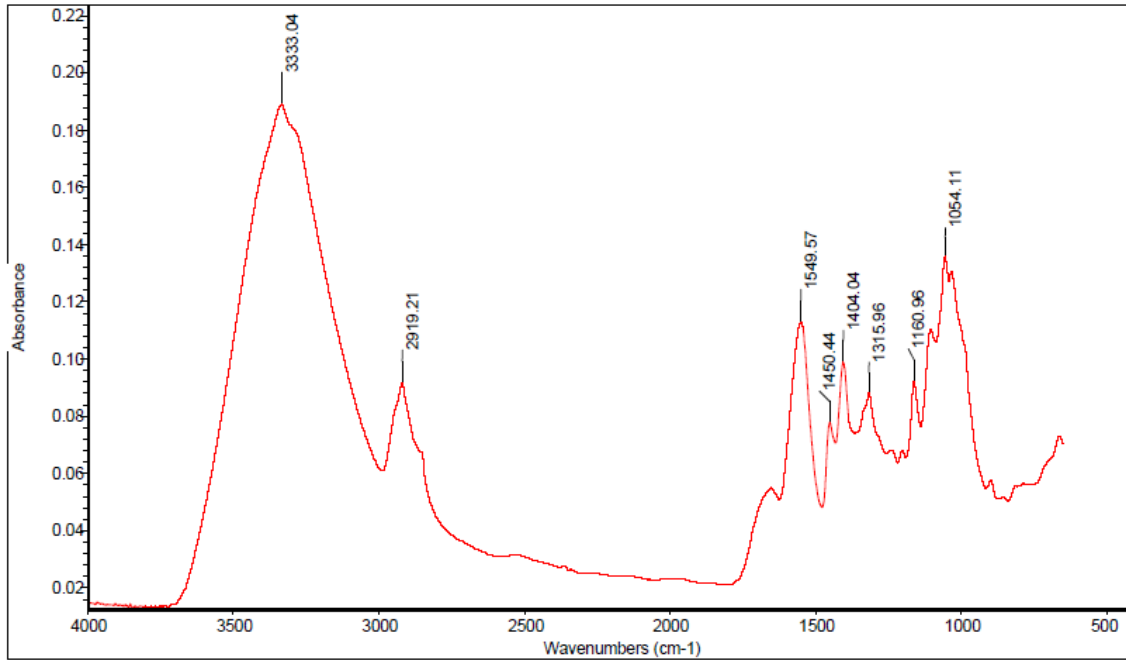
**Figure-6**  
**Anion herbal organic cotton**

