

**DESIGN AND DEVELOPMENT OF NEEDLE PUNCH FABRIC  
USING BAGGASE**

**M.NANDHINI  
(16PBX004)**

A Thesis Submitted To The  
Avinashilingam Institute for Home Science and  
Higher Education for Women  
Coimbatore-641 043

*In partial fulfilment of the requirement for the*

**DEGREE OF MASTER OF SCIENCE**

**IN**

**BIO TEXTILES**

**APRIL, 2018**

---

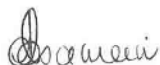
**DESIGN AND DEVELOPMENT OF NEEDLE PUNCH FABRIC  
USING BAGGASE**

**M.NANDHINI  
(16PBX004)**

A Thesis Submitted To The  
Avinashilingam Institute for Home Science and  
Higher Education for Women  
Coimbatore-641 043

*In partial fulfilment of the requirement for the*  
**DEGREE OF MASTER OF SCIENCE**  
**IN**  
**BIO TEXTILES**  
**APRIL, 2018**

Certified as Bonafide Research Work



Signature of the  
Head of the Department



Signature of the  
Supervisor

## ACKNOWLEDGEMENT

The investigator places her humble salutations and prayer to the **ALMIGHTY GOD** for his uncountable blessings showered upon her throughout the study.

The investigator expresses her sincere thanks to the former chancellor of Avinashilingam Institute for Home Science and Higher education for women, Coimbatore, **AYYA THIRU. Dr. T .S. AVINASHILINGAM** and former vice chancellor **HONY.COL.PADMASHRI, AMMA, Dr. (Tmt). RAJAMMAL P. DEVADAS, M.A., M.Sc., Ph.D.(ohio state), Hon. D.SC. (Azad Agri. University, Kanpur),** for their heavenly blessing.

The investigator expresses her sincere thanks to **PadmashriDr.P.R.KRISHNAKUMAR,** Chancellor, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for providing the infrastructural facilities for the conduct of the study.

The investigator is indebted to **Dr. (Mrs.) PREMAVATHY VIJAYAN, M.Sc., M.Ed., Dip.spl.Edn. M.Phil.,Ph.D., Vice-Chancellor, Avinashilingam Institute for Home Science and Higher Education For Women, Coimbatore,** for providing all the amenities required for the conduct of the study.

The investigator records her gratitude to **Dr. (Mrs.) S.KOWSALYA, M.Sc., M.Phil., Ph.D., Registrar, Avinashilingam Institute for Home Science and Higher Education For Women, Coimbatore,** for providing all the help for the smooth conduct of the study.

The investigator records her respectful tribute to **Dr. (Mrs.) N.VASUGIRAAJA, M.Sc., M.B.A., M.Phil. (Madras), Ph.D.,** Dean, Faculty of Home Science, Department of Textiles And Clothing, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for constant support , guidance and encouragement which have helped in the successful completion of this study.

She expresses her respectful regards and sincere thanks to **Dr. (Mrs.) S.AMSAMANI, M.Sc., M.Phil., Ph.D.,** Professor and Head of the Department, Department of Textiles and

Clothing, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for rendering all help needed for the successful completion of the study.

The investigator feels extremely proud and privileged for having worked under the guidance of her esteemed guide **Dr. (Mrs.) S.AMSAMANI**, M.Sc., M.Phil, Ph.D., Assistant Professor, Department of Textiles and Clothing, Avinashilingam Institute for Home Science and Higher Education For Women, Coimbatore, for her constant motivation, keen interest, restless support, untiring patience, innovative ideas, suggestions, constant love and easy approach throughout the study.

She also wishes to thank all the **TEACHING AND NON TEACHING STAFF** members of the department of textiles and clothing for their help to carry out the research work.

I extend my sincere thanks to **Dr. PRAKASH VASUDEVAN**, Director – South India Textile Research Association (SITRA) and **Dr. KETAN KUMAR VADADORIA** Head of the Department – Coe Medical Textile SITRA for permitting to carry out the project and for their timely help for the study.

It's the privilege and honor to record my extend of gratitude to **Mr. T. SURESHRAM** Senior scientific officer department of physics- COE (centre of excellence for medical textiles), South Indian Textile Research Association (SITRA), for his guidance's, encouragement, motivation and inspiration throughout the course of study.

I take immense pleasure to thank **Mr. S. RAVICHANDRAN, Ms. R. SHANTHI, Mr. S. SANGRAM** COE – physical laboratory and other staff members of COE SITRA for their incredible help, encouragement, patient and cooperation in carrying out the thesis work. Their kind support and timely help have been a great value for complete the research work.

The investigator gratefully acknowledges the encouragement, timely help and support received from her friends. She expresses her deepest sense of gratitude to her **Beloved Parents, Family members and Friends** for extending their support without whom the study would never have seen the light of the day.

## CONTENTS

CHAPTER NO	TITLE	PAGE NO
	LIST OF TABLES	
	LIST OF FIGURES	
	LIST OF PLATES	
	LIST OF APPENDICES	
<b>I.</b>	<b>INTRODUCTION</b>	<b>1</b>
<b>II.</b>	<b>REVIEW OF LITERATURE</b>	<b>8</b>
	2.1 Non-woven	11
	2.1.1 Introduction	11
	2.1.2 History of non-woven	11
	2.1.3 Uses of Non-woven fabric	13
	2.1.4 Advantages of nonwoven	14
	2.1.5 Types of Nonwoven Fabrics	14
	2.1.5.1 Materials produced by physicochemical methods	15
	2.1.5.2 Mechanically produced materials	16
	2.1.6 Properties of Non-woven Fabric	20
	2.1.7 Non-woven Fabrics Produced in Textile Industry	20

2.2 Natural fiber	20
2.2.1 Cotton	20
2.2.2 Advantages of cotton	22
2.2.3 Disadvantages of Cotton	22
2.2.4 Properties of Cotton Fibers	22
2.2.5 Characteristics of Cotton Fiber	23
2.3 Bagasse fiber	24
2.3.1 Bagasse	24
2.3.2 Uses of Bagasse Fiber	24
2.3.3 Advantages of bagasse fiber	25
2.3.4 Characteristics of sugarcane fibers	25
2.3.5 Bagasse Sugarcane Product	26
2.3.6 Composition and Properties of Bagasse Fibers	26
2.3.7 Physical Properties of the Bagasse Fibers	27
2.4 Composite	29
2.4.1 Advantages of Composite	29
2.4.2 Disadvantages of Composite	29

2.5 Raw Material for Sanitary pad	30
2.5.1 Types of Sanitary Napkin	30
2.5.2 Sanitary Napkin Size	31
2.5.3 Conventional Structure and Material used in Sanitary Napkin	31
2.5.4 Disposable Hygiene Product	32
2.5.5 Advantages of Bagasse Using Sanitary Pad	33
2.5.6 Carding Process	33
2.5.7 Needle Punching Process	34
2.5.8 Market Status	36
2.5.9 Sanitary Napkin Players & Consumers	36
<b>III EXPERIMENTAL PROCEDURE</b>	<b>37</b>
3.1 Selection of Raw Material	38
3.2 Selection of Fabric Construction Method	39
3.3 Preparation of Non-woven Fabric	39
3.3.1 Lab Formation	39
3.3.2 Preparation of Layers for needle punching	42
3.3.3 Needle Punching	42
3.3.4 Preparation of Sanitary Napkin	43
3.4 Objective Evaluation	45

3.4.1 Air Permeability	45
3.4.2 Liquid Strike through Time	46
3.4.3 Disposability	47
3.4.4 Wet back method	47
3.4.5 Run of method	47
3.4.6 Centrifuge	48
3.4.7 FTIR	48
3.4.8 pH value	49
3.4.9 Size (Length and Width)	49
3.4.10 Thickness	49
<b>IV. RESULTS AND DISCUSSION</b>	<b>51</b>
4.1 Run of the Time	52
4.2 pH value	53
4.3 Length	54
4.4 Width	55
4.5 Thickness	56
4.6 Weight	57

## LIST OF TABLES

TABLE NO	TITLE	PAGE NO
I.	Properties of Cotton Fibers	22
II.	The quality of cotton depends on the following parameters	23
III.	Composition and properties of bagasse fibers	26
IV.	Physical Properties of the Bagasse Fibers	27
V.	Chemical Composition of Bagasse Fibers	28
VI.	Mechanical Properties of Bagasse Fibers	28
VII.	Sanitary Napkin Sizes	31
VIII.	NOMENCLATURE	45
IX.	Run of the Method	52
X.	pH value	53
XI.	Length	54
XII.	Width	55
XIII.	Thickness	56
XIV.	Weight	57

## LIST OF FIGURES

FIGURE NO	TITLE	PAGE NO
1.	Run of the Time	52
2.	pH value	53
3.	Length	54
4.	Width	55
5.	Thickness	56
6.	Weight	57

## LIST OF PLATES

PLATE NO	TITLE	PAGE NO
1.	SUGARCANE	40
2.	GRINED MACHINE	40
3.	SUGARCANE BAGASSE	40
4.	COTTON FIBER	40
5.	CARDING PROCESS MACHINE	41
6.	LAB FORMATION	41
7.	BAGASSE WITH COTTON	41

## APPENDICES

APPENDIX NO	TITLE	PAGE NO
I.	Sanitary Napkin sample	66

# I.INTRODUCTION

The term “nonwoven” became popular more than half a century ago when nonwovens were regarded as low-price substitutes for traditional textiles. However, today, the nonwoven fabric technology is the most modern method used in the branch of textile industry. Nonwoven technology exists to approximate the appearance, texture, and strength of conventional woven and knitted fabrics due to their simple production stages, high efficiency of production, lower cost, and disposability. Multi-layer nonwoven composites, laminates, and three-dimensional nonwoven fabrics are commercially produced. Nonwovens combined with other materials have different chemical and physical properties. Nonwovens have three key features and are as follows for the fabrics are composed of textile fibers. The basic structural element of textile fabrics is fibers, rather than yarns or threads. The fabrics are held together by means other than the interlacing or interloping characterizing traditional woven or knit fabrics. Therefore, nonwovens can be used as wide variety of industrial engineering, consumer, and health-care goods. (Lunenscholoss, 2014).

The major area in nonwovens can generally be split into disposable products such as diapers, sanitary wipes and napkins, and durable products such as materials for apparel, home building, packaging, and industrial applications (Gillies, 2011). This research focused on the durable nonwoven products. Nonwoven products are taking the place of many woven and knit materials because of their lower cost and lighter weight. In the automotive industry, it was estimated that the yearly demand for nonwoven materials consumed in the automotive

Among the textiles applications, nonwovens are one of the fastest-growing segments of the textile industry and constitute roughly one third of the fiber industry. (Albrecht, 2010).

Cotton nonwoven made exclusively from low cost, low-grade cotton waste has almost disappeared from the market; cotton in various forms is still used extensively in non woven fabrics. The cotton used today may be a waste, such a comber, and will produce a soft, absorbent non-woven fabric with good bulk and bonding properties. The practice of blending various fibers affords the opportunity to use clean inexpensive grades in blends with the more uniform man-made fibers. The principle uses for cotton are in disposables and medical textiles, which together

absorbed about 30 % of the total poundage, although any other fibers are used in these fields along with cotton.

Cotton has long been a dominant natural fiber in the textile industry. Low quality greige fibers or low value textile wastes predominantly consisting of cotton fibers that could not be used directly in the apparel industry, have a high potential in the manufacturing of composite nonwovens that are quite promising materials in the insulation market, especially in the automobile insulation market. (Aguilar, 2002).

Cotton fiber and the cross section of cotton fibers. Cotton's shape and structure make it suitable for the production of nonwoven bonded fabric: cotton has a ribbon-shaped cross-sectional form, spiral twist, a hollow structure, a high wet strength for a hollow structure, a high wet strength for a high module, and it is hygroscopic.

Cotton fiber was used extensively during the early development period of nonwoven business. Cotton mills in USA tried to find ways to upgrade the waste cotton fibers into saleable products. The first method was bonding the short cotton fibers with latex and resin. These products were used in industrial wipes. Over the past decade, bleached cotton fiber has been used for producing fabrics on conventional nonwoven equipment. These products were used in medical and health-care applications, wiping and wiper markets, and some apparel markets. At the same time, cotton fiber has physical properties like fiber length, strength, and resilience, which is important particularly to its process-ability. For example, long cotton fiber is suitable for producing nonwovens. The fiber has excellent absorbency and feels comfortable for the skin. The wet and dry strengths are good. Dimensional stability and resilience recovery are moderate. The spun lace process is usually utilized in producing medical and health-care fabrics, especially in Japan and the Asian region. (Wiley, 2003).

