THE STUDY ON ABSORBENTS AND FINISHES USED FOR DIAPERS

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ABSTRACT:

Diapers the basic need of babies and parents have also entered the lives of adult who face the problems of incontinence, urinal disorders or who are on bed due to some other illness. These diapers are in the direct contact with the skin which caused diaper rashes and skin disorders to the wearer. To avoid these problems, some finishes have been used. In this study we are presenting about the absorbents and finishes used for diapers.

Disposable diapers have contributed in huge amount in the landfill waste. We studied the physical and chemical properties of the diapers available in market (5 baby diapers and 4 adult diapers, 1 bamboo fibre material diaper). Most of the diapers are made from synthetic material which are non-biodegradable material. So, it is need of hour to manufacture the bio diaper which won't cause any harm to the environment.

INTRODUCTION:

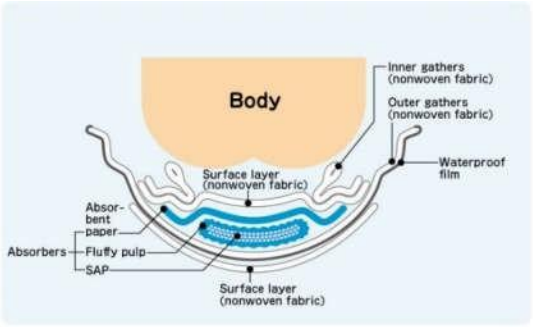
Diaper comes under the product of medical textile. Now a day's parents find diapers very much essential. It saves their time as well as it's easy to wear. Diaper is also known as the hygiene product. As we know diaper are used to collect the urine and stool of the baby, it is made up of soft material and absorbents. Disposable diaper is easy to use, there is no issue of washing and cleaning but it causes huge harm to environment. Studies says that it takes thousands of years for a diaper to degrade completely, its combustion releases harmful gases which are very dangerous for environment. As the time will pass the use of diapers is going to increase and result of it will be increase in waste and pollution caused by these diapers.

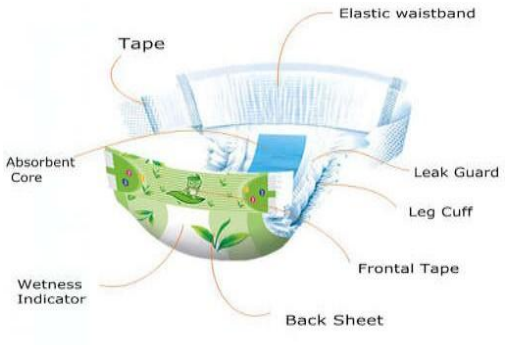
Along with environmental aspects if we speak about health aspects, it is necessary to keep the diapers antibacterial, free from hazardous chemicals as it is in direct contact with the human skin. Therefore, various types of antibacterial and anti-fungal finishes are applied on diapers to make it human friendly. Our focus must be on making eco-friendly diapers at affordable costs.

A) *STRUCTURE OF DIAPER*:

Diaper has three layers: 1. Permeable layer 2. Superabsorbent layer 3. Impermeable layer

First layer is mostly made up of polypropylene fibre, it does not hold the water and directly transfers it to the middle layer. Middle of diaper is soft core made up of SAP (super absorbent polymer) like sodium polyacrylate and viscose or cotton fibers. This layer absorbs the water 100 to 1000 times of its weight to its property of super absorbency. Third layer is made up of polyethylene, it locks the material so that there is no leakage. Diapers also have a colorful strip at third layer, which indicates that diaper is wet and it needs to be changed.





NEED OF ECO-FRIENDLY DIAPERS:

The disposable diapers are made from polypropylene, polyethylene and SAP. All these materials are non-biodegradable. Which are going to stay in the land for many years. The need for eco-friendly diapers arises from the growing awareness of environmental sustainability, the impact of conventional disposable diapers on the environment, and the desire for healthier, eco-conscious baby care products. Chemicals used in diaper may not be 100% harmless to human body. Use of natural and renewable resources will reduce the use of petroleum-based plastics. Even consumers are demanding for eco-friendly products with increasing environmental awareness.

NEED OF ANTIMICROBIAL AND ANTI BACTERIAL FINISHES:

Diapers with antibacterial coatings have multiple uses.

1. Preventing Diaper Rash: Bacteria and yeast that thrive in the warm, moist environment that a diaper creates are frequently the cause of diaper rash. Diaper rash can be prevented by using antibacterial finishes, which can help stop bacteria from growing on the diaper's surface.