KOTEX TOPSHEET



**Figure-7**  
**Kotex**

SOFY ANTIBACTERIAL



**Figure-8**  
**Sofy antibacterial**

STAYFREE SECURE COTTON

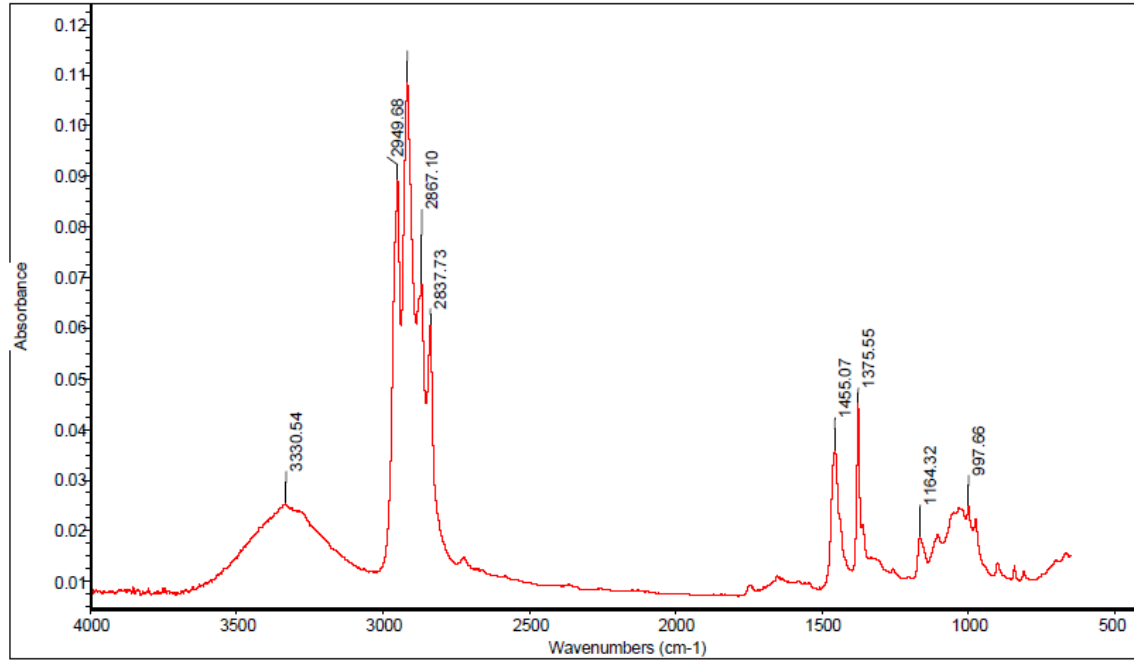


Figure-9

Stayfree secure cotton

WHISPER CHOICE ALOEVERA

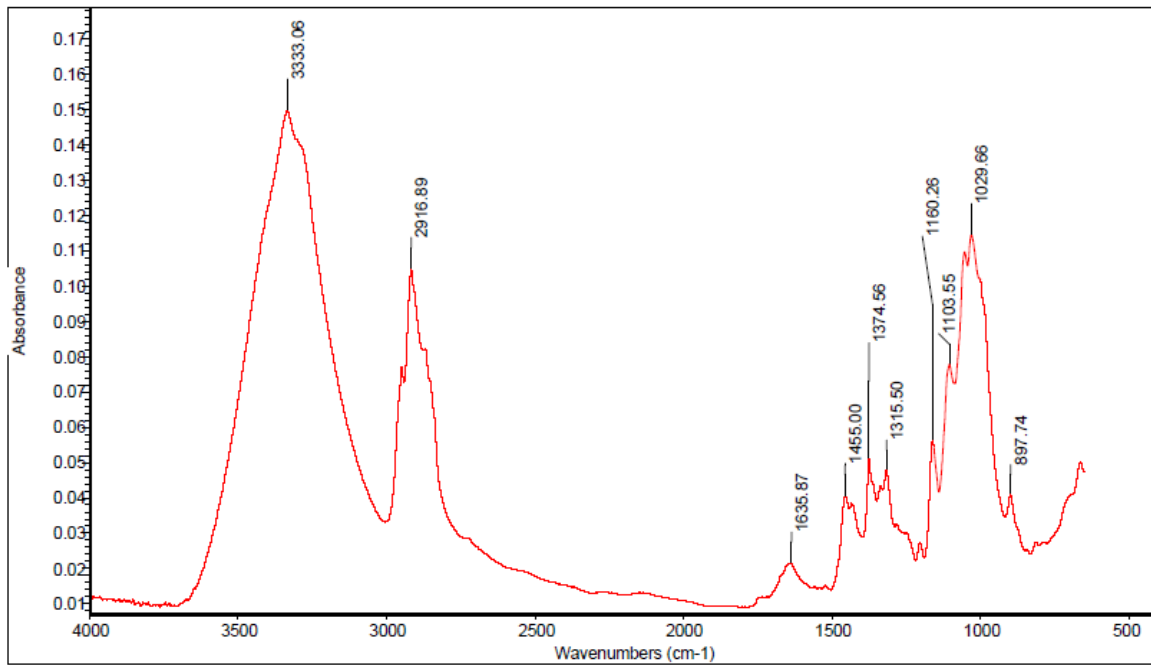
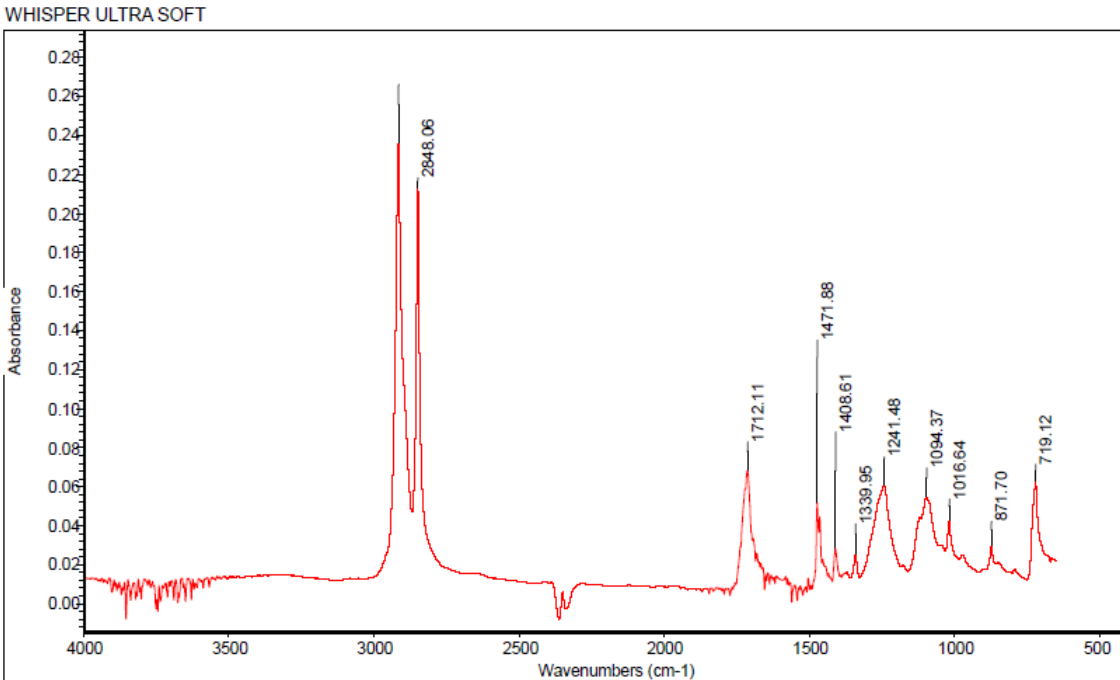