One of the most abundant natural fiber resources is the by-product of the sugar industry, viz., the bagasse. U.S. sugar mills produced about 13 million tons of dry bagasse in the year 2001 (Chen, & Negulescu, 2002). Bagasse has been widely used throughout the world in such products as pulp and paper, particle and fiber boards, poultry litter, agricultural mulch and soil conditioner (Rao, 2005). U.S., only a portion of bagasse has been used for power generation or as a raw material for producing low-value products, while large amounts of bagasse went to landfill or

were allowed to decay (Chen, & Negulescu, 2002). Disposal of bagasse has become a problem for both agricultural profitability and environmental protection.

The sugar cane stalk is composed of an outside rind and an inner pith. The inner pith consists mainly of short fibers and sucrose, while the outside rind contains longer fibers, arranged randomly throughout the stem. The fibers are bound together by lignin and hemicellulose (Collier, Collier, Thames, & Elsunni, 2005). Defined as the fibrous residue of the cane stalk from a sugar mill after crushing and extraction of the juice, bagasse is a mixture of hard rind fibers and soft pith tissue composed mainly of cellulose fibers, pentosans, lignin, sugar and minerals. The relative proportions of the components of the bagasse's cell wall are showed in Table 2-4 (Rao, 2005).

During cane harvest time, bagasse is readily available. Other than the harvest time, bagasse has to be stored for use. Special care is needed to prevent bagasse from fermentation due to its sugar content. To increase the storage life, bagasse is usually depithed before storage. The depithed and dried bagasse can be baled and stored outside. Bagasse can also be stored wet for several years if specially handled. In the wet method, large bales of bagasse are specially stacked to ensure adequate air flow; the heat from fermenting sugars will effectively sterilize the bales (Youngquist, 2006).

Sugarcane is also the Second generation biofuels could avoid many of these concerns since it relies on nonfood bio resources, such as lignocellulosics. These lignocellulosic materials are relatively inexpensive and available in large quantities. One of the most commonly examined lignocellulosic materials for second-generation ethanol production is sugarcane bagasse. (Krzysik, 2002)

Sugarcane is a versatile plant grown for sugar production, and its major by-product is bagasse. Bagasse is the residue obtained after sugarcane is milled for juice extraction. In sugarcane production, the bagasse retrieved from crops is roughly 27-28 dry weight % of plant biomass. It is a highly heterogeneous material that consists roughly of 20-30% lignin, and 40-45% cellulose and 30-35% hemicelluloses with limited amounts of extractives and ash. Its composition makes it a promising feedstock for second-generation 6 biofuel production. Similar to other lignocellulosic materials, sugarcane bagasse has low nutritional value, which precludes

concerns about the food vs. fuel debate. A variety of 8 species of sugarcane, Saccharin, are grown in Latin America, which leads it to numerous differing resources of bagasse, which is generally underutilized. Furthermore, bagasse represents approximately 0.3 metric ton for every 1 metric ton of sugarcane grown and is often considered a waste stream. A comprehensive understanding of bagasse chemical constituents and its physical and chemical characteristic changes associated with the bioconversion process from biomass to biofuel is necessary in order to amplify bagasse as a renewable source. The delicate problem for second-generation biofuel production is the optimization of pretreatment technologies, which may include hydrothermal, dilute acid, steam explosion, alkaline and organosolv. Although it is costly, the pretreatment of bagasse has been reported to facilitate up to 90% conversion of sugars to ethanol compared to 20% without pretreatment for acid hydrolysis.(Hofsetz, 2012).

Needle punching is the oldest method of producing nonwoven products. Needle punching technique has been used in industry since 1870s. The needle-punching process is very commonly used to manufacture medium to heavy weight nonwoven fabrics. The first needle punching loom in U.S. was made by James Hunter machine co. in 1948. Then in 1957, James Hunter produced the first high speed needle loom, the Hunter model 8 which is still used today. The bonding of webs by using needle punching technique is now a day's extensively utilized for the production of numerous products which not only competes with the conventionally used textiles, but exhibit properties hitherto unknown and not attainable by any other method.

The needle punching industry enjoys one of the greatest successes of any textile related process. The needle punching industry around the world is a very exciting and diverse trade involving either natural or both natural and synthetic fibers.

Nature has encompassed every solution within itself. With more and more use of natural fiber in hygiene product will make it ecofriendly. Use of natural fibre in sanitary pad will reduce the cost of the product will lower accessible to low income group women. As the product is biodegradable, prevent non-biodegradable waste generation. We as a technologist have to find a sustainable way so that we endow a better world for next generation. (Foster, 2002).

Currently, the world is facing a very big problem of carbon footprint of feminine hygiene product. As there is a huge amount of non-biodegradable material dumped in landfill, which

releases harmful gasses into to the atmosphere. India being a developing country, with a population of 1.34 billion, out of which 323.6 million female between the age group of 15-49. If we consider that 10% of Indian women uses disposable sanitary pad then each individual will generate at least half a kilo of waste a month. In that way, 10% of the female population in India will generate 16180 tons of waste every month. In order to deal with it, we need to focus on developing a more sustainable product by choosing the raw material having low carbon footprint. Material which are used in feminine hygiene product are derived from natural resource mostly petroleum based which cannot be reused or compost and at the same time over-exploitation of these resources have to be stopped otherwise nothing will be left for our future generation. We have to find an alternative raw material that is sustainable in nature, without compromising on the functional requirement of the product. (Farage, 2007).

Limited attention has been paid to the role of menstrual hygiene as a barrier to women's health and participation in society in the developing world. However, the effects on quality of living are substantial. Inadequate access to sanitation has been linked to school absenteeism, productivity declines, rashes and infections, and seclusion and embarrassment. In fact, found that 14% of girls studied between ages 15-18 in Iran stated that dysmenorrhea interfered with their daily life activities and caused them to be absent from school one to seven days per month. (Bharadwaj, 2004).

The development of the sanitary napkin in the west has a long history that takes advantage of a number of innovations in materials and materials processing. Prior to the 1920s, American women hand-produced napkins from cotton, gauze, flannel, or rags to be pinned to undergarments and hand-laundered (Vostral, 2008).

Over the last thirty years composite materials, plastics and ceramics have been the dominant emerging materials. The volume and numbers of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly. Modern composite materials constitute a significant proportion of the engineered materials market ranging from everyday products to sophisticated niche applications. While composites have already proven their worth as weight-saving materials, the current challenge is to make them cost effective.

A composite is a material that consists of more than one component, in which at least one of the components remains in solid state during its manufacture. (Weeton, 1987). The light weight and superior mechanical properties of polymer composites have made them good candidates for applications in wide areas of the modern industry that range from transportation, building, to medicine and packaging (Seavey, Ghosh, Davis, & Glasser, 2001).

The efforts to produce economically attractive composite components have resulted in several innovative manufacturing techniques currently being used in the composites industry. The composites industry has begun to recognize that the commercial applications of composites promise to offer much larger business opportunities than the aerospace sector due to the sheer size of transportation industry. Thus the shift of composite applications from aircraft to other commercial uses has become prominent in recent years. The introduction of newer polymer resin matrix materials and high performance reinforcement fibers of glass, carbon and aramid, the penetration of these advanced materials has witnessed a steady expansion in uses and volume. The increased has resulted in an expected reduction in costs. High performance FRP can now be found in such diverse applications as composite armoring designed to resist explosive impacts, fuel cylinders for natural gas vehicles, windmill blades, industrial drive shafts, support beams of highway bridges and even paper making rollers. For certain applications, the use of composites rather than metals has in fact resulted in savings of both cost and weight. Some examples are cascades for engines, curved fairing and fillets of pre-existing structures that have to be retrofitted to make them seismic resistant, or to repair damage caused by seismic activity. Whilst the use of composites will be a clear choice in many instances, material selection in others will depend on factors such as working, lifetime requirements, number of items to be produced (run length), complexity of product shape, possible savings in assembly costs and on the experience & skills the designer in tapping the optimum potential of composites. In some instances, best results may be achieved through the use of composites in conjunction with traditional materials. (Sujan, 2013).

Considering the above mechanical facts as study on “Design and Development of Needle punch fabric using bagasse” Was planned. The main objectives of the study are

## **Objectives;**

- To identify suitable natural source for preparation of non-woven textiles.
- To prepare non-woven textile using bagasse.
- To use the prepared non-woven bagasse textile material for preparation of sanitary pad.
- To evaluate the physical properties of the prepared non-woven textile and sanitary pad.

## **2. REVIEW OF LITERATURE**

Reviews of literature for the present study on Design and Development of “**Needle Punch Fabric Using Bagasse**” are discussed under the following headings:

### **2.1 Non-woven**

2.1.1 Introduction

2.1.2 History of non-woven

2.1.3 Uses of Non-woven fabric

2.1.4 Advantages of nonwoven

2.1.5 Types of Nonwoven Fabrics:

2.1.5.1 Materials produced by physicochemical methods

2.1.5.2 Mechanically produced materials

2.1.6 Properties of Non-woven Fabric

2.1.7 Non-woven Fabrics Produced in Textile Industry

### **2.2 Natural fiber**

2.2.1 Cotton

2.2.2 Advantages of cotton

2.2.3 Disadvantages of Cotton

2.2.4 Properties of Cotton Fibers

2.2.5 Characteristics of Cotton Fiber

## **2.3 Bagasse fiber**

2.3.1 Bagasse

2.3.2 Uses of Bagasse Fiber

2.3.3 Advantages of bagasse fiber

2.3.4 Characteristics of sugarcane fibers

2.3.5 Bagasse Sugarcane Product

2.3.6 Composition and Properties of Bagasse Fibers

2.3.7 Physical Properties of the Bagasse Fibers

## **2.4 Composite**

2.4.1 Advantages of Composite

2.4.2 Disadvantages of Composite

## **2.5 Raw Material for Sanitary pad**

2.5.1 Types of Sanitary Napkin

2.5.2 Sanitary Napkin Size

2.5.3 Conventional Structure and Material used in Sanitary Napkin

2.5.4 Disposable Hygiene Product

2.5.5 Advantages of Bagasse Using Sanitary Pad

2.5.6 Carding Process

2.5.7 Needle Punching Process

2.5.8 Market Status

2.5.9 Sanitary Napkin Players & Consumers

## **2.1 NON-WOVEN**

### **2.1.1 Introduction**

Non-woven fabrics are engineered fabrics that may be a limited life, single-use fabric or a very durable fabric. Non-woven fabrics provide specific functions such as absorbency, liquid repellency, resilience, stretch, softness, strength, flame retardancy, wash ability, cushioning, filtering, bacterial barrier and sterility.

Non-woven fabric is a fabric-like material made from long fibers, bonded together by chemical, mechanical, heat or solvent treatment. The term is used in the textile manufacturing industry to denote fabrics, such as felt, which are neither woven nor knitted. Non-woven materials typically lack strength unless densified or reinforced by a backing. In recent years, nonwovens have become an alternative to polyurethane foam.(Bardhan, 2006).

### **2.1.2 History of non-woven**

The term nonwoven is an interesting word. To most, the word nonwoven means “not a woven” or “not a knit”, but nonwoven fabrics are much more. The Prologue of Technology provides a historical listing of possible beginnings of nonwovens. These hypothetical beginnings range from historical legends to early technology developments. The actual roots of nonwovens may not be clear but in 1942 the term “nonwoven fabrics” was coined and were produced in the United States. These early “nonwoven fabrics” were created by adhesively bonding fiber webs. The first written definition of nonwoven fabrics came from the American Society for Testing and materials in 1962 which defined them as “textile fabrics made of carded web or fiber web held together by adhesives”. Currently INDA defines a nonwoven as “sheet or web structures bonded together by entangling fiber or filaments (and by perforating films) mechanically, thermally or chemically. They are flat, porous sheets that are made directly from separate fibers or from molten plastic or plastic film. They are not made by weaving or knitting and do not require converting the fibers to yarn” (INDA). Technical definitions express the fundamental basis for the nonwoven processes, but due to the wide variety of production techniques, a general description of nonwoven fabrics is not enough. As with woven or knitted fabrics each process possesses unique characteristics. The resulting fabrics do not have much in common aside from

being categorized as nonwoven. Nonwoven components such as; fiber selection, web formation, bonding, and finishing techniques can be altered to manipulate fabric properties or reverse engineer fabrics based on functional requirements. Due to its assortment of achievable characteristics nonwoven fabrics penetrate a wide range of markets including medical, apparel, automotive, filtration, construction, geotextiles, and protective. One of the oldest nonwoven fabrics is felt. Felt is either 100% wool fibers, or a blend containing wool fibres. These fibers are then treated with heat, moisture and then agitated. In 1930's and 1940's synthetic polymers, with thermoplastic properties, were developed and introduced on to the market. Freudenberg (a major player in the nonwovens market to this day) began trading in 1938 and went into production artificial leather for World War Two. The main nonwoven process technologies were developed between 1940 and 1965, and this can be seen as the start of the nonwovens industry

The term “nonwoven” became popular more than half a century ago when nonwovens were regarded as low-price substitutes for traditional textiles. However, today, the nonwoven fabric technology is the most modern method used in the branch of textile industry. Nonwoven technology exists to approximate the appearance, texture, and strength of conventional woven and knitted fabrics due to their simple production stages, high efficiency of production, lower cost, and disposability. Multi-layer nonwoven composites, laminates, and three-dimensional nonwoven fabrics are commercially produced. Nonwovens combined with other materials have different chemical and physical properties. Therefore, nonwovens can be used a wide variety of industrial engineering, consumer, and health-care goods. (Bernard, 2011)

While manufacturing nonwovens some conventional textile operations, such as carding, drawing, roving, spinning, weaving, or knitting, are partially or completely eliminated. For this reason, the choice of fiber is directly related to fabric quality. All kinds of fibers can be used to produce nonwoven fabrics. The selection of fibers is based on the following features:

- The cost-effectiveness
- The ease of process ability, and
- The desired end-use properties of the web.