2. Hygiene: Because of their delicate skin, babies are susceptible to illnesses. By keeping the diaper surface cleaner, antibacterial coatings can lower the chance of bacterial contamination and subsequent illnesses.

3. Odor Control: Unpleasant odors can be caused by bacteria on the surface of diapers. By reducing bacterial development, antibacterial coatings can help manage the smells associated with soiled diapers.

4. Extended Wear Time: Antibacterial finishes can help diapers stay fresher for longer by preventing bacterial growth. This could lengthen the time between diaper changes and lower the frequency of skin problems associated with changing diapers.

5. Peace of Mind for Parents: The antibacterial qualities of their baby's diapers can help parents feel more at ease and provide greater cleanliness and comfort for their infants.

It's important to remember that, even though antibacterial finishes have advantages, they should only be applied sparingly and in conjunction with appropriate diaper changing procedures. Overuse of antibacterial chemicals can irritate some people's skin or lead to the emergence of microorganisms resistant to antibiotics. Thus, it's imperative to find a balance between upholding good cleanliness and refraining from overusing antimicrobial treatments.

ANTIMICROBIAL FINISHES USING NATURAL AGENTS:

NATURAL AGENTS: natural agents are obtained from nature i.e. plant, organisms, marine life etc. herbs like tulsi, aloe Vera, neem have antibacterial properties. The antibacterial compounds can be derived from various parts of the plants e.g. Bark, leaves, stem, flowers etc. they have common coloring agents like flavonoids, quinonoid and tannin. These antimicrobials don't harm nature and are safe for use.

a) Tulsi extract: its leaves are used as antimicrobial, insecticidal and antiprotozoal agent. It belongs to Labiacea family.
b) Turmeric: the yellow pigment named curcumin possess antimicrobial properties.
c) Sericin: it also has antibacterial properties, UV resistance and moisturizing properties.
d) Neem: it is also known as Azadirachta Indica which belongs to Meliacceae family. It's all parts are useful to one or other medicinal purpose. Its extract has a potential to inhibit the growth of both gram positive and gram negative.
e) Aloevera: due to its antimicrobial property it is also used in cosmetic products. it is also known as the Lilly of the dessert
f) Natural dyes: natural dyes like henna, pomegranate are the antimicrobial agents. The antimicrobial activity of the textile substrate impregnated with the natural dyes depends on the dye uptake and the presence of functional group.






Methods of Applying Antibacterial Finishes:

Antimicrobial finishes are generally applied to textile products as final finishing process. In medical textile it plays a major role.

The textile fabrics can be finished with antimicrobial agents by different methods.

1) **By using spun in additives**: antimicrobial agents are added to the dope solution during the manufacturing process of manmade fibers or yarns.
2) **Padding method**: this method is simple to perform but the finish is poor because of weak linkages between the fibers and antimicrobial agents. In this method fabric is immersed in aqueous solution containing antimicrobial agents for 5-10mins and padded through squeeze rolls. The fabrics are then dried and cured at specific temperature and time.
3) **Exhaust method**: the fabric is soaked in solution containing antimicrobial agents and allowed to reach equilibrium. This method enables the movement of finishing agents from the solution on to the fabric until it is completely exhausted
4) **Spraying**: spraying of solution particularly on non-woven fabrics. There is also the risk of inhalation

5) **Micro encapsulation**: it is the process in which liquid droplets or smaller particles are coated with continuous film of polymeric material. It is an important technique for imparting functional finishes to textile materials. The capsules formed are applied to fibers by padding, impregnation, exhaust and spraying techniques.

6) **Polymer modification**: it is brought about copolymerizing antimicrobial agent with fibre monomer. Durability of the finish is higher when compared to other techniques as the biomaterial form an integral part of the fibre. This method is costly as it requires distinct polymerization units.

7) **Nanotechnology**: cotton fabric finished with nanomaterials prepared from neem extract exhibited excellent antimicrobial activity. Antimicrobial activity was retained even after 25 washes whereas the fabric coated with neem extract retained the antimicrobial activity only up to 10 washes

According to the study the finish applied by microencapsulation method is long lasting and shows better results than other methods.

WHAT ARE ABSORBENTS?

SAP is widely used in diapers. It has capacity of absorbing the water by 100 to 1000 times of its weight. It is present in white granular form in the diaper. It is also non-biodegradable. Biodegradable alternative must be found to replace the SAP.

