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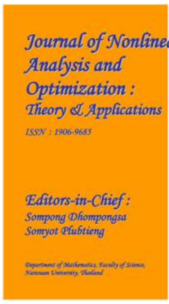

A STUDY ON THE EFFECT OF AGEING OF OXYGEN PLASMA TREATED FABRIC

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ABSTRACT

In this study bamboo spunlace nonwoven fabric was treated with oxygen plasma. Oxygen plasma was used to improve the hydrophilicity property of the fabric at selected process parameters of 550 Watts discharge power,60 seconds of exposure duration and inter electrode spacing of 5 cm. Vertical strip wicking test was used to measure the wettability of the fabric. The samples were measured at an interval of 10 seconds from 10 seconds to 60 seconds. Then the plasma treated bamboo nonwoven fabric was subjected to ageing study. The study was carried out by measuring the wicking height for a period of 20days (1 day, 5 days, 10 days, 15 days, 20 days) in both machine direction and cross direction of the samples. The ageing phenomenon was evaluated by using one way Anova test.

Key Words:
Bamboo fabric, surface modification, oxygen plasma, wickability, ageing

INTRODUCTION:

Bamboo fabric is a natural textile that has been growing in popularity in recent years, both for its quality and its environmental friendliness. Bamboo fabric is made from the pulp of bamboo plants, which are actually a type of grass. The fastest growing grass species in the world, in fact, making them one of the most easily renewable natural resources we have. The bamboo plant has a natural resistance to pest and fungal infestation due to an ant-microbial agent known as "bamboo kun" that prevents harmful matters from cultivating on the plant. Bamboo fabric have a soft and comfortable feel and a special lustre. (www.bamboofabricstores.com)

Bamboo can be processed into fabric mechanically or chemically. In mechanical process, woody parts of bamboo plant are crushed and made into a mashy mass by using natural enzymes for breaking the bamboo walls, so that the fibres are combed out mechanically and spun into yarn. On the other hand, chemically manufactured bamboo fibres are produced by steeping and cooking the bamboo leaves and woody shoots of the bamboo plant in strong chemical solvents. Then it is subjected to alkaline hydrolysis in combination with multi-phase bleaching (Sinha & Malik, 2011). Currently, regenerated bamboo fibres are used in apparels (undergarments, sports textiles, t-shirts and socks), hygienic products (sanitary napkins, absorbing pads, masks, bandages and surgical gowns), ultraviolet protective clothing, home furnishing textiles, food packaging bags, etc. (www.bamboovillage.com)

Nonwovens, because of their easily modifiable properties and excellent performance, have become indispensible in medical application. Application of textile materials in the medical field is gradually increasing due to its several important characteristics. Textile materials have found a variety of medical applications which include a vast range of applications, viz.., adhesive tapes, bandages, beddings, blankets, castings, diapers, wound dressing, eye pad, gauzes, productive clothing, sutures, surgical covers, swabs, sanitary products, hospital gowns etc. In addition to productive medical apparel, textiles in fibre and fabric form are used for implants, blood filters, surgical dressings etc. (Supriya Pal, 2009).

The two most widely used methods of nonwovens manufactured using mechanical bonding are needle punching and spun lacing techniques. Spun lacing employs high-speed jets of water to strike the web and create entanglement of fibre segments in the web thereby providing fabric integrity. The other specific terms that are used to denote spunlace nonwovens are jet-entangled, water-entangled or hydro-entangled. The main characteristic features of spunlace nonwovens are its softness, drape and high strength. This unique combination of properties makes it viable for specific end use applications.(www.sourcenonwoven.com/spunlace-nonwoven-process-application)

When a piece of matter is constantly supplied with energy, increase in temperature takes place and therefore it passes from liquid state to gaseous state. If again more energy is supplied, the kinetic energy of the elementary particles increases to a point at which disintegration of atomic shell takes place leading to formation of radicals, negatively charged electrons and positively changed ions. The resultant mixture of ionized gas formed of electrons, ions, neutral atoms, free radicals and UV radiation is referred to as 'Plasma'(Babu & Shankar, 2005).