The commonly used fibers include natural fibers (cotton, jute, flax, and wool), synthetic fibers (polyester (PES), polypropylene (PP), polyamide, and rayon), special fibers (glass, carbon, Nano fibers, bio component, superabsorbent fibers).

Two or more types of fibers are typically utilized. The fibers are usually blended or mixed in order to improve performance properties of nonwovens, such as strength and other properties. The fiber blend or mix can be natural/natural, synthetic/synthetic, or natural/synthetic.

Man-made fibers are the most widely used in the nonwoven industry. Owing to impurities and higher costs, natural fibers are of minor importance for the production of nonwovens. Fiber characteristics influence not only nonwoven fabric properties but also processing performance. Web cohesion, fiber breakage, and web weight uniformity are the key quality parameters and are influenced by fiber diameter, fiber length, fiber tensile properties, fiber finish, and crimp. The properties of nonwoven fabrics are largely dependent on fiber properties and fabric structural geometry.(Turbak, 2008).

The utility of nonwoven products increased dramatically in the last decade due to their light weight and low production cost. Nonwovens have found utility in automotive manufacturing, building construction, medical applications, etc. There are two important steps in nonwoven manufacturing that will influence the characteristics of the final product: the first is the forming of the fiber web, and the second is the web bonding method. In the web forming procedure it is customary to blend two or more fibers in order to improve the characteristics of the final product.(Chiparus, 2004).

### **2.1.3 Uses of the nonwoven fabric**

- medical and health non-woven fabrics: surgical clothing, protective clothing, disinfection cloth, medicine bags, masks, diapers, civilian clothes, wipes, wet towel, magic towel, Counting Towel Roll, beauty products, sanitary napkins , sanitary pads, and disposable hygiene with a cloth;
- Non-woven home decoration: carpets, paste wall coverings, tablecloths, sheets, bedspreads, curtains, scouring pads, mops and the like;

- Non-woven clothes: lining, interlining, flasks, stereotypes cotton, all kinds of synthetic leather, fabric and so on
- non-woven fabrics for industrial use; car roof sheeting, filter materials, insulation materials, packing bag, geotextiles, coated fabrics and so on;
- Non-woven fabrics agriculture: crop protection cloth, cloth seedlings, irrigation cloth, insulation curtain, etc.

#### **2.1.4 Advantages of nonwoven**

The advantages of using nonwovens instead of traditional textiles

- Excellent absorption
- Softness
- Smoothness
- Stretch-ability
- Comfort and fit
- Strength
- Double fluid barrier effect allowing moisture to be absorbed and retained
- Good uniformity
- High strength and elasticity
- Good strike through, wet back and run off
- Cost effectiveness
- Stability and tear resistance
- Opacity / stain hiding power
- High breathability

#### **2.1.5 Types of Nonwoven Fabrics**

Nonwovens, depending on the production process can be divided into:

- Materials produced by physicochemical methods and
- Mechanically produced materials.

### **2.1.5.1 Materials produced by physicochemical methods**

Most nonwoven materials are made by binding fibers with adhesives. The most common glued materials are those based on fibrous cloth (a layer of textile fibers whose weight is 10–1000 gsm and more). The cloth is most often formed mechanically from several layers of combed fibers passing through the dotting drum of a combing machine. Fibrous cloth may be produced by the aerodynamic method in which the fibers are removed from the drum of the combing machine by a stream of air and transferred to a mesh drum (condenser) or a horizontal mesh with a maximum speed of up to 100 m/min, or by water dispersion of the fibers on the mesh of a paper machine.

A fibrous cloth is usually made of cotton, a mixture of viscose and polyamide fibers or the waste products of textile manufacture, including unspun fibers. The most common method of producing bonded nonwoven materials is to impregnate the cloth with a liquid adhesive or spraying/printing the adhesive over the surface of the cloth. Gluing the fibers includes saturate bonding and spray bonding or a latex adhesive is applied to the fibers and then the fabric is dried. The impregnated material is dried and treated in chambers heated by hot air or infrared radiation. The nonwoven materials made in this fashion (at a rate of 50 m/min and more) are used as interlacing and sealing materials, as heat and sound insulation materials for upholstery, bedding and drapery liners.

Melting fibers together can only be accomplished with synthetic, thermoplastic fibers or with a blend of fibers containing thermoplastic fibers or fusible powders. These methods include thermal bonding (heat applied to the web with or without pressure) a carded web, thermobonding a spun laid web with a calendar, thermo bonding a melt blown or flash spun web with a calendar, thermal bonding a carded or air laid high loft web in an oven. In the hot-pressing process, the fibers are bonded by thermoplastics such as polyamides, polyethylene, and polyvinyl chloride at pressures of up to 2 mega newtons per sq m (MN/m<sup>2</sup>), or 20 kilograms-force per sq cm (kgf/cm<sup>2</sup>), at high temperatures, usually on special calenders. The bonding is preceded by thermal treatment of the fiber layer, which contains an adhesive that is applied to the fibrous cloth during its formation or after its formation.

In the spun bonded method, synthetic fibers are formed as they leave the spinnerets of spinning machines and pass through troughs in which they are stretched in an air current; they are then placed on a conveyor belt and form a sheet. The material formed in this way is most often bonded with an adhesive; in some cases the stickiness of the fibers themselves is sufficient.

### **2.1.5.2 Mechanically produced materials**

Mechanically produced material are listed below

- **Stitch bonded Nonwovens**

According to the maliwatt technique in the German Democratic Republic [GDR] and the Arachne technique in Czechoslovakia, stitched nonwoven materials are made by joining fibers into the fabric, which is moving through a knitting-stitching machine, stitching with threads placed and joined like foundation stitches on a knitting machine. Such nonwoven materials are used as thermal insulation or packing material or as the foundation in the manufacture of quilts, blankets and jackets.

Thread-stitched nonwoven materials (Malimo materials; GDR) are made by stitching with one or more thread systems. They are used for decoration, for beach wear or for towels. Especially useful are thread-stitched materials with pile loops (half-loops), which can compete successfully with woven shag fabrics. Sheet-stitched nonwoven materials are made by stitching a pile-woven textile sheet with napped yarn which facilitates improved structure and properties of the sheet. Foundations for tufted carpets (550 cm wide) are stitched with carpet yarn, using needles to pull it through the fabric. On the return motion of the needle, the worsted is caught on a hook, and a loop is made. To secure the loops, an adhesive is applied to the reverse of the carpet. Thread less nonwoven materials are made on knitting-stitching machines (Vortex material in the GDR and Arabeva in Czechoslovakia). Such materials may consist of fabric and cloth made of staple fibers. After the cloth fibers are pulled through the scrim, sturdy loops are formed on the reverse of the material, and a deep, fluffy pile is formed on the front. Such materials are used as thermal stuffing or linings for rugs and carpets and blankets.

- **Mechanical interlocking**

Mechanically interlocking includes spun lace (hydro entangled) and needle punching. Spun lacing is a process of entangling a web of loose fibers on a porous belt or moving perforated or patterned screen to form a sheet structure by subjecting the fibers to multiple rows of fine high-pressure jets of water. The formed web is first compacted and rewetted to eliminate air pockets and then water needled. Pressures as high as 2200 psi are used to direct the water jets onto the web. The impinging of the water jets on the web causes the entanglement of fibers. The jets exhaust most of the kinetic energy primarily in rearranging fibers within the web and, secondly, in rebounding against the substrates, dissipating energy to the fibers. A vacuum within the roll removes used water from the product, preventing flooding of the product and reduction in the effectiveness of the jets to move the fibers and cause entanglement.

The application of spun lace nonwovens includes kitchen and bath towels and wipes and also for bed linen as they are eco-friendly, oil and water absorbent, bacteria proof with no smell and safe for sensitive skin.

- **Melt blowing**

The melt blowing process is a one-step process in which high-velocity air blows a molten thermoplastic resin from an extruder die tip onto a conveyor or take-up screen to form a fine fibrous and self-bonding web. In other words it is a nonwoven web forming process that extrudes and draws molten polymer resins with heated, high velocity air to form fine filaments. The filaments are cooled and collected as a web onto a moving screen. In some ways the process is similar to the spun bond process, but melt blown fibers are much finer and generally measured in microns. Melt blowing is a spun laid process. The term is also spelled “melt blowing.

- **Needle punching**

Needle punched nonwovens are created by mechanically orienting and interlocking the fibers of a spun bonded or carded web. This mechanical interlocking is achieved with thousands of barbed felting needles repeatedly passing into and out of the web with the help of a needle loom. It is a kind of dry non-woven, nonwoven fabrics of acupuncture is the use of the needle puncture effect, fluffy fiber net reinforcement into cloth.

The needle loom is made up of needle board with thousands of needles is fitted into a needle beam which passes up and down through two perforated plates the bottom web plate moves the fabric and the top stripper plate which removes the fibers from the needles. The exit rolls wind the needle punched fabric at the end of the loom. Four types of nonwovens for mattresses namely medium soft, hard with plain surface, one side hard and one side soft and nonwoven poly pet are used as intermediate product by home furnishing manufacturers and mattress manufacturers. They are also used as spring insulators that hold staples that fasten the upholstery to the wood frame, insulators in mattress construction to cover springs and as flanges are the panels of material that surrounds the edge of the mattress and join the mattress top and bottom together.

- **Air laid paper**

Air laid paper is a textile-like material categorized as a nonwoven fabric made from wood pulp. Unlike the normal papermaking process, air-laid paper does not use water as the carrying medium for the fiber. Fibers are carried and formed to the structure of paper by air. The characteristics of air laid paper nonwovens are outstanding absorbency for wipes and towels, multi-layered materials that gather dust, microbes, and other household irritants efficiently and economically, tabletop and table napkin with excellent printability, versatile fabrics for every task from dusting to heavy scrubbing, improved strength in wet or dry wiping, specialty fabrics available for pre-moistened wipes, low lint-gathering properties and embossed wipe surface for antimicrobial qualities. The applications include napkins and tablecloths, pre-moistened cleaning wipes, dry wipes, kitchen towels, vacuum cleaner bags and kitchen and fan filters.

- **Engineered nonwoven fabrics**

A major benefit of a nonwoven is the ease of engineering physical property requirements into the fabric that may be necessary for specific conversion operations or performance issues. Nonwovens that go into the home furnishing market are relatively easy for manufacturers to produce as opposed to more technical applications. Household furnishings must withstand high wear and tear, stains, spills and dirt which bring in the necessity of engineering nonwovens to ensure a longer lifespan. Thermal bonded spun laid polyester nonwovens made from bicomponent filaments, with a polyester core and a polyamide skin, are used as a primary backing in applications such as tiles and broadloom carpeting for dimensional stability. Spun bonded nonwovens are ideal for the furniture, bed coverings, spring insulation, quilting and cushioning markets. High loft needle punch and spun bond technologies are used to produce indoor and outdoor bedding products, quilts, comforter tops and pads. High loft provides the bulk and resilience and needle punching the strength and stability to the products.

Engineered nonwoven fabrics can be designed to have an extremely high melting point as well as dimensional stability at high temperatures. Relative to their weight, engineered nonwoven fabrics can be designed to wear better than comparable weights of woven or knitted materials. When used as backing material, engineered nonwoven fabrics can increase the longevity of upholstery by reducing internal abrasion (up to five times more durable than other traditional materials). Many engineered nonwoven fabrics have higher tensile, tear, and burst strength than their traditional textile counterparts and can resist repeated load bearing. Home furnishings can thus retain their form and appearance over longer periods of time, making them very cost-effective.

