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RESEARCH ARTICLE

EFFECT OF SALINE WATER TREATMENT ON NONWOVEN AND COMPOSITES DEVELOPED FROM NATURAL FIBRES

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ABSTRACT

The development of technology in various fields has led the mankind into a new world of consumerism. In the field of textiles also, the technological developments have created a lot of new consumer products to meet the ever increasing demand of the public. In previous years, the use of natural fibres was widespread and restricted to conventional products. Though there were other materials such as jute, ramie, sisal, coir, banana known to man, their uses were restricted to non textile materials such as packing materials, ropes etc., The developments in the use of latest technology in adopting these non apparel fibres have led to introduction of new diversified products such as composites. The technology of composites making is very new and has very high potential in the natural fibres says Mathews (1999). Nonwoven products are taking the palce of many woven and knit materials because of their lower cost and lighter weight. A study was conducted to find out the effect of nonwoven and composites developed from natural fibres such as Jute, Coir, Banana and blends. Seven samples were taken from the developed nonwoven and composites. They are Jute, Coir, Banana nonwoven and composite as 1st and 2nd & 3rd samples, Jute Coir, Banana Coir, Jute Banana nonwoven and composites as 4th, 5th and 6th and Jute Coir Banana nonwoven and composites as 7th sample. These developed samples were subjected to saline water treatment. Colour fastness and an observation test were carried out. The study revealed that nonwoven prepared from Coir had absorbed more water when compared to Banana Jute and Coir Banana Jute. The composite made up of Coir had absorbed more water due to the space found in between the composite than the other composites.

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INTRODUCTION

The technical textiles use both natural and manmade fibres in manufacturing a variety of products. One of the important recent developments in fibre use is in the manufacture of composites in which the fibre acts as a reinforcing "skeleton" for a matrix of plastics. The composite materials are characterized by low mass and high strength and are finding applications in a multitude of end products in which these two properties are of value. It has been found that these natural fibre composites possess better electrical resistance, good thermal and acoustic insulating properties and higher resistance to fracture. Fibre reinforced plastics composites have been successfully employed in various applications, with one of the primary objectives being corrosion prevention Lubin, George, (1969). Fibre reinforced plastics (FRP) shipboard structures, such as masts and spars, deckhouses, tanks, radar equipment, floats, and buoys; chemical plants equipment; and aerospace structures have all been successfully designed and used in highly corrosive environments for many years. Chemical corrosion can be prevented if the proper resins, reinforcements and additives are chosen with care. Fibre reinforced composites can also be employed in the absence of a lightning like protection scheme when the design involves a deliberate attempt to prevent strikes. Today with the increasing consumer markets, new products have been introduced in order to replace materials such as glass, metals, carbon, cement that are heavy, costly corrosive and less environmental friendly. One such material is fibre composites. Composites began to be used more and more in every day commodities like bath tubs, railings, electrical goods, sports equipment, aerospace and ship industry. Now their applications have enhanced says Tang et al. (1997). Natural fibre reinforced composite is an emerging area in polymer science. Natural fibres are low cost fibres with low density an high specific properties compared to glass which is normally used to construct country boat, along with a resin. This represents a modern technology which is adopted to produce fibre reinforced composites using unsaturated vinyl ester, polyester etc. Natural fibres can be substituted for glass

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and carbon fibres in polymer composites. Their potential for use in moulded articles, which need high strength for acceptable performance, has been tried in equipment like housing, roofing and in large diameter piping as pointed out by Mishra (2000). Composites provide the designer, fabricator, equipment manufacturer, and consumer with sufficient flexibility to meet the demands presented by different environments. Since composites can be designed to provide an almost unlimited selection of characteristics, they are employed in practically all industries. Composites are used to produce a variety of economical, efficient, and sophisticated items, ranging from toys and tennis, rackets to reentry insulation shields and miniature printed circuits for spacecraft. In order to develop composites with better mechanical properties and environmental performance, it is necessary to impart hydrophobicity to the fibres by chemical reaction with suitable coupling agents or by coating with appropriate resins. Modification of jute and other natural cellulosic fibres can be done by chemical means, coating with polymeric solutions and graft co-polymerization. The hydroxyl groups of jute are blocked when chemically treated and the fibres become more hydrophobic.

Jute–glass fibre combination can be suited for such applications. Incorporation of glass with jute brings large increases in mechanical properties of composites. Thus, in order to increase the potential application area of jute fibres as reinforcement in composites, it is necessary to concentrate more on three major aspects (a) fibre modification (b) resin matrix and (c) coupling agents. With increasing emphasis on fuel efficiency, jute and coir composites would enjoy wider applications in automobiles and railway coaches. In fact, the market segment for railway coaches in India has a vast potential which is yet to be tapped to a good extent. Epoxy resins can be used in both laminating and moulding techniques to make fibre reinforced articles with better mechanical strength, chemical resistance and electrical insulating properties than those obtained with unsaturated polyesters. Only the higher price of epoxies prevents their wider use within this field. Recent reports indicate that plant-based natural fibres can very well be used as reinforcement in polymer composites, replacing to some extent more expensive and non-renewable synthetic fibres such as glass says Sara J. Kadolph et al. (2002).

Environmental Effects on Composites

Environmental effects on composite materials must be considered in the earliest stages of a system design. The design engineer must consider both natural and induced environments. Most important, when considering environmental effects, is to address the combined effects of the total environmental factors to which the system will be exposed says Wallen Berger et al. (2004).

MATERIALS AND METHODS

The natural fibers have started to be used again because of being naturally derived from plants and due to their characteristics of being light weight compared to glass. The plant fibre reinforcements are resoluble, good insulator of heat and sound, degradable and have a low cost. Natural fibre can be substituted for glass and carbon. Coir fibre is known for its stiffness and resilience. It can withstand large amount of pressure and abrasion. Coir can be used for thermal insulation due to its insulation property. Coir