Figure-10


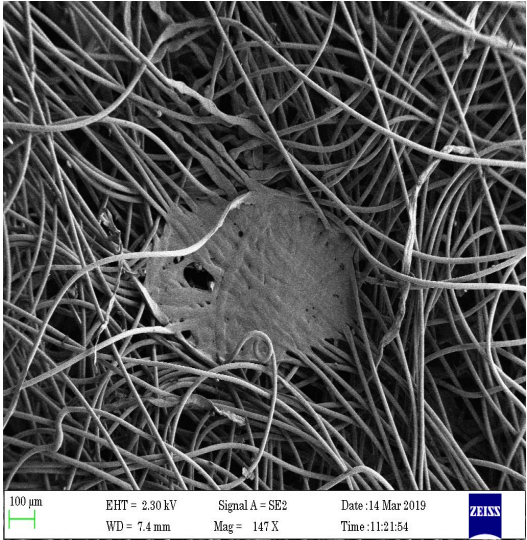

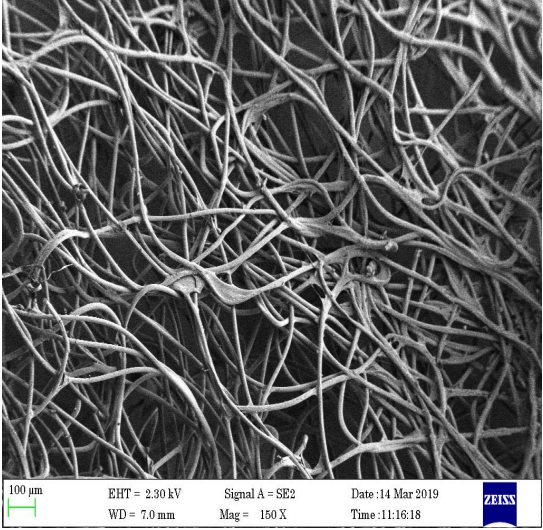
Whisper choice aloe vera



**Figure-11**  
**Whisper ultra soft**

FTIR test was performed to analyze the type of material that was used for making sanitary napkin top sheet. As indicated from the above graphs, most of the sanitary napkin top sheet is made up of polypropylene; very few are made up of cellulose. (Sofy, whisper choice aloe vera, stay free secure cotton and kotex). For all the cellulose material, a band at **3333-3500** cm-1 refers to the O-H stretching, indicating cellulose material. For polyolefin's we can see C-H stretching at 2800-3000 cm-1 and CH<sub>2</sub> Stretching at 1450 cm-1 indicate that of polyolefin's.

#### 4.4 SEM analysis:

ORIGINAL SAMPLE	SEM STRUCTURE
 <p data-bbox="285 1010 571 1087">Plate-26 Stayfree secure cotton</p>	 <p data-bbox="1024 1052 1187 1087">SEM images</p>
 <p data-bbox="245 1713 607 1791">Plate-27 Anion herbal organic cotton</p>	 <p data-bbox="1029 1713 1198 1749">SEM images</p>