Plasma technology being a surface-sensitive method, allows selective modification in nm-range. By passing energy into a gas, quasi-neutral plasma can be generated consisting of neutral particles, electrically charged particles and highly reactive radicals. When a textile material is placed in the reaction chamber, the ignited plasma generates particles that interact with the surface of the textile. Depending on the type of gas and control of the process, the textile surface is specifically structured, chemically functionalized or even coated with an nm-thin film. By integrating plasma process in an existing production line, it paves way for the realization of new materials and of new research zones(Raje et al., 2004).

Surface modification of the substrate is dependent on various plasma process parameters such as discharge power, treatment time, gas flow rates, nature of the gas, inter-electrode spacing and the nature of the substrate. The type of gas used plays a predominant role in introducing different functionalities on the substrate (Kale & Desai, 2011). Wickability describes the ability to curtain capillary flow whereas wettability describes the initial behaviour of fabric yarn or fibre in contact with liquid. The interaction of fibre assembles (yarn or fabric) with liquid depend on the chemical nature of the fibre surfaces, geometry of the fibre assembles including pursue distribution fibre diameter and surface richness and liquid properties such as surface tension viscosity and density. (K.K Wong, 2001).

The term "ageing of polymers" is used to refer to the processes of slow degradation of bulk and surface properties of polymers under the influence of external factors such as sunlight, outdoor temperature, humidity, oxygen and ozone, mechanical stress and others. The environmental or storage conditions have a profound impact on ageing process of plasma treated substrate (Morent et al., 2007). Therefore it is imperative to conduct studies on the effect of ageing on wettability properties of the fabric.

METHODOLOGY:

Selection of material:

Regenerated bamboo spunlace nonwoven fabric purchased from The South Indian Textile Research Association (SITRA), Coimbatore was used for the study. The surface mass of the fabric is 111.6 g/sq.m (ISO 9073-1) and thickness is 0.6 mm (ASTM D 1777). The fibre fineness is 1.4 denier (ASTM D1577) and staple length is 38mm (BISFA 2004 - SITRA FP/03/2017).

Application of Plasma:

The number of samples to be treated were calculated according to thenumber of parameters involved. The parameters selected for the study are as follows,

Gas	: Oxygen
Discharge Power	: 550W
Pressure	: 3.5millibar
Exposure Duration	: 60sec
Temperature	: Room temperature
Distance between electrodes	: 5cms
Sample	:100% Bamboo Spunlace Nonwoven Fabric

The bamboo spunlace nonwoven fabric was placed between the two electrodes. The oxygen gas was passed on the sample. The plasma was created using different process parameters such as Discharge Potential, Exposure Duration and inter electrode spacing. The effect of plasma was created at 3.5millibar. Finally the samples were subjected to the evaluation.

Wicking test:

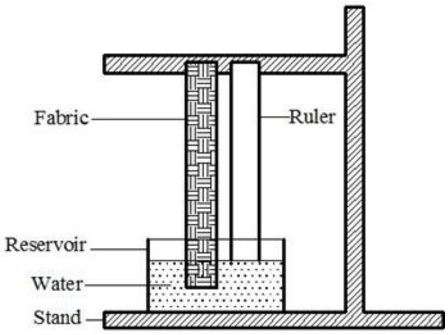

Fig -1

The rate of water transport is measured according to a vertical strip wicking test as shown in Figure 1. The capillarity method measures the rate of vertical capillary rise in a specimen strip suspended in the test liquid. This test method basically measures the rate of absorption of the nonwoven and difficulties could be encountered when judging and comparing the results obtained with anisotropic materials. One end of a fabric strip is secured vertically while the opposite end dangles in a dish containing distilled water. The height to which the water was transported along the strip is measured at intervals of 10sec, 20sec, 30sec, 40sec, 50sec and 60sec and reported in mm. Higher wicking values show greater capability for transporting liquid water.

Evaluation of Ageing Effect:

The plasma treated bamboo nonwoven fabric was subjected to ageing study. The study was carried out by measuring the wicking height at different duration (10s, 20s, 30s, 40s, 50s, 60s) for a period of 20days (1 day, 5 days, 10 days, 15 days, 20 days) in both machine direction and cross direction of the samples.