Engineered nonwoven fabrics can be designed to retain fluids and to resist staining. Engineered nonwoven fabrics can also be designed to resist attack by many solvents, alkalies, and other chemicals. (Bernard, 2011)

### 2.1.6 Properties of Non-woven Fabric

Some key characteristics of non-woven fabrics have pointed out in the below

- The presence of non-woven fabrics maybe felt like, paper like or very similar to that of **woven fabrics**.
- Non-woven fabric may be too much thicker than or as thin as tissue paper.
- It may be opaque or translucent.
- Some non-woven fabrics have excellent launder ability where others have none.
- The drapability of non-woven fabric varies from good to none at all.
- Burst strength of this fabric is to very high tensile strength.
- Non-woven fabric may be fabricated by gluing, sewing or heat bonding.
- Non-woven fabric may have a resilient, soft hand.
- This type of fabric may be stiff, hard, or broadly with little pliability.
- These types of fabric porosity ranges from low tear.
- Some non-woven fabrics may be dry-cleaned.

### 2.1.7 Non-woven Fabrics Produced in Textile Industry

Those are listed in the following:

• Geotextile fabrics	• Diaper cover stocks
• Filters (Air & Liquid	• Barriers in Medical diapers
• PVC copolymers	• Medical Products
• Industrial protective apparel	• Hazmat Applications
• Surgical gowns	• Home furnishing
• House Wrap Sealing	• performance standing leg cuff
• Blankets	• Automotive interior trim Carpets
• Upholstery	• Felt

<ul style="list-style-type: none"> <li>• Heat insulation</li> </ul>	<ul style="list-style-type: none"> <li>• Sound insulation</li> </ul>
<ul style="list-style-type: none"> <li>• Automotive heat insulation</li> </ul>	<ul style="list-style-type: none"> <li>• Acrylic weather ability water repellency</li> </ul>
<ul style="list-style-type: none"> <li>• Roofing</li> </ul>	<ul style="list-style-type: none"> <li>• Insulation</li> </ul>
<ul style="list-style-type: none"> <li>• Face masks</li> </ul>	<ul style="list-style-type: none"> <li>• Synthetic leather</li> </ul>
<ul style="list-style-type: none"> <li>• Cushion pads</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Medical Products</b></li> </ul>
<ul style="list-style-type: none"> <li>• Protective wrapping material</li> </ul>	<ul style="list-style-type: none"> <li>• Blood filters</li> </ul>
<ul style="list-style-type: none"> <li>• Flame retardancy.</li> </ul>	

## 2.2 Natural fibers

Natural plant fibres are cell walls that occur in stem and leaf parts and are comprised of cellulose, hemicelluloses, lignins and aromatics, waxes and other lipids, ash and water-soluble compounds.(Akin, 2008).

### 2.2.1 Cotton

Cotton is the most important vegetable fiber used to produce nonwoven bonded fabrics. The oldest textiles made from cotton originated around 5800 B.C. At present, cotton is cultivated in about 75 countries on 79 million acres of land, which represents about 0.8 % of all agricultural areas worldwide. Cotton plants grow in shrub-or tree-like forms to heights o from 25 cm to 2 m, depending on origin, soil, climate, and cultivation conditions. It grows fruit the size of walnuts which contain seeds that burst open and the cotton swells out in thick white flocks. The process of sowing to harvesting takes 175-225 days. Hand picking is advantageous compared to machine picking, as only fibers from completely mature capsules are being collected. After the harvest, the seeded cotton is ginned. Among the plant-derived fibers, cotton has the highest percentage of cellulose and is free of wooden particulates.(Joseph, 2005).

### 2.2.2 Advantages of cotton

- Comfortable
- Absorbent
- Good color retention
- Washable
- Dyes & prints well
- Strong
- Drapes well
- Easy to handle and sew
- Inexpensive

### 2.2.3 Disadvantages of Cotton

- Shrinks in hot water
- Wrinkles easily
- Weakened by perspiration and sun
- Burns easily
- Affected by Mildew

### 2.2.4 Properties of Cotton Fibers

Raw cotton contains the following substances:

**TABLE 1**  
**Properties of Cotton Fibers**

Cellulose	80-90%
Water	6-8%
Hemicelluloses and pectin	4-6%
Ash	1-10%),
Waxes and fats	0.5-1.0%
Proteins	0-1.5%

- **The quality of cotton depends on the following parameters:**

**TABLE 2**

Length of fiber	10-60 mm
Fineness of fiber	1.0-4 dtex
Linear density	1.50-1.54 g/cm <sup>3</sup>
Maturity degree	75-85%
Purity	trash and dust
Tensile strength	25-50 cN/tex
Elongation	7-10%
Moisture absorption	7-8%, and
Moisture regains	7.1-8.5 %

### **2.2.5 Characteristics of Cotton Fiber**

Cotton, as a natural cellulosic fiber, has many characteristics, such as:

- good absorbency
- comfortable
- good color retention
- well printable
- machine-washable
- dry-cleanable

- good strength
- well drape able and
- easy to handle and sew

Cotton fiber was used extensively during the early development period of nonwoven business. Cotton mills in USA tried to find ways to upgrade the waste cotton fibers into saleable products. The first method was bonding the short cotton fibers with latex and resin. These products were used in industrial wipes. Over the past decade, bleached cotton fiber has been used for producing fabrics on conventional nonwoven equipment. These products were used in medical and health-care applications, wiping and wiper markets, and some apparel markets. At the same time, cotton fiber has physical properties like fiber length, strength, and resilience, which is important particularly to its process-ability. For example, long cotton fiber is suitable for producing nonwovens. The fiber has excellent absorbency and feels comfortable for the skin. The wet and dry strengths are good. Dimensional stability and resilience recovery are moderate. The spun lace process is usually utilized in producing medical and health-care fabrics, especially in Japan and the Asian region. (Koerner, 2005).

## **2.3 Bagasse Fiber**

### **2.3.1 Bagasse**

**Bagasse**, also called **megass**, fiber remaining after the extraction of the sugar-bearing juice from sugarcane. The word bagasse, from the French baggage via the Spanish bagazo, originally meant “rubbish,” “refuse,” or “trash.” Applied first to the debris from the pressing of olives, palm nuts, and grapes, the word was subsequently used to mean residues from other processed plant materials such as sisal, sugarcane, and sugar beets. In modern use, the word is limited to the by-product of the sugarcane mill.(Thomas, 2009).

### **2.3.2 Uses of Bagasse Fiber**

Many research efforts have explored using bagasse as a renewable power generation source and for the production of bio-based materials.

Bagasse is used to produce composites of natural fibers. Composite is a mixture of dispersed particles held together by a bonding agent of inorganic or organic origin. Some composites of natural fibers are used by the automobile industry, for textiles, for construction materials, with

inorganic and organic matrices and more recently, recycled composites made of natural fibers are bonded with thermoplastic polymers.

In the apparel industry, bagasse is utilized for production of textile rayon fibers such as viscose, modal and lyocell. The bagasse is shredded, broken down with eco-friendly chemicals or other chemicals, and then when it is still in a liquid form, it is shot at very high pressure through tiny holes. This long strand of fiber is then solidified and spun into yarn. Rayon fibers are thus produced. Since rayon is manufactured from organically occurring polymers, it is considered as a semi-synthetic fiber. Sugarcane rayon is glossier and more silk-like than wood pulp rayon. Sugarcane rayon, in particular, has a delightful lustre however, this could also merely be a manufacturing difference, and not a material difference.

### **2.3.3 Advantages of bagasse fiber**

- Made from agriculture waste
- Low cost
- Biodegradable
- Comparatively high tensile strength
- High impact strength
- Weight is low
- Easily available
- These composite can be recycled

### **2.3.4 Characteristics of sugarcane fibers**

Bagasse is burned as fuel in the sugarcane mill or used as a source of cellulose for manufacturing animal feeds. Paper is produced from bagasse in several Latin American countries, in the Middle East, and in sugar-producing countries that are deficient in forest resources. Bagasse is the essential ingredient for the production of pressed building board, acoustical tile, and other construction materials and can be made into a number of biodegradable plastics.

Bagasse is also employed in the production of furfural, a clear colorless liquid used in the synthesis of chemical products such as nylons, solvents, and even medicines. Bagasse is readily available as a waste product with a high sugar content and has potential as an environmentally

friendly alternative to corn as a source of the biofuel ethanol (ethyl alcohol). (ManoharRao, 2007).

### 2.3.5 Bagasse Sugarcane Products

Sugarcane is a tree-free renewable resource. Historically, bagasse waste has been burned in the fields, and thereby creating pollution. Now, bagasse is used to manufacturer eco friendly food service products replacing traditional paper, plastics and Styrofoam products. Products manufactured from bagasse require less energy than plastics products. By adopting bagasse products, you indirectly help in reducing the pollution and energy consumption. Bagasse sugarcane plates, bowl, compartment trays, to go containers, clamshells are much better alternative for food service industry. Bagasse Sugarcane products normally biodegrade within 90 days. While plastic can take up to 400 years to degrade and Styrofoam never degrades! So, bagasse products are environmentally sustainable solution for food service and packaging disposables industries. The rate of decomposition depends on the composting conditions – the temperature, turnover rate, moisture etc. Generally, they will biodegrade much faster, if they are broken into smaller pieces.

Rather than throwing away or burning sugarcane stalks, the pulp is made into paper-like substance called Bagasse. Bagasse can be molded into different shapes and products that are perfect for food service packaging. (Cerqueira, 2011).

### 2.3.6 Composition and Properties of Bagasse Fibers

The classification of the selected plant fibers. These fibers could easily be used in the composite manufacture.

**TABLE 3**

#### **Composition and Properties of Bagasse Fibers**

Botanical name	GramineaesaccharumOfficinarum
Plant origin	Bast
Production per metric ton	135

Highest aspect ratio will exhibit highest tensile properties provide high surface area which are advantageous for reinforcement purposes.

### 2.3.7 Physical Properties of the Bagasse Fibers

**TABLE 4**

**Physical Properties of the Bagasse Fibers**

Dia( $\mu\text{m}$ )	10-34
Length(mm)	0.8-2.8
Aspect Ratio(l/d)	76
Moisture content (%)	49
Moisture regain (%)	13
Elastic recovery (%)	50

The chemical composition of bagasse plant fibers, and their physical properties. It is noted that cellulose is the main constituent of plant fibers followed by hemi-celluloses and lignin interchangeably and pectin respectively. Cellulose is also the reinforcement for lignin, hemi cellulose and Pectin.

- **Chemical Composition of Bagasse Fibers**

**TABLE 5**

**Chemical Composition of Bagasse Fibers**

Cellulose (%)	45-55
Hemi cellulose (%)	20-25
Lignin (%)	18-24
Pectin (%)	0.6-0.8
Ash (%)	1-4
Extractives (%)	1.5-9

Mechanical properties of bagasse fibers, by which we use fibers as reinforcement for good mechanical properties of composite materials.

- **Mechanical Properties of Bagasse Fibers**

**TABLE 6**

**Mechanical Properties of Bagasse Fibers**

Tensile Strength (Mpa)	180-290
Young's Modulus (Gpa)	15-19
Failure Strain (%)	1-5
Density (Kg/m3)	880-720
Breaking elongation (%)	2.5 and 3.5

## **2.4 Composite**

A composite is a material that consists of more than one component, in which at least one of the components remains in solid state during its manufacture. (Weeton, 2006). The light weight and superior mechanical properties of polymer composites have made them good candidates for applications in wide areas of the modern industry that range from transportation, building, to medicine and packaging (Seavey, Ghosh, Davis, & Glasser, 2001).

Over the last thirty years composite materials, plastics and ceramics have been the dominant emerging materials. The volume and numbers of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly. (Kelly, 2001).

### **2.4.1 Advantages of Composite**

- A higher performance for a given weight leads to fuel savings. Excellent strength-to-weight and stiffness to weight ratios can be achieved by composite materials. This is usually expressed as strength divided by density and stiffness (modulus) divided by density. These are so-called "specific" strength and "specific" modulus characteristics.
- Laminate patterns and ply buildup in a part can be tailored to give the required mechanical properties in various directions
- It is easier to achieve smooth aerodynamic profiles for drag reduction. Complex double-curvature parts with a smooth surface finish can be made in one manufacturing operation.
- Part count is reduced.
- Production cost is reduced. Composites may be made by a wide range of processes
- Composites offer excellent resistance to corrosion, chemical attack, and outdoor weathering however, some chemicals are damaging to composites (e.g., paintstripper).

### **2.4.2 Disadvantages of Composite**

- Composites are more brittle than wrought metals and thus are more easily damaged. Cast metals also tend to be brittle.
- Composites have high recurring costs.
- Composites are higher nonrecurring costs.