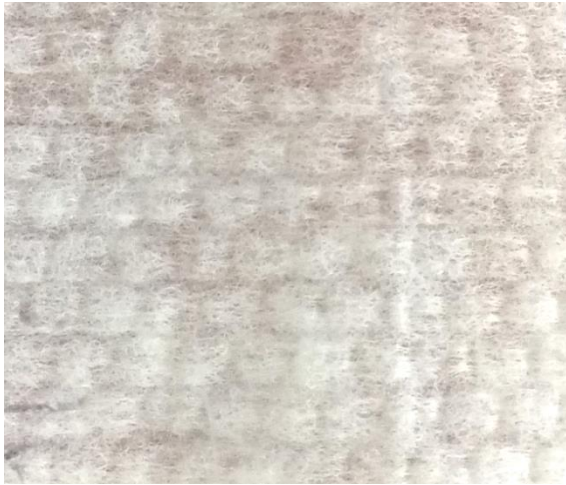
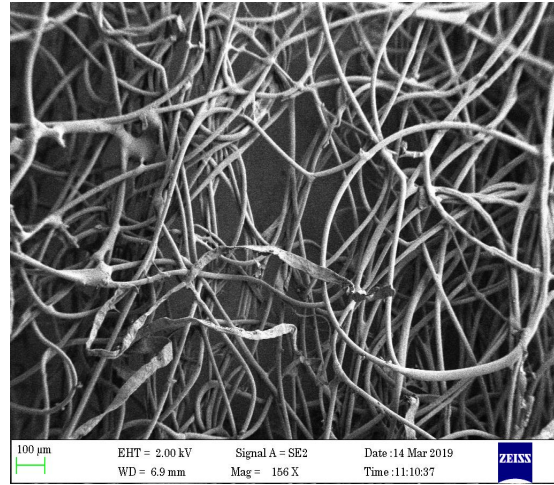