RESULTS AND DISCUSSION:

TABLE-1 Nomenclature of Samples

S.No.	SAMPLE PARTICULARS	NOMENCLATURE
1	Aged sample(1day) - Machine direction	1DMD
2	Aged sample (5 Days) - Machine direction	5DMD
3	Aged sample (10days) - Machine direction	10DMD
4	Aged sample (15days) - Machine direction	15DMD
5	Aged sample (20days) - Machine direction	20DMD
6	Aged sample (1day) - Cross direction	1DCD
7	Aged sample (5days) - Cross direction	5DCD
8	Aged sample (10days) - Cross direction	10DCD
9	Aged sample (15days)- Cross direction	15DCD
10	Aged sample (20days)- Cross direction	20DCD

TABLE-2 The Capillary Rise of Aged Samples in Machine Direction

Sample	**Wicking height (mm)**					
	10s	**20s**	**30s**	**40s**	**50s**	**60s**
1DMD	37.4	51.2	61.4	69.6	76	82.6
5DMD	37.6	51.4	60.2	68.2	74.4	80
10DMD	35.6	48.8	57.6	65.2	74	78
15DMD	36.2	48.6	56.8	65	71.4	77.4
20DMD	35.1	47.8	56.1	64.4	72.1	77

It is clear from the Table-2 that the sample 20DMD exhibits minimum wicking height at 10 seconds and the sample 1DMD exhibits maximum wicking height at 60 seconds compared to all other samples in machine direction.

TABLE-3 The Capillary Rise of Aged Samples in Cross Direction

Sample	**Wicking height (mm)**					
	10s	**20s**	**30s**	**40s**	**50s**	**60s**
1DCD	33.4	46.8	55.6	68.4	70.4	76
5DCD	34.2	47.4	56.8	64.6	71	77
10DCD	35	46.6	56	64	68.4	75
15DCD	35	45	54.4	62.2	67.2	74.4
20DCD	34	44.6	54	63.1	66.7	74

It is clear from the Table-3 that the sample 1DMD exhibits minimum wicking height at 10 seconds and the sample 5DMD exhibits maximum wicking height at 60 seconds compared to all other samples in cross direction.

Hypothesis of The Study (ANOVA):

H_0 = There is significant different among the wicking height of aged samples.

In order to find out the relationship between the wicking height of the aged samples, a null hypothesis was formulated. One way anova was used and the test results are displayed below.

TABLE-4 ANOVA (MACHINE DIRECTION)

SOURCE OF VARIATION	**SUM OF SQUARE**	**DF**	**MEAN SQUARE**	**'F' VALUE**	**'P' VALUE**	**Fcrit**
Between	6274.259	5	1254.852	326.5575	3.03E-21	2.620654
Between Sample	92.224	24	3.842667			
Total	6366.483	29				

TABLE-5 ANOVA (CROSSDIRECTION)

SOURCE OF VARIATION	**SUM OF SQUARE**	**DF**	**MEAN SQUARE**	**'F' VALUE**	**'P' VALUE**	**Fcrit**
Between	5815.599	5	1163.12	495.9999	2.15E-23	2.620654
Between Sample	56.28	24	2.345			
Total	5871.879	29				

The results of Analysis of variance presents that the F- ratio being 2.6206 which is higher than the table value 2.54 at 5% level in both machine direction and cross direction indicating that, there is no significant difference between the wicking height of the aged samples. Hence the hypothesis is rejected.

CONCLUSION

In the present study, the ageing effect on wettability of oxygen plasma treated bamboo spunlaced nonwoven was investigated by conducting vertical wicking test. The wicking height of the samples was measured after a storage period of 5, 10, 15 and 20 days. The significant effect of ageing process on wettability of samples was analysed by conducting One way ANOVA test from which it is evident that ageing has no significant effect on the wicking height of the samples in both machine direction and cross direction. The increased capillary rise in machine direction compared to that of cross direction is due to the preferential orientation of fibers in spunlaced nonwoven construction.

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