- Composites have higher material costs.
- Composites have very expensive repairs and maintenance.
- Composites needed isolation to prevent adjacent aluminium part galvanic corrosion.  
(Amitesh,2016).

## 2.5 Raw Material for Sanitary Napkin

### Sanitary napkin

Absorbent hygiene products Modern disposable absorbent hygiene products (AHPs) have made an important contribution to the quality of life and skin health of millions of people.

(Mishra,2016) Users of AHPs (i.e. baby diapers, feminine hygiene products and adult incontinence products) benefit from the softness, smoothness, leakage prevention, strength and protection provided by nonwoven fabrics. (Woeller, 2015).

#### 2.5.1 Types of Sanitary Napkin

- **Panty liner:**Designed to absorb daily vaginal discharge, light menstrual flow, spotting, slight urinary incontinence, or as a backup for tampon or menstrual cup use.
- **Ultra Thin:**A very compact (thin) pad, which may be as absorbent as a regular or maxi/super pad but with less bulk.
- **Regular:**A middle range absorbency pad.
- **Maxi/ super:**A larger absorbency pad useful for the start of the menstrual cycle when menstruation is often heaviest.
- **Over night:**A longer pad to allow for protection while an absorbency suitable for overnight use
- **Maternity:**These are usually slight longer than a maxi/super pad and are designed to be worn to absorb lochia (bleeding that occurs after childbirth) and also can absorb urine.
- **Cloth menstrual pads:**Alternatively some women use a washable or reusable cloth menstrual pad. These are made from a number of types of fabric most often cotton flannel or hemp (which is highly absorbent and not as bulky as cotton). Washable menstrual pads

do not need to be disposed of after use the there for offer a more economical alternative for women.(Teli, 2011).

## 2.5.2 Sanitary Napkin Sizes

**TABLE 7**  
**Sanitary Napkin Sizes**

S.No	Size	Usage	Types	Absorbency Capacity	Wings	SAP	Pcs/Pack	Packs/CTN
1	155mm	Daily use	Ultra-Thin	>10ml	No	No	30	40
2	280mm	Day/Night	Ultra-Thin	>90ml	2	0.3g	20/30	24
3	290mm	Night	Regular	>100ml	2	0.3g	20	24
4	310mm	Night	Ultra-Thin	>130ml	4	0.4g	20	24
5	365mm	Night	Ultra-Thin	>150ml	4	0.7g	20	24
6	410mm	Night	Regular	>170ml	4	0.8g	16+4	24

## 2.5.3 Conventional Structure and Material Used in Sanitary Napkin

It consists of three main layers the top sheet, absorbent core and barrier sheet

- **Top sheet:**

It is designed to transfer fluid quickly from the top sheet to secondary layers. The top sheet contains thermoplastic fibers to prevent capillary collapse of this layer, and small amount of hydrophilic absorbent fiber to allow fluid to absorb. Commercially available top sheet are made up of polypropylene fiber.(Hochwalt, 2015).

- **Absorbent core:**

It is interposed between top sheet and barrier layer main function is to absorb and retain the fluid. Moreover, to have comfort, absorbent core need to be thin, soft and pliable. The core was made up of wood pulp traditionally but there is 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 retract back.(Srivastava, 2015).

- **Barrier sheet:**

It seals the fluid from staining or leakages. It is a breathable but fluid impermeable film made up of polyethylene. Few components of sanitary pad will disintegrate and be attacked by the bacteria in a public or private sewage disposal system but polyethylene or polymeric films used as a barrier sheet remain intact as this polymer are inert and are not broken down by bacteria and thus pollutes the environment.(Farage,2007).

## **2.5.4 Disposable Hygiene Product**

The following raw materials can be used to replace existing material used in sanitary pads

### **Raw material for top sheet:**

Organic cotton as top sheet is one the commonly advised raw material for sanitary napkin because of its non-irritant, skin friendly and superior liquid retention properties. It is soft and breathable which gives comfort and dryness. Cotton wicks away moisture and keeps skin dry and its pH compatibility makes it skin friendly. (Mburu, 2013).Organic cotton are cultivated from non-treated Genetically Modified (GMO) seed and is grown using method and materials having low impact on environment that is without any use of synthetic agricultural chemical such as fertilizer and pesticides. The crop needs to be certified by a certifying body or the USDA. As cotton fiber comes directly from nature, it degrades when disposed. (Mallick, 2015).

### **Absorbent core:**

It is interposed between top sheet and barrier layer main function is to absorb and retain the fluid. Moreover, to have comfort, absorbent core need to be thin, soft and pliable. The core was made

up of non woven composite material like bagasse and cotton to improve its absorption efficiency. Also its biodegradable absorbent core was used.

### **Barrier sheet:**

It seals the fluid from staining or leakages. It is a breathable but fluid impermeable film made up of polyethylene. Few components of sanitary pad will disintegrate and be attacked by the bacteria in a public or private sewage disposal system but polyethylene or polymeric films used as a barrier sheet remain intact as this polymer are inert and are not broken down by bacteria and thus pollutes the environment.(Farage,2007).

## **2.5.5 Advantages of bagasse using sanitary pad**

The other brands use Pulp which is made of Pine Wood mostly imported and expensive. We aim to use local agricultural wastes, knitwear wastes and other wastes like Water hyacinth to make the pads, thus:

- Reducing costs
- Creating more localized demand for waste biomass
- Reducing dependency on import markets and international currency fluctuation
- Create livelihood opportunities around raw material procurement/ supply

## **2.5.6 Carding Process**

Carding is a process used to comb the individual fibers to be relatively parallel, and to make the different kinds of fibers blend uniformly. Cotton fibers were blended manually with bagasse fibers in the desired ratio and fed twice into the LSU F015D Universal Laboratory Carding Machine shown in figure 3-1. Cotton fibers acted as an entangling material for the coarse bagasse fibers the mixed staple fibers were oriented and entangled to form a loss, continuous fiber web.(Rust, 2001).

**Carding** is a mechanical process which starts with the opening of bales of fibres which are blended and conveyed to the next stage by air transport. They are then combed into a web by a carding machine, which is a rotating drum or series of drums covered in fine wires or teeth. The precise configuration of cards will depend on the fabric weight and fibre orientation required.

The web can be parallel-laid, where most of the fibres are laid in the direction of the web travel, or they can be random-laid. Typical parallel-laid carded webs result in good tensile strength, low elongation and low tear strength in the machine direction and the reverse in the cross direction. Relative speeds and web composition can be varied to produce a wide range of fabrics with different properties.(Seyam, 2001).

Card machines have been around for many decades and have been used to produce webs used to manufacture yarn. The card will feed in the batt using a slow saw tooth wire-covered roll to the main cylinder that is also covered in saw tooth wire, but travelling at a much higher speed. The main cylinder will move the fiber very fast by stationary plates that are also wire-covered. The gap between where the carding action takes place the cylinder and the stationary plates is very tight, as close as 0.010 of an inch. This opens the fibre individually and combs them so the length of the fiber is oriented in the same direction the cylinder is moving (machine direction). At the exit, a slower wire-covered roll removes the web of fibres from the main cylinder to a conveyor that will take them to bonding.. (Kao, 2004).

### **2.5.7 Needle Punching Process**

Needle punching is the oldest method of producing nonwoven products. Needle punching technique has been used in industry since 1870s.The needle-punching process is very commonly used to manufacture medium to heavy weight nonwoven fabrics. The first needle punching loom in U.S. was made by James Hunter machine co. in 1948. Then in 1957, James Hunter produced the first high speed needle loom, the Hunter model which is still used today. The bonding of webs by using needle punching technique is now a day's extensively utilized for the production of numerous products which not only competes with the conventionally used textiles, but exhibit properties hitherto unknown and not attainable by any other method.(Milin Patel,2011).

Needle-punching is a process used to entangle fibers in the direction perpendicular to the web surface, making the fiber web much more compact with balanced absorbability. A needle-punching process was employed for the web bonding using a MorissonBenkshire needle-punching machine with the speed of 5.4 feet/min and 228 strokes/min, correspondingly. In this research, the needle-punching had another function, that is, to punch lots of tiny holes through

the cellulose web, thus allowing the lyocell solution to penetrate the web easier. Each sample was needle-punched two times, faced up and down.(Sheikkariem,2000).

In needle punching the bonding of the fiber web is the result of intertwining of the fibers and of the inter fiber friction caused by the compression of the web.

The web is passed over a feed table, through the drawing in rollers and via feed rollers the web is fed to needling area. Here, the web is repeatedly punctured or perforated by a battery of needles and reoriented. This operation is carried out several times minute. In modern machines it is carried out around 2000 strokes per minute. When the needling is done from above, as shown, the web is pressed against the lower boss, also known as the needle to throat plate; flat bed. The upper plate is called stripping plate or holding down plate. The needle beam supporting the needle board is situated above the needle plate and is powered by a main drive over a cam shaft. Holes are bored into the needle board to take the needles. The three sided shanks of the needles have barbs which grip the fibers as the web is perforated, and pull them through the web. As the needle return, the fibers remain in their new position virtually unchanged since the barbs only face in one direction. The deliver rollers transport the needle web from the needle zone. The material feed can be either intermittent or continues. To achieve the desired compression and bonding, it is common practice to have several needling zones in a row, one after the other, with different needle settings and direction of stitching.(Patel, 2012).

## **End uses**

The needled fabrics have a variety of end uses. They have been used extensively as disposable, automobile seat covers, carpets, filters, geo-textiles,

Packing material, upholstery and wall coverings the HI technology needle loom can use a wide range of natural and man-made fibers blends to develop cotton based non-woven substrates. (Cannity 2010).

These cotton non-woven fabrics find a variety of applications such as filter bag, Oil-spill absorbents, high loft waddings etc. Nowadays, geotextiles and filtration are the two important areas, where the needled fabrics are used exhaustively according to Needled staple fibre or continuous filament; fabrics are used for a variety of geo-textile applications. On-woven needle

punched materials can be strained over 40 percent before breaking, compared with 20 to 30% for non-woven heat bonded fabrics and less than 15% for woven fabrics.(Ramkumar 2003).

## **2.5.8 MARKET STATUS**

### **Nonwoven – India Market Potential**

- India's nonwoven market is growing at a rate of 8-10% & going into the future this market is expected to grow at a rate of 12-15%
- Production of non-woven in India is estimated to be around 3.54 lakh MT for FY16
- During 2011-2016, the non-woven production grew at a CAGR of ~13%.
- There are nearly 50 nonwoven plants already existing in India.
- Gujarat is the hub for non-woven textile production in India, accounting for 45% of the total production. Maharashtra, Delhi and Haryana accounts for another 30% of the total production.

### **2.5.9 Sanitary Napkin Market Players & Consumers**

- Procter & Gamble
- Hengar International Group Company Limited
- Kimberly- Clark Corporation
- Edge well Personal Care Company
- KCO Corporation

The latest report by IMARC Group titled Sanitary Napkin Market, global industry trends, share, size, growth, opportunity and forecast 2017-2022.

Global sanitary napkin reached value around Us \$ 14.5 billion in 2016.

### **3. EXPERIMENTAL PROCEDURE**

#### 3.1 Selection of Raw Material

#### 3.2 Selection of Fabric Construction Method

#### 3.3 Preparation of Non-woven Fabric

##### 3.3.1 Lab Formation

##### 3.3.2 Preparation of Layers for needle punching

##### 3.3.3 Needle Punching

##### 3.3.4 Preparation of Sanitary Napkin

#### 3.4 Objective Evaluation

##### 3.4.1 Air Permeability

##### 3.4.2 Liquid Strike through Time

##### 3.4.3 Disposability

##### 3.4.4 Wet back method

##### 3.4.5 Run of method

##### 3.4.6 Centrifuge

##### 3.4.7 FTIR

##### 3.4.8 pH value

##### 3.4.9 Size (Length and Width)

##### 3.4.10 Thickness

### **3.1 Selection of Raw Material**

Cotton can effectively be used in personal care products and medical application because of its good water absorbency, softness and skin friendliness. Cotton is a soft, comfortable and most widely used material for apparel purpose. It has excellent qualities such as coolness, high tensile strength, abrasion resistance and low of cost. Cotton is widely used in the apparel due to its comfortable in wearing. (Christy Miller, 2010).

The virgin cotton without finish possesses absorbency of 25.7 g/g, whereas the mercerized cotton, 31.1 g/g. further, looking at its easy processibility to produce nonwoven structure, industrial applications can also be identified. The cotton fiber was purchased from near spinning mill in Coimbatore. Hence 100% cotton fiber was selected for the study.