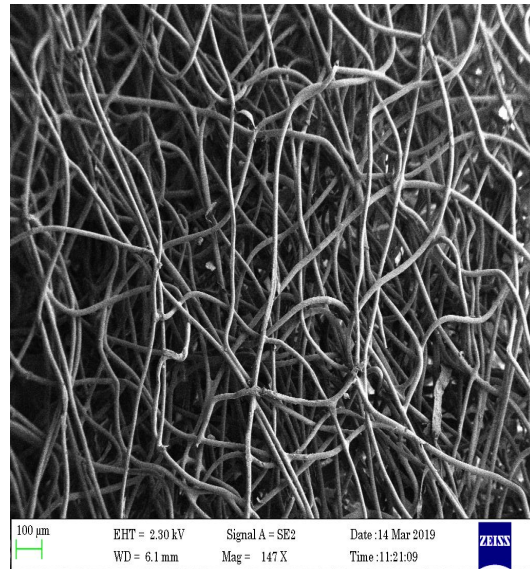
Plate-28  
Anion organic cotton



SEM images



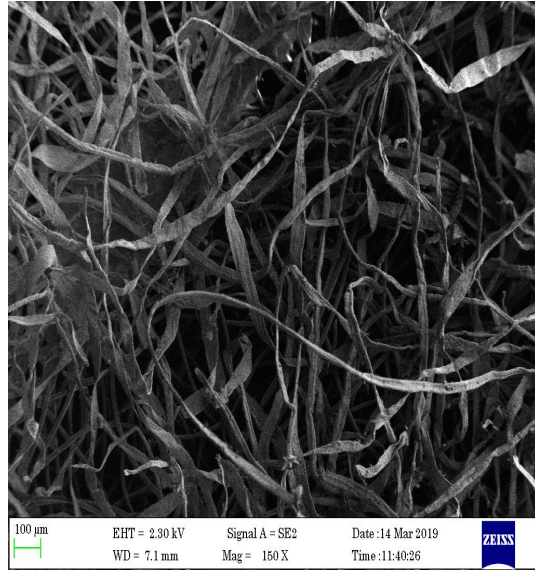
Plate-29  
Kotex



SEM images



Plate-30  
Whisper choice aloevera



SEM images

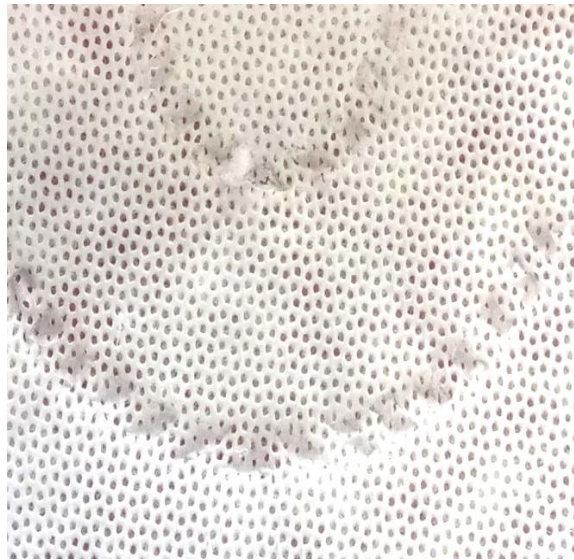
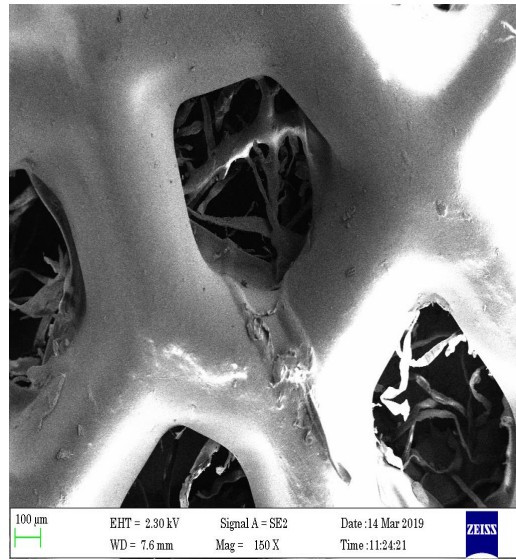


Plate-31  
Saathi



SEM image

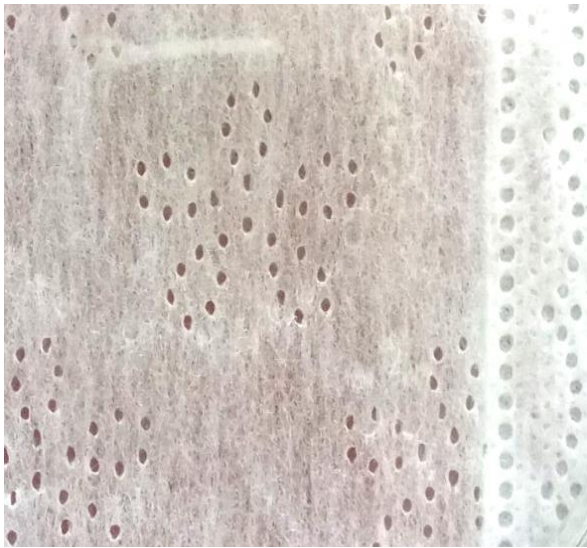
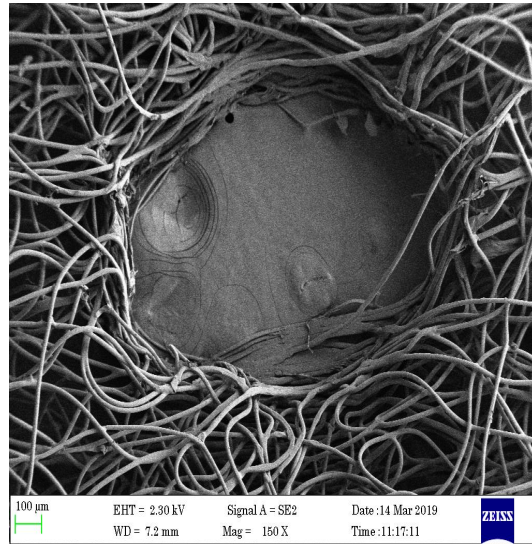


Plate-32  
Whisper ultra soft



SEM image

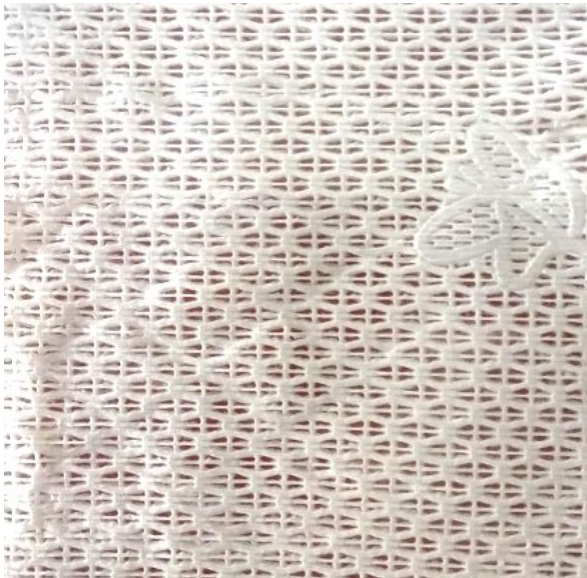
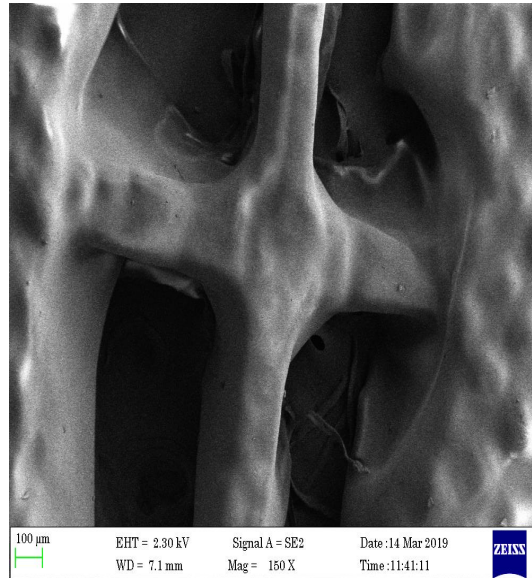