We can also use the natural fibre as absorbents so that the amount SAP used in diapers can be reduced. Use of bamboo fibre, banana fibre, hemp can be made.

Bamboo fibre absorbs 3X of its weight. Hemp fibers are characterized by a high ability for water and moisture absorption. Banana fibre is naturally super absorbent and highly effective at locking away the fluid. It is used in sanitary pads. We can also use it for diapers

Researchers carried out the study using Poly (y-glutamic) acid (PGA) and gellan gum. The study was related to replacement of SAP in diaper.

PGA is water-soluble and biodegradable linear molecule with a high molecular weight between 100,000 to 1,000,000 g/mol. The polymer structure of PGA is shown in Figure 4. PGA is a ubiquitous amino acid used in the synthesis of proteins, which facilitates in the industrial production using a mutant *Brevibacterium flavum*, yielding roughly 40 g/L in 2 days [11]. Naturally, PGA occurs in organisms by the condensation of glutamate and ammonia, as shown in Figure 5, an essential role in the

metabolism of nitrogen. In humans, PGA facilitates natural processes in the intestines, regulates acidbase balance in the kidneys, activates immune cells, and feeds cancerous cells. Studies such as [12] by Kunioka show that PGA hydrogels are efficient agents for the purification of turbid water. The absorbency and biodegradability of the PGA with L-lysine gel depends heavily on the degree of crosslinking, so optimization of the polymers components would be necessary before application in the diaper industry.

Poly (y-glutamic) acid:

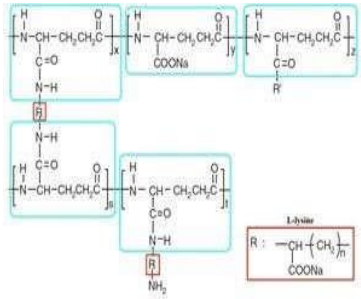


Fig.1. Molecular structure of the PGA gel

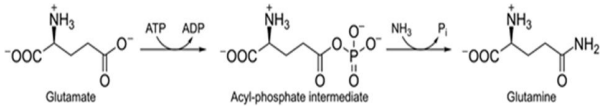


Fig.2. Synthesis of glutamine by the condensation of glutamate and ammonia

Gellan gum and Jeffamine 130 + EDC/NHS:

Gellan gum can be obtained in a high acyl or low acyl form. When hydrated, high acyl gellan gum, its natural form, forms a soft elastic hydrogel while the deacylated low acyl gum forms a stiffer more robust hydrogel. The chemical structure of the primary crosslinker Jeffamine is shown in Figure. The advantage of EDC/NHS combination is that urea is the only by-product of the reaction, and it is water soluble and non-toxic. Thus, the manufacturing process of the hydrogel produces minimal cytotoxic waste which is an important consideration when choosing an alternative to sodium polyacrylate.

Studies suggest that the high absorptivity gellan gum-Jeff amine polymer may be biodegradable if high acyl gellan gum is used and the EDC/NHS content is carefully chosen to balance the stiffness and absorptivity of the polymer with the biodegradability

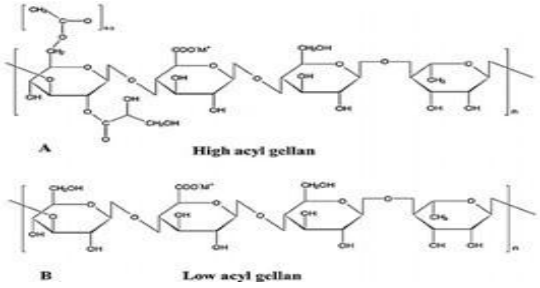


fig.3.Chemical structure of high acyl and low acyl gellan gum.

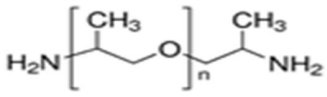


Fig.4. Chemical structure of Jeffamine

Fig.5. Predicted structure of gellan gum-Jeffamine hydrogel after crosslinking, represented by gellan gum (blue), Jeffamine (red), and zero-length EDC/NHS crosslinking points (yellow)

A lightly crosslinked PGA has the best potential to replace the current sodium polyacrylate SAP because of its superior water absorbance and ability to significantly reduce the accumulation of diapers in landfills because of its degree of biodegradability in microbial BOD testing.

TESTING OF SAMPLES:

Materials: We Have Taken 5 Baby Diaper Samples And 4 Adult Diaper Samples for Studying Its Physical and Chemical Properties.