Bagasse fibers are natural fiber products and it biodegrades in 25-65 days. Bagasse fibers are the bast fiber like as banana fibers. It consists of water, fibers and small amounts of soluble solids.

The present review concentrates on the properties and chemical composition of bagasse fibers. It is challenge to the creation of better materials for the improvement of quality of life with better mechanical properties. This present study focuses on the physical and mechanical properties, fiber types, and chemical composition of bagasse fibers. Hence bagasse was selected for the present study.

### **3.2 Selection of Fabric Construction Method**

Nonwoven fabric is a fabric-like material made from staple fiber (short) and long fibers (continuous long), bonded together by chemical, mechanical, heat or solvent treatment. The term is used in the textile manufacturing industry to denote fabrics, such as felt, which are neither woven nor knitted. Nonwoven fabrics are broadly defined as sheet or web structures bonded together by entangling fiber or filaments (and by perforating films) mechanically, thermally or chemically. They are not made by weaving or knitting and do not require converting the fibers to yarn. Nonwoven fabrics are engineered fabrics that may have a limited life, single-use fabric or a very durable fabric.

Nonwoven fabrics provide specific functions such as absorbency, liquid repellence, resilience, stretch, softness, strength, flame retardancy, wash ability, cushioning, thermal insulation, acoustic insulation, filtration, use as a bacterial barrier and sterility. These properties are often combined to create fabrics suited for specific jobs, while achieving a good balance between product use-life and cost. They can mimic the appearance, texture and strength of a woven fabric and can be as bulky as the thickest paddings. In combination with other materials they provide a spectrum of products with diverse properties, and are used alone or as components of apparel, home furnishings, health care, engineering, industrial and consumer goods. considering the above facts non woven method of fabric construction was selected for the study.

### **3.3 Preparation of the Non Woven Fabric**

Fresh bagasse fibers were collected after they were crushed for extracting juice by using a hand crushing machine. These fibers were then spread on a water proof sheet to reduce the moisture content.

After approximately one week, bagasse fibers were dried with sun light. After the fiber were grinded. The grinded bagasse fibers were kept in a neat dry container for future use.

#### **3.3.1 Lab Formation**

In this process the purchased 100% cotton fibers were weighted using electronic balance. (15 gm). Then the cotton fibers are passed between the rollers which clean, intermixes the fibers and produce a continuous web for subsequent processing.

Web formation used dry laid web formation in this process. The most common form of dry laid web formation is carding. Immediately after carding, the webs were parallel lapped, which involved laying the webs over one another in the machine direction to improve final web uniformity further without changing the predominant fiber orientation. The resulting web is anisotropic in nature, in that fibers are preferentially aligned in the longitudinal direction. In this manner cotton were conversed in to laps.



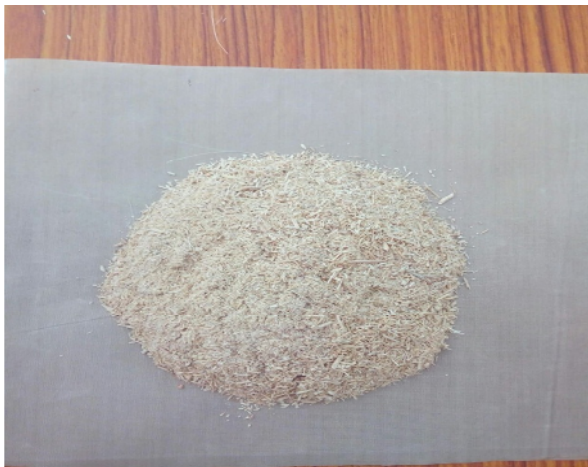
**PLATE 1**

**SUGARCANE**



**PLATE 2**

**GRINED MACHINE**



**PLATE 3**

**SUGARCANE BAGASSE**



**PLATE 4**

**COTTON FIBER**



**PLATE 5**

**CARDING PROCESS MACHINE**



**PLATE 6**

**LAB FORMATION**



**PLATE 7**

**BAGASSE WITH COTTON**

### **3.3.2 Preparation of Layers for Needle Punching**

Two layers of prepared cotton laps were placed one above the other. Twenty grams of powdered bagasse was spread over this cotton lap. Later two cotton laps with bagasse powder were kept one above the other such that the bagasse formed a layer at the center. This layer was then passed into the needle punching machine.



**PLATE 8**

### **NEEDLE PUNCHING PROCESS**

#### **3.3.3 Needle Punching**

Needle punching premixing and opening were achieved by a CMC Rando Cleaner. The cotton lap with bagasse fibers was then fed through the chute feed system, which fed the fibers to a 51 cm (20 in) pneumatic card. From the card, the fiber web was fed onto a 61 cm (24 in) automatex cross lapper conveyor system. The formed and cross-lapped webs were then needle punched on a 53 cm (21 in) automatex needle loom at a rate of 200 strokes per minute and a delivery speed of one meter per minute to yield nominal 1700 g/m<sup>2</sup> sample fabrics.(Davis,2002).in this manner non woven needle punched cotton bagasse fabric was formed.



**PLATE 9**

### **NEEDLE PUNCHING**

#### **3.3.4 Preparation of Sanitary Napkin**

The needle punched non woven cotton bagasse fabric was taken. This was placed in the template to develop the shape required. The sticking leak proof sheet was placed below the shaped needle punched non woven cotton bagasse fabric. This was wrapped with polypropylene sheet and finally passed through the sealing machine. The sanitary napkin was made with the polypropylene sheet at the top, non woven cotton-bagasse fabric at the center and leak proof sheet at the bottom. This was named as BS.

In order to study its properties with the commercial sanitary napkins a commonly used commercial napkin, similar in size and color was selected and named CS. Both of them were compared for various physical properties. After approximately one week, bagasse fibers were dried with sun light. After the fiber were grinded. The grinded bagasse fibers were kept in a neat dry container for future use.



**PLATE 10**

**SANITARY NAPKIN**

**TABLE 8**  
**NOMENCLATURE**

S.NO	SAMPLE DETAILS	NOMENCLATURE
1	Commercial sample	CS
2	Bagasse sample	BS

### 3.4 Objective Evaluation

#### 3.4.1. Air permeability

Air permeability is the rate of air flow passing through a predetermined area of the nonwoven material. The test method details how the nonwoven must be clamped to isolate a specific circular area of the material. Using a vacuum, gradient air pressure is induced causing upstream air pressure to be greater than downstream. Consequently, air will naturally migrate towards the area of lower pressure and the resulting air flow is used to determine air permeability. The air permeability of a material is generally measured in  $\text{cm}^3/\text{s}/\text{cm}^2$  or  $\text{ft}^3/\text{min}/\text{ft}^2$ .

Air permeability is the most important property of nonwoven materials for the application in dry filtration. The evaluation of air permeability and its relationship with physical parameters of the fabric, such as weight, thickness and density are reported in the considering the importance of air permeability, it was carried out for CS and BS samples and the data was recorded. In general, the air permeability decreases with the increase in fabric weight. While with increase in fabric weight, the fabric becomes thicker as well as denser, resulting in consolidated fabric structure, though the amount of pores increases with the increase in the number of fibers, the pore size becomes smaller. This research reported that the air permeability decreased with the increase in fabric weight in case of reclaimed chemical bonding by calendaring process respectively. (Dent, 2006).

As per the results it's clear that the air permeability of the CS sample was 22 which increased cm which proves that the use of bagasse a decreased the amount of air passing through the sanitary pad .this may be due to the needle punching also.

Hence it could be concluded that air permeability of the prepared cotton bagasse sanitary pad.

### **3.4.2 Liquid strike through time**

Liquid through time tester, to determine the liquid strike-through time of nonwoven samples being penetrated of low conductivity liquids.

The parameters for liquid strike through time test are:

- The capacity of burette, more than 100ml
- Burette moving distance 0.1---150mm
- Burettes moving speed 50--200mm/min
- Penetrating disc with precision positioning device
- The specimen holder can directly lift the penetration disc and is equipped with a positioning and fixing device
- Transmission plate is made of special white wire<sup>13</sup>. The instrument equipped with automatic liquid release device,
- Liquid flow rate controlled in 6 seconds through the flow 80ml, the error is less than 2ml

The sanitary napkins shall absorb 30 ml of coloured water or oxalated sheep or goat blood or test fluid when flowed on to the centre of the napkin (at the rate of 15 ml per minute) and it shall not show up at the bottom or sides of the sanitary napkin.

Both the samples were place on the table and 30 ml of colored waste was powdered at the center of the sanitary napkins. The absorbency of the samples were noted and recorded.

The liquid strike through time show and average off 16. 2 seconds this was considered to be above average. Commercial sanitary napkin results or not enclosed due to ethical issue.

### **3.4.3 Disposability**

Disposability is an important physical properties and sanitary napkin. It is carried by disposabling a sanitary napkin with the cover removed, as per standard it should be immersed in 15 liters of water and stirred. The pad should disintegrate in the water in not more than 5 minutes.

Therefore the prepared and commercial sanitary napkins were put in to container of 15 liters of water and are stirred. The disposability of napkins were note and recorded.

Sanitary napkins should be made from materials which are disposable. For that they are put in a container of 15 liters of water and are stirred. Disposable pads get disintegrated when they are subjected to the test

On absorption the commercial pad show does solution were as they prepared cotton package sanitary pad show done more clear solution with dust like particles floating around this proof that the bagasse used was not using to dispose.

### **3.4.4 Wet Back Method (ISO 9073)**

A top layer is placed over a standard absorbent medium which is then loaded with a specific quantity of simulated urine. A standard weight is placed onto the top layer and absorbent medium to ensure even spreading of the liquid. A pre- weighted pick up (blotter) paper is then placed on the top layer and the weight is again placed on top. The mass of absorbed liquid by the pick-up (blotter) paper is weighted and is recorded.

The wet bag was 0.25 g for the prepared cotton bagasse sanitary pad. The standard division value was 11.44% the results showed moderate wet baking.

### **3.4.5 Run of Method (ISO 9073 -11)**

This test was carried out to quantitatively to determine the surface effect of non-woven sanitary napkin. 0.9% saline solution was prepared. The sanitary napkin samples were weighted and their weights recorded. The fluid dosing position was marked 10 cm above the top edge of the masking tape. A separatory funnel was clamped with the spigot 1 cm above the pre-marked dosing position and the timer was set for 10 min, 25 ml of 0.9% saline solution was dispensed

into the separatory funnel. The balance was positioned at the bottom of the 30 degree incline table with a folded paper towel on the weighing surface to contain any fluid that runs off. The scale was set at zero and the separatory funnel tap was opened. The paper towel absorbed any fluid that run off. The run off weight was recorded to the nearest 0.01 grams. This is called the primary run-off value. After 10 min. interval, the steps were repeated with a new paper towel and the run-off weight was called the secondary run-off value. After another 10minutes interval, the process was repeated with a new paper towel and this run-off weight is called the tertiary run-off value. The average run-off value and the standard deviation of the run-off values were calculated.

### **3.4.6 Centrifuge**

A centrifuge is a device for separating particles from a solution according to their size, shape, density, viscosity of the medium and rotor speed. In this testing the sample were 0.2 gram of bagasse fiber was taken in preweighted empty tea bag and immersed in 0.9% of NaCl, for 30 min. the solution along with the tea bag was centrifuged at 1900 Rpm for 2 min. the final weight of the tea bag was determined.

From the centrifuge it's clear that the weight of the tea bag as decreased by 32 percent which proof that there is that the particles are got separated Commercial centrifuge results or not enclosed due to ethical issue.

### **3.4.7 FTIR**

Assessment of the fibres functional groups before was carried out using Fourier Transform Infrared Spectroscopy (FTIR NICOLET iS10). This revealed the functional groups present and to what extent they will enhance the property required for the product. This is with particular reference to the hydroxyl (OH) group which enhances moisture absorption in the cellulosic fibres. The dried treated fibres were made into powdery form and mixed with KBr to form a disc which improved the transparency of the fibres. This was further subject to test and results wereRecorded.

The FTIR test was carried out only for the bagasse fiber. From the graph it's very clear that the peak values show the presents of OH group which groups enhance moisture absorbency which is

suitable criteria for sanitary napkins. Some peaks also show the presents of phytochemicals. This might help the sanitary pad to have some medicinal properties against bacteria.Hence it could conclude bagasse is write choice for sanitary napkins.

### **3.4.8 pH value**

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 fulfill their purpose without leaking and without causing any discomfort or irritation The sanitary napkin shall be free from acidic and alkali material and the pH of the absorbent material shall be 6 to 8.5 when tested by the method given in testing report. The prepared napkin was dropped in water allowed

The pH value of the commercial range between 6 and 7 similar results also obtain from cotton bagasse napkin. Hence it could be concluded the sanitary napkins neutral pH.

### **3.4.9 Size (Length and Width)**

Sanitary napkins come with or without wings and are curved or contoured to prevent leakage on the sides. • Length: As per IS, the requirement for regular, large and extra-large sizes is 180mm to 220mm, 220mm to 260mm, and 260mm to 300mm, respectively, to be able to provide adequate coverage. As per IS the width of the napkins has to be in the range of 60mm–75mm depending upon the size as declared. Hence the length and width of the prepared napkin were measured using a scale and noted.

### **3.4.10 Thickness**

The napkin thickness has been printed by the manufacturer depending upon the size/area of the pad and the category (from regular to extra-large) under which it falls. The suitability and comfort of the user are to be considered. Some prefer thick protection while others use thin pads to serve their needs/ convenience. The thicknesses were measured by stacking 10 complete

napkins and measuring the stack height. The average thickness for the 10 pads shall be used as the pad thickness.

All the above mention parameters were tested and results were noted. This is discussed in the chapter 4 results and discussion.

## **4. RESULTS AND DISCUSSION**

Result and discussion includes the following aspects:

4.1 Run of the Time

4.2 pH value

4.3 Length

4.4 Width

4.5 Thickness

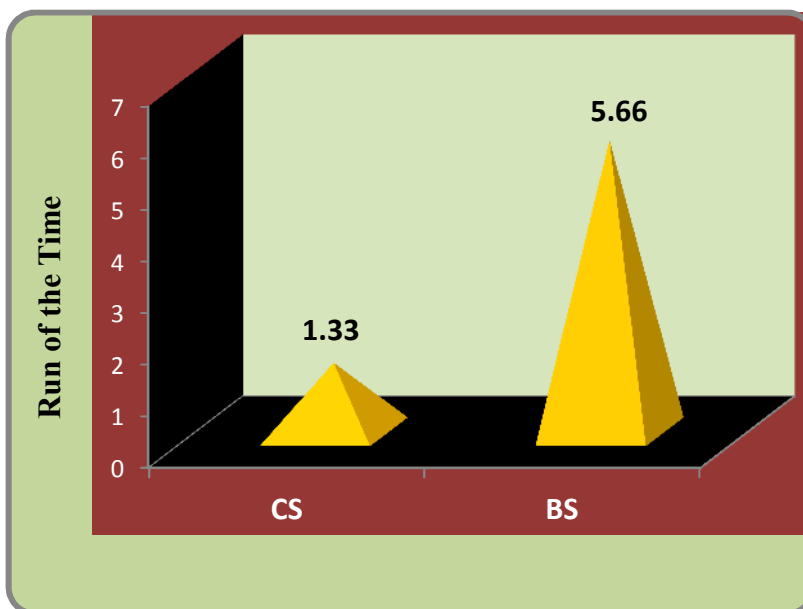
4.6 Weight

## 4.1 Run of the Time

**TABLE 10**

**Run of the Method**

S.NO	Sample	Mean	Std.Deviation	Significant	“T”test
1	CS	1.3333	3.51188	.242	-2.137
2	BS	5.6667			



**FIGURE 1**

From the above table and it's cleared that the run of time taken for the prepared cotton bagasse sanitary pad 6.5 were as the CS source 1.3.

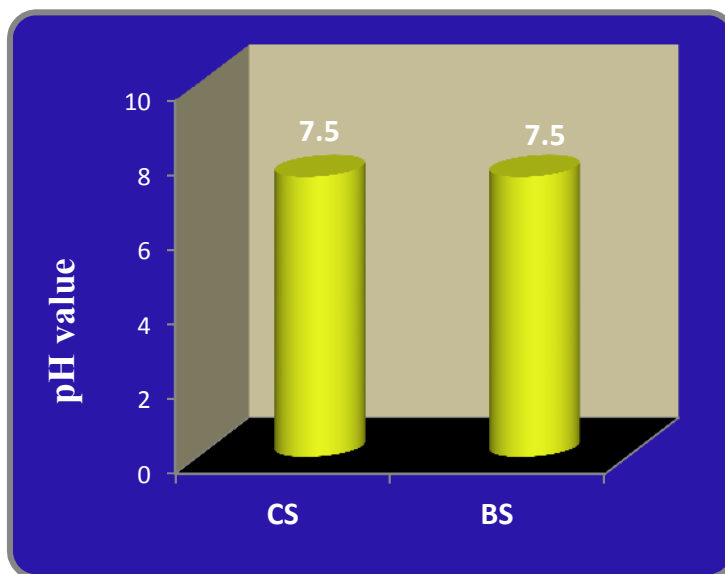
Hence could be concluded that cotton bagasse sanitary pad takes more time for absorbency the t value source significant at 0.5 percent.

## 4.2 pH value

**TABLE 11**

**pH value**

S.NO	SAMPLE	MEAN	Std.Deviation	Significant	“T”test
1	CS	6.5067	0.5568	.148	-32.975
2	BS	7.5667			



**FIGURE 2**

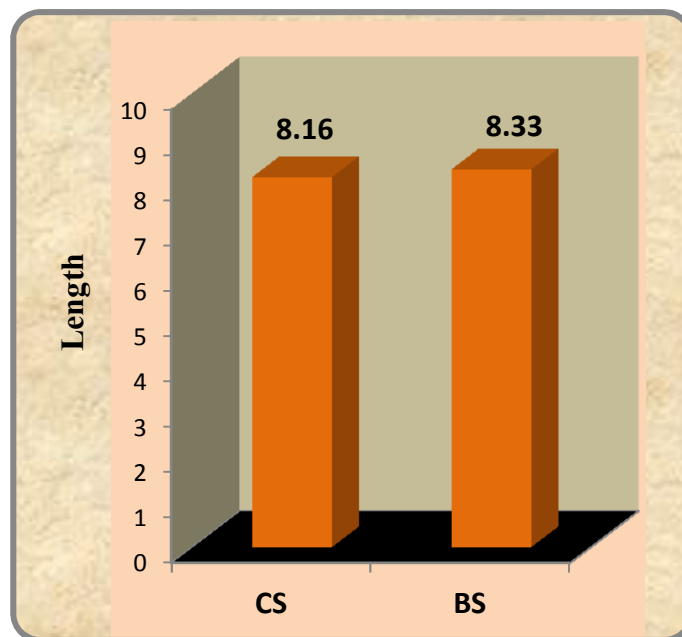
Form above table figure is clear that the commercial sanitary pads 6.5 were as cotton bagasse sanitary source 7.5 since it's is in within the neural value it could be considers good.

Hence it could be concluded the sanitary napkin within the natural “T” value also proofs the significant at 0.5 percent level.

### 4.3 Length

**TABLE 12**  
**Length**

S.NO	SAMPLE	MEAN	Std.Deviation	Significant	“T”test
1	CS	8.1667	.57735	.000	-.500
2	BS	8.3333			



**FIGURE 3**

From above table it's cleared that there is 0.2 centimeter difference between the commercial sanitary pad and cotton bagasse sanitary pad Hence could be conclude that prepared sanitary pads its equal to the commercial sanitary napkin

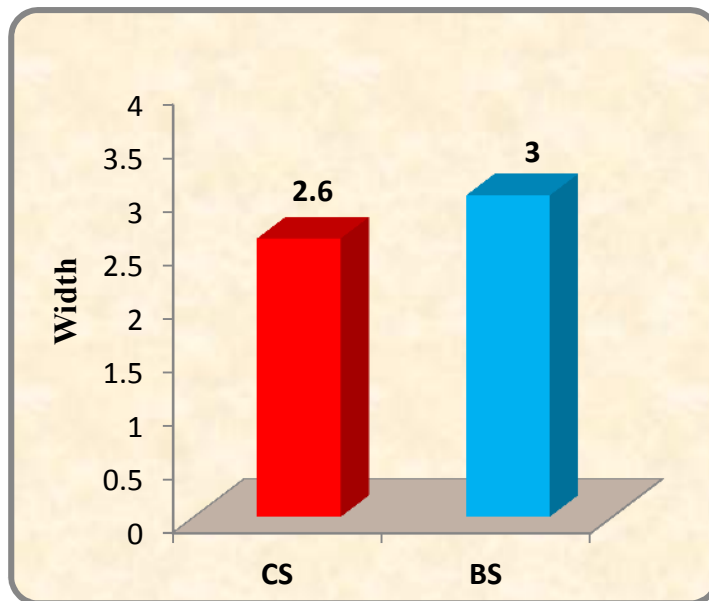
The “T” values also show as significant difference.

#### 4.4 Width

**TABLE 13**

**Width**

S.NO	SAMPLE	MEAN	Std.Deviation	Significant	“T”test
1	CS	2.6000	.26458	.667	-2.619
2	BS	3.0000			



**FIGURE 4**

On compared in the width of the commercial pad and the cotton bagasse sanitary napkin form the table figure 4 it's cleared that there is .4 centimeter in the mean value.

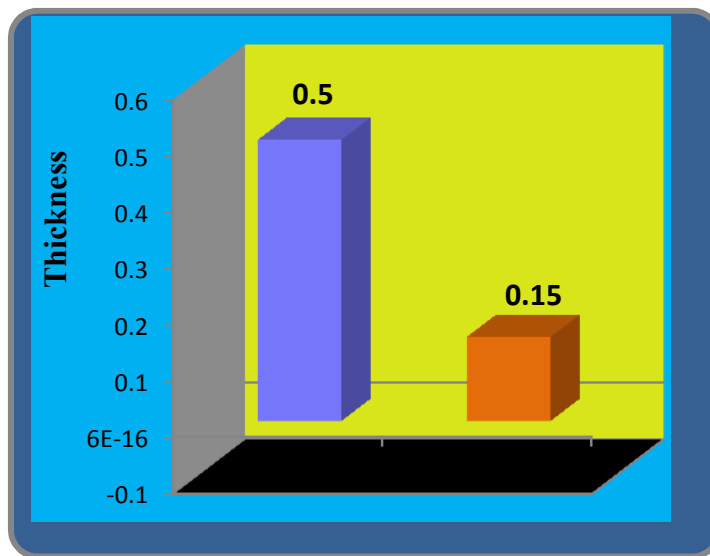
Hence the prepared cotton bagasse sanitary pad could be considered as equal to the commercial sanitary napkin. The “T” value is also significant.

## 4.5 Thickness

**TABLE 14**

**Thickness**

S.NO	SAMPLE	MEAN	Std.Deviation	Significant	“T”test
1	CS	.0500	.02754	.121	-2.619
2	BS	.0167			



**FIGURE 5**

From the above table figure 5 it's cleared that the bagasse sample showed & decreased above points 4 mm in thickness when compared to the commercial sanitary napkin. The decreased may be due to needle punching. The “T” test values also proof the results of the significant at 0.5%.

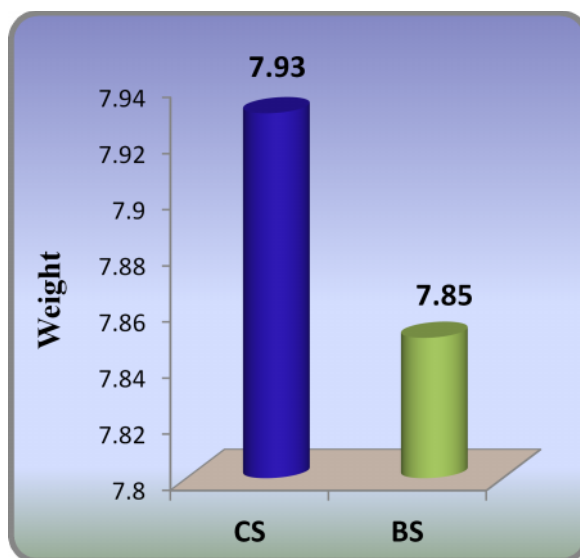
Hence could be concluded that the cotton bagasse sanitary napkin could be used for preparation of ultra-thin sanitary napkins.

## 4.6 Weight

**TABLE 15**

### Weight

S.NO	SAMPLE	MEAN	Std.Deviation	Significant	“T”test
1	CS	7.9367	.42194	.875	.342
2	BS	7.8533			



**FIGURE 6**

From the above table and figure 6 it's confirmed that the weight of the cotton bagasse sanitary napkin is 0.1 gram more when compared to the commercial.

Hence it could be concluded that weight of the prepared cotton bagasse sanitary napkin its equal to the commercial sanitary napkin. The results are also significant .

## SUMMARY AND CONCLUSION

The term “nonwoven” became popular more than half a century ago when nonwovens were regarded as low-price substitutes for traditional textiles. However, today, the nonwoven fabric technology is the most modern method used in the branch of textile industry. Nonwoven technology exists to approximate the appearance, texture, and strength of conventional woven and knitted fabrics due to their simple production stages, high efficiency of production, lower cost, and disposability. Multi-layer nonwoven composites, laminates, and three-dimensional nonwoven fabrics are commercially produced. Nonwovens combined with other materials have different chemical and physical properties. Nonwovens have three key features and are as follows for the fabrics are composed of textile fibers. The basic structural element of textile fabrics is fibers, rather than yarns or threads. The fabrics are held together by means other than the interlacing or interloping characterizing traditional woven or knit fabrics. Therefore, nonwovens can be used as wide variety of industrial engineering, consumer, and health-care goods.

Cotton has long been a dominant natural fiber in the textile industry. Low quality greige fibers or low value textile wastes predominantly consisting of cotton fibers that could not be used directly in the apparel industry, have a high potential in the manufacturing of composite nonwovens that are quite promising materials in the insulation market, especially in the automobile insulation market.

Sugarcane is a versatile plant grown for sugar production, and its major by-product is bagasse. Bagasse is the residue obtained after sugarcane is milled for juice extraction. In sugarcane production, the bagasse retrieved from crops is roughly 27-28 dry weight % of plant biomass. It is a highly heterogeneous material that consists roughly of 20-30% lignin, and 40-45% cellulose and 30-35% hemicelluloses with limited amounts of extractives and ash. Its composition makes it a promising feedstock for second-generation 6 biofuel production. Similar to other lignocellulose materials, sugarcane bagasse has low nutritional value, which precludes concerns about the food vs. fuel debate. A variety of 8 species of sugarcane, Saccharin, are grown in Latin America, which leads it to numerous differing resources of bagasse, which is generally underutilized. Furthermore, bagasse represents approximately 0.3 metric ton for every 1 metric ton of sugarcane<sup>1</sup> grown and is often considered a waste stream. A comprehensive

understanding of bagasse chemical constituents and its physical and chemical characteristic changes associated with the bioconversion process from biomass to biofuel is necessary in order to amplify bagasse as a renewable source. The delicate problem for second-generation biofuel production is the optimization of pretreatment technologies, which may include hydrothermal, dilute acid, steam explosion, alkaline and organosolv. Although it is costly, the pretreatment of bagasse has been reported to facilitate up to 90% conversion of sugars to ethanol compared to 20% without pretreatment for acid hydrolysis.

Needle punching is the oldest method of producing nonwoven products. Needle punching technique has been used in industry since 1870s. The needle-punching process is very commonly used to manufacture medium to heavy weight nonwoven fabrics. The first needle punching loom in U.S. was made by James Hunter machine co. in 1948. Then in 1957, James Hunter produced the first high speed needle loom, the Hunter model 8 which is still used today. The bonding of webs by using needle punching technique is now a day's extensively utilized for the production of numerous products which not only competes with the conventionally used textiles, but exhibit properties hitherto unknown and not attainable by any other method.

The needle punching industry enjoys one of the greatest successes of any textile related process. The needle punching industry around the world is a very exciting and diverse trade involving either natural or both natural and synthetic fibers.

Considering the above mechanical facts as study on "Design and Development of Needle punch fabric using bagasse" was planned. The main objectives of the study are

- To identify suitable natural source for preparation of non-woven textiles.
- To prepare non-woven textile using bagasse.
- To use the prepared non-woven bagasse textile material for preparation sanitary pad.
- To evaluate the physical properties of the prepared non-woven textile and sanitary pad.

Cotton is a soft, comfortable and most widely used material for apparel purpose. It has excellent qualities such as coolness, high tensile strength, abrasion resistance and low of cost. Cotton is widely used in the apparel due to its comfortable in wearing.

Bagasse fibers are natural fiber products and it biodegrades in 25-65 days. Bagasse fibers are the bast fiber like as banana fibers. It consists of water, fibers and small amounts of soluble solids.

The present review concentrates on the properties and chemical composition of bagasse fibers. It is challenge to the creation of better materials for the improvement of quality of life with better mechanical properties. This present study focuses on the physical and mechanical properties, fiber types, and chemical composition of bagasse fibers. Hence cotton and bagasse were selected for the present study.

Nonwoven fabrics provide specific functions such as absorbency, liquid repellence, resilience, stretch, softness, strength, flame retardancy, wash ability, cushioning, thermal insulation, acoustic insulation, filtration, use as a bacterial barrier and sterility. These properties are often combined to create fabrics suited for specific jobs, while achieving a good balance between product use-life and cost. They can mimic the appearance, texture and strength of a woven fabric and can be as bulky as the thickest paddings. In combination with other materials they provide a spectrum of products with diverse properties, and are used alone or as components of apparel, home furnishings, health care, engineering, industrial and consumer goods. considering the above facts non-woven method of fabric construction was selected for the study.

## **CONCLUSION**

From the above study menstruation has been a problem across the world where, young stars and woman face varies problems in order to help them the market with padded with huge variety of sanitary napkins but amount spent and side effect cost by high tech. sanitary napkin does not suitable that pocket of every Indian women and alternative and the need of the hour hence considering these factor the study focuses on preparation on low cost sanitary napkins using agro waste namely bagasse. The results as opened new steps to find have very effective thin sanitary napkin. This could enhance over economy also

### **Limitation of the Study**

- Due to ethical issues many of the results could not be compared with commercial sanitary napkin.
- However study, time limitation has restricted were study.

### **Scope for Future Study**

- The prepared cotton bagasse sanitary napkin could be finished natural source that enhance absorbency
- Absorbency, action against bacteria, fungi.

Difference combination of cotton and bagasse can be used for preparation of sanitary napkin.

## BIBLIOGRAPHY

- Book – “non-woven bonded fabrics”, by S.Lunenscholoters & W.Albrecht.
- Book – “Non-woven fabrics”, by Francis M.Buresh.
- Book- “Manuals of Non wovens”, by prof.Dilp.1Ng. Dr.Radko Krcma
  
- Agarwal B.D. and Broutman L.J.; Analysis and performance of fiber composites, John Wiley & Sons, New York (2006): p. 3-12.
- Alvarez VA, Ruscekaite RA, Vazquez A; Journal of Composite Material, 37, No.17, (2003): p.1575.
- Ashok Pandey, Carlos R. Soccol, Poonam Nigam, Vanete T. Soccol. Biotechnological potential of agroindustrial
- Berghezan, A.Nucleus; 8(5), 2005, (Nucleus A Editeur, 1, rue,Chalgrin,Paris, 16(e).
- Bilba K, Arsene M.A., Quensanga A.; Sugar cane bagasse fibre reinforced cement composites. Part I. Influence of the botanical components of bagasse on the setting of bagasse/cement composite, Cement Concrete Composite 25 (2010) 91–96.
- Biocomposites reinforced with natural fibers: 2000-2010”. Prog.
- Cao Y., Shibata S., Fokumoto I.; Mechanical properties of biodegradable composites reinforced with bagasse fiber before and after alkali treatment. Composites Part A, Applied Science and Manufacturing 37 (2006) 423–429
- Chand N., Rohatgi P.K.; Natural fibers and their composite, Periodical Experts, Delhi (2014).
- Composites: Part A 35 2004, 371 – 376.
- D. Maldas, B.V. Kokta.; Studies on the preparation and properties of particleboards made from bagasse and PVC: II. Influence of the addition of coupling agents, Bioresource Technology 35 (2001) 251-261.
- D. Zhou. “A study of oriented structural board made from hybrid poplar. Physical and mechanical properties of OSB”. Holz Als Roh Und Werkstoff, Berlin, v. 48, n. 7-8, p. 293-296,(2005).

- Elsunni M. M. and Collier J. R.; Processing of Sugar Cane Rind into Nonwoven Fiber, *Journal of American Society of Sugar Cane Technologists*,16, (2012): p. 94– 110.
- Faruka, O., Bledzki, A. K., Fink, H. P., and Sain, M.,
- G. Han, Q. Wu. “Comparative properties of sugarcane rind and wood strands for structural composite manufacturing”. *Forest Products Journal* 54(12): p. 283-288, December/2004.
- G. Painter, H. Budman, M. Pritzker. “Prediction of oriented strand board properties from mat formation and compression operating conditions”. Part 2: MOE prediction and process optimization. *Wood Sci Technol*, 40 (4), pp. 291–307, 2006.
- Hassan M.L., Rowell R.M., Fadl N.A., Yacoub S.F. and Chrisainsen A.W.; Thermo plasticization of Bagasse. I. Preparation and Characterization of Esterified Bagasse Fibers, *Journal of applied polymer science*, 76 (2010) 561- 574.
- Hassan M.L., Rowell R.M., Fadl N.A., Yacoub S.F. and Chrisainsen A.W.; Thermo plasticization of Bagasse. II. Dimensional Stability and Mechanical Properties of Esterified Bagasse Composite, *Journal of applied polymer science*,76 (2012) 575-586
- J. P. Silva. “Aplicação de partículas longas e orientadas de bagaço de cana-de-açúcar na produção de painel particulado similar ao OSB”. Tese (Doutorado). Escola de Engenharia de São Carlos da Universidade de São Paulo, (2014).
- Jartiz, A.E.; *Design* (2010), p.18.
- Joshi S.V., Drzal L.T., Mohanty A.K., Arora S. Are natural fiber composites environmentally superior
- Kelly A.; *The Nature of Composite Materials*, scientific American Magazine 217, (B), (2015): p. 161.
- Monteiro S.N., Rodriquez R.J.S., De Souza M.V., D'Almeida J.R.M.; Sugar Cane Bagasse Waste as Reinforcement in Low cost composites, *Advanced performance Material* (2002) ,5, No.3, pp. 183-191
- Paiva J.M.F. and Frollini E.; Sugarcane Bagasse Reinforced Phenolic and Lignophenolic Composites, *Journal of applied polymer science*, 83 (2002) 880-888.

- Paturau J.M. By-Products of Sugar Cane Industry, 3rd Edition, Elsevier, Amsterdam (2013).
- Paturau J.M.; By-Products of Sugar Cane Industry, 3rd Edition, Elsevier, Amsterdam (2001).
- Polym. Sci., 37, 1552-1596, 2012.
- Residues. I: sugarcane bagasse. Bioresource Technology 74 2000, 69 – 80.
- Rowell RM, Young RA, Rowell JK; Paper and composites from agro-based resources, CRC Lewis Publishers, Boca Raton RL (2013).
- S. Suzuki, K. Takeda. “Production and properties of Japanese oriented strand board I: effect of strand length and orientation on strength properties of sugi oriented strand board”. Japan Wood Science, Tokyo, v. 46, p. 289-295. 2000.
- S.M. Luz, A.R. Gonçalves, and A.P. Del’Arco, Jr; Mechanical behavior and microstructural analysis of sugarcane bagasse fibers reinforced polypropylene composites, 38 (2007) 1455-1461
- Shinichi Shibata, Yong Cao, Isao Fukumoto; Effect of bagasse fiber on the flexural properties of biodegradable composites, Journal of polymer composite, 26 (2005) 689-694.
- Suchetclan Van; Philips Res. Repts. 27, (1972): p. 28.
- The contribution of non woven to a suitable world”, by pierre wiertz, EDANA, ICTN-2008, Presented at IIT-Delhi, india.
- Usmani M.Arthur, Salyer O. Ival, Ball L. George, Schwendeman L. James; Bagasse-Fiber-Reinforced Composites, Journal of Elastomers and Plastics, 13, No. 1, (1981): p. 46-73.
- V. Yadama, M. P. Wolcott, L. V. Wolcott. “Elastic properties of wood-strand composites with undulating strands”. Compos Part A: Appl Sci Manuf, 37 (3), pp. 385–392, 2006.
- Vazquez A., Dominguez V. A., Kenny J. M.; Bagasse Fiber-Polypropylene Based Composites, Journal of Thermoplastic Composite Materials, 12 (1999) 477-497
- W. Thomas. “Poisson’s ratios of an oriented strand board”. Wood Sci Technol, 37, pp. 259–268, 2003. [5] T. Nishimura, M. P. Ansell, N. Ando. “The relationship between the

arrangement of wood strands at the surface of OSB and the modulus of rupture determined by image analysis". *Wood Sci Technol*, 35 (6), pp. 555–562, 2003.

- Zheng Yu-Tao, Cao De-Rong, Wang Dong-Shan, Chen Jiu-Ji; Study on the interface modification of bagasse fibre and the mechanical properties of its composite with PVC, *Composites: Part A*, 38 (2007) 20–25.
- Nilza. Jústiz-Smith, Junior Virgo, Vernon.Buchanan, bagasse fibres as composite materials, *Materials Characterization*, Volume 59, Issue 9, September 2008, pp. 1273-1278.

APPENDIX - 1

SAMPLE