Plate-33  
Stayfree dry max all night



SEM image

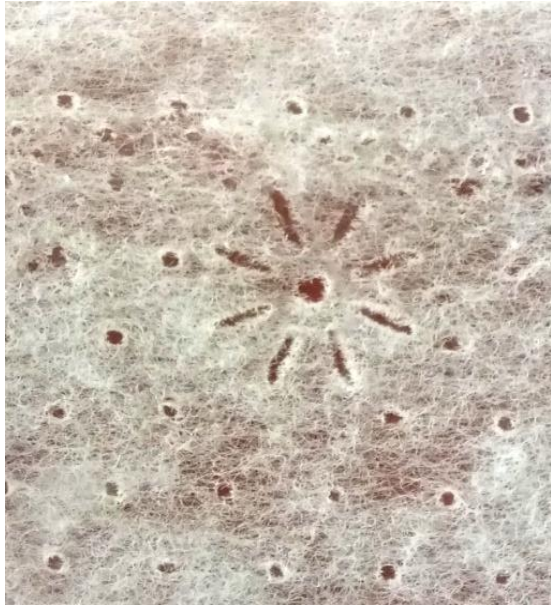
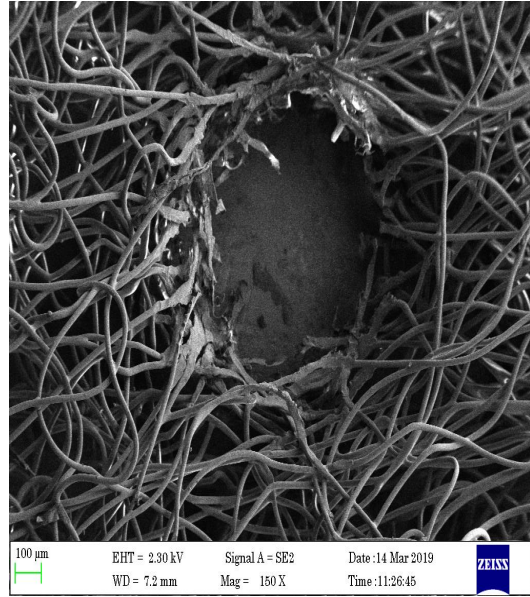