Test Performed:

- Gsm- ***Wsp 130.1.R4(12)***
- Pore Size of Fabric- ***Astm E 1294-89***
- Water Absorbency- ***Astm D570***
- Liquid Strike Through Test- ***Edana Wsp 70.3***
- Fibre Identification

RESULT AND DISCUSSION

S- Baby Diapers A- Adult Diapers

Samples	Weight	Gsm	Liquid Strike Through	Water Absorbency
S1	24	614	0.840	76.2
S2	29	774	0.780	66.01
S3	31.09	741	1.150	58.06
S4	37	841	0.960	62.91
S5	26	564	1.370	84.63
S6	26	661	1.120	84.63
A1	65	632	0.890	39.97
A2	55	806	4.70	43.54
A3	70	911	2.060	58.16
A4	60.93	920.49	1.99	38.18

GSM: ***Wsp 130.1.R4(12)***

Samples	Gsm	1st Layer	2ndlayer	3rdlayer	4th Layer	5thlayer	Pore Size of Permeable Fabric
S1	608	51.49	528.	28.48			79.7322 (1st Layer)
S2	819.40	99.06	601.76	117.38			77.5268(1st Layer)
S3	736.08	21.74	24.55	68.47	522.52	95.78	100.1152(1st Layer)
S4	876.86	89.75	557.48	211.95			209.736 (1st Layer) 200.7751(2nd Layer) 130.3993(3rd Layer)
S5	602.27	7452	46693	57.50			126.45(1st Layer)
S6	661	55	65	26	385	130	149(1st Layer) 190(2nd Layer)
A1	632	16.65	13.84	525.33	65		183.9908(1st layer)
A2	806	21.97	65.30	40	655.52	28	127.0306(1st layer)
A3	911.82	17.2	21.1	790.97	63.05		168.2735(1st layer)
A4	920.49	23.24	30.90	736.28	76.22		103.4755(1st layer)

DIAPER PROTOTYPE:

We Also Prepared a Diaper Sample Made from Cotton Fabric and Bamboo Fibres.

Fabric Used= Cotton Fabric
GSM=42.5
After Finish = 50 GSM
Finish Applied= Saraguard Fl (Antibacterial finish)
Water Proof Finish= Coating Paste Made With
Synthetic Thickener, Gsm = 185
Core= Bamboo and Sap (Sourced)= Gsm= 325
Stitched Into Diaper Using Traditional Design 100% Cotton Fabric of Gsm 40 Was Procured.

It Was Then Desized, Scoured And Bleached. Part Of Fabric Was Finished Using Antibacterial Agent and Remaining Fabric Was Coated with Water Proof Finish.

Recipe of antibacterial finish:

Padding method was used to apply finish

Saraguard FL – 20-50 gm/l
Pickup- 65-70%
Bath ph- 5-6
Drying -110-120 deg.c, time- 1–2-minute

Recipe of water proof coating:

chemicals	**concentration**	**quantity**
Cellbind-213 polyacrylic base	50 parts	250gm
Seraprint AC crosslinker	2 parts	10gm
Synthick P328	2 parts	10gm
Ammonia liquor 30%	10 parts	10-20 ml
water	rest	215 ml
Total	100	500gm

TEST AND OBSEVATION:

Gsm- *Wsp 130.1.R4(12)= 845*

Pore Size of Fabric- *Astm E 1294-89=370, 6.23,0.343*

Water Absorbency- *Astm D570=64.6*

Liquid Strike Through Test- *Edana Wsp 70.3 = 4.20*

Fibre Identification= Bamboo Fibre

Total Weight Of Sample= 37 Gm

OBSERVATION:

Some Bio degradable diapers also consist of some synthetic material; therefore, we can't say it as 100 percent biodegradable Application of finishes affects the appearances of fabrics. It also results in reduction of strength and absorbency of the fabric Natural finishes leave odor and stains behind. The durability of natural finishes is low. The shelf life of the product is very less when we go for 100 percent natural product.

CONCLUSION:

Energy required to manufacture natural diapers is very high. At the same time the price point of the diapers is high compared to other disposable diapers as natural fibers are very expensive compare to the synthetic fibers. Making of 100% biodegradable or natural diaper is hardly possible because at some or other point we have to use the chemicals. Natural's materials are yet to be found which are degradable and show absorbency as good as SAP. When it comes to price point parents hardly care about the bio diapers, prefer the common brands as they are pocket friendly for them.