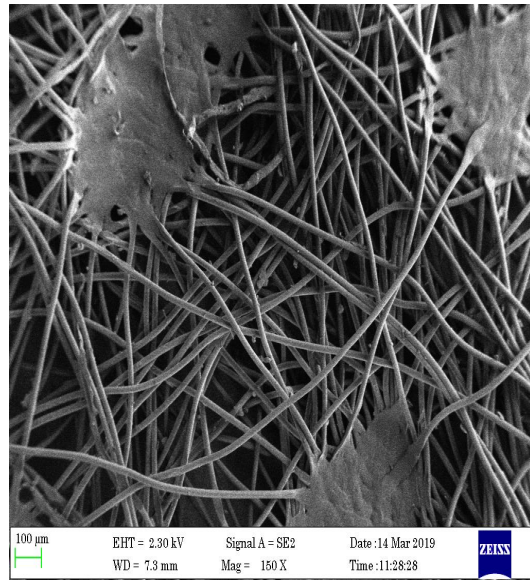
Plate-34  
O- Sample



SEM images



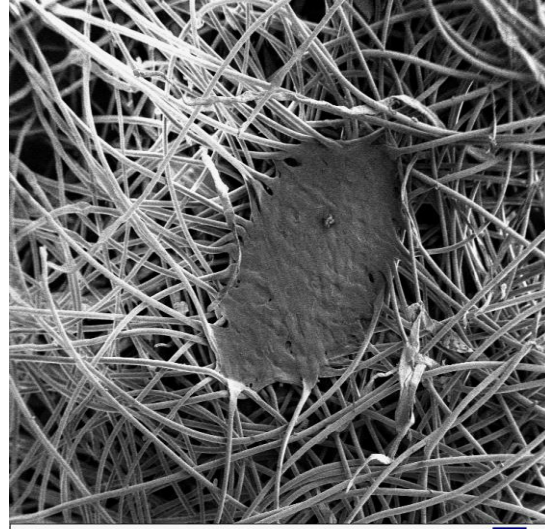
Plate-35  
Scarlett ultra



SEM image



Plate-36  
Bella normal maxi

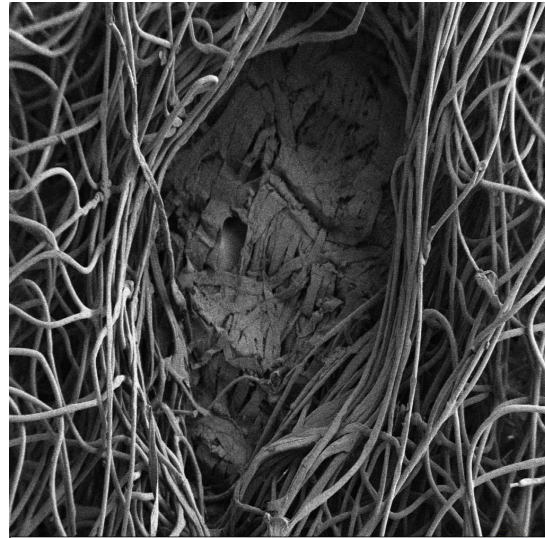


100  $\mu$ m EHT = 2.30 kV Signal A = SE2 Date :14 Mar 2019  
WD = 7.1 mm Mag = 150 X Time :11:42:56 ZEISS

SEM image



Plate-37  
Sofy antibacterial



100  $\mu$ m EHT = 2.00 kV Signal A = SE2 Date :14 Mar 2019  
WD = 6.9 mm Mag = 150 X Time :11:11:50 ZEISS

SEM image

SEM images indicate that the surface topography of the top layer used in commercial samples. All the images were taken at a magnification of 150X. The Whisper choice aloe vera freshness images clearly show the cellulose fibers which are flat when compared with synthetic fibers used in other samples. The points of sealing during calendring is also clearly visible which holds the fibers together in all samples except stay free dry max in which structure is very open. This clearly indicates the presence of more pores in all samples for quick absorption.

## **Summary and conclusion**

## 5. SUMMARY AND CONCLUSION

The hygiene textile is one of the fast growing segments in medical textiles. Most of these hygiene products are disposables or single time usable products. These products are mainly made up of nonwoven structure. The range of products available for healthcare and hygiene is vast, but they are typically used either in the operating theatre or in the hospital wards for hygiene, care and safety of the staff and patients. They could be washable or disposable. The hygiene products include both disposable and non disposable products mainly used in hospitals such as wipes, baby diaper, adult diaper, sanitary pads, tampons and incontinence products.

Sanitary pads are designed to absorb and retain menstrual fluid discharge. The main requirements of sanitary pads are stop leak aging, prevent odor, absorbency, comfort and safety. The sanitary pad consists of three layer top sheet, absorbent core and barrier sheet. The present work is to evaluate and understands the dynamics of the sanitary napkins top layer that determines the amount of the liquid permeation through it and also evaluate the pH of these as separate core and sanitary pad as a whole and understand the properties affecting the same.

## METHODOLOGY

- The sample is prepared to evaluate pH value of the aqueous extract of the sanitary pads shall be held to be representative of the lot.
- The preparation of test specimens should be taken into separate core (absorbent) and sanitary pad as a whole and the sample in triplicates or of dimensions such that the test samples will rapidly wet out. Manipulate the material as little as possible.
- Prepare the extract in triplicate at the temperature of laboratory by taking a test specimen weighing  $2 \pm 0.05\text{g}$  and 100 ml of the distilled water into a Stoppard glass flask agitate the flask for 20-30 min by hand to ensure that the specimen is properly wetted out.
- Ensure that the electrodes in the strike-through plate are clean. Place the strike-through plate on top of the non woven, with the center of the plate over the center of the test piece. Center the burette and the funnel over the plate.
- Adjust the height of the funnel so that it is  $(5 \pm 0.5)$  mm above the top of the cavity in the plate.
- Ensure the electrodes are connected to the timer activate the timer and set the clock to zero.
- Keep the discharge valve of the funnel closed and run 5.0ml of liquid from the burette into the funnel.
- Open the magnetic discharge valve of the funnel to discharge 5.0 ml of liquid.
- The initial flow of liquid will complete the electrical circuit and start timer.
- Then shake it mechanically for 20-30 minutes .

- pH value can be measured by using digital pH meter.
- The sample is prepared to evaluate Liquid strike through test for sanitary pad top sheet according to the ISO 186, ensuring that the areas from which the samples are taken have no visible flaws and are not creased.
- The preparation of test specimen can be swatches into 10 pieces measuring 125mm\*125mm.
- The test piece should be in condition and filter papers in one of the atmospheres specified in ISO 1390.
- Liquid strike through test first set up the ring stand holding the funnel and positions the burette with the tip inside the funnel.
- Place one nonwoven test piece on top of one set of five filter paper on the base plate.
- Place the nonwoven on the filter paper in such a way that the side of the nonwoven which is intended to be in contact with the user's skin is upper most.
- It will stop when all the liquid has penetrated into the nonwoven and fallen below the level of the electrodes in the strike-through plate.
- Record the time indicated on the electronic timer. Repeat for the required number of test pieces.
- The Fourier transform infrared spectroscopy is an analytical technique used to identify the top film material in commercially available sanitary pads.
- This technique measures the absorption of infrared radiation by the sample material versus wave length.
- The infrared absorption bands identify molecular components and structure for sanitary pads.
- The frequency range of FTIR is measured as wave numbers typically over the range 650-4000  $\text{cm}^{-1}$  in transmission mode.
- The sanitary pads (top film) was taken separately to identify the surface morphological analysis was performed using a Scanning electron microscope (care zeiss) the magnified images allowed the analysis of the structure of sample.

## **FINDINGS OF THE STUDY**

### 1. pH Test:

- The results obtained from the experiments were compared and checked in triplicates.
- The inferences showed that is no discrete change in the core layer as well as the whole pad. Statistical analysis using a t-test at a confidence level of 0.05 showed no significant difference between the core and the whole napkin.
- This indicates that the raw materials used in the sanitary napkin such as glue, top layer and bottom layer didn't contribute much difference in pH.

- As per IS standard for sanitary napkin, the pH should fall between 6.5-8.5 as shown in above graph except first one, most of the commercial samples when tested were within this range.
2. Liquid strike through test:
- We could observe that all the commercial samples would allow the liquid within a range of 0.6-7 secs.
  - However, we could not correlate between the time and thickness as it was independent and also the type of test liquid also has an effect due to the surface tension, the surface topography and the porosity was influencing the liquid strike through properties in sanitary pads.
  - The SEM indicates that o-sample has more openings when compared with any sample. The maximum time was observed in scarlett ultra which has minimal openings despite being thinner.
  - Different structures and porosity contribute a lot for the liquid penetration through the top layer.

### **FTIR ANALYSIS:**

- FTIR test was performed to analyze the type of material that was used for making sanitary napkin top sheet.
- As indicated from the above graphs, most of the sanitary napkin top sheet is made up of polypropylene; very few are made up of cellulose. (Sofy, whisper choice aloe vera, stay free secure cotton and kotex).
- For all the cellulose material, a band at 3333-3500  $\text{cm}^{-1}$  refers to the O-H stretching, indicating cellulose material.
- For polyolefin's we can see C-H stretching at 2800-3000  $\text{cm}^{-1}$  and  $\text{CH}_2$  stretching at 1450  $\text{cm}^{-1}$  indicate that of polyolefin's.

### **SEM ANALYSIS:**

- The points of sealing during calendaring is also clearly visible which holds the fibers together in all samples except stay free dry max in which structure is very open.
- This clearly indicates the presence of more pores in all samples for quick absorption.

### **CONCLUSION**

To conclude, there was no much significant difference in terms of pH between the absorbent cores in comparison with whole napkin itself. Clearly all samples were within the IS

standard range of 6.5-8.5 except one sample. FTIR clearly indicated that both polypropylene and cellulose fibers were in the making of the top sheet which effected the liquid strike through. All the samples absorbed within maximum time frame of 7s irrespective of thickness, GSM, material, porosity. We couldn't co-relate between these parameters as they were independent of the result obtained in liquid strike. Porosity plays a significant role in the liquid strike through, which can be observed in the SEM images. Overall, the commercial samples fall as per standard when tested accordingly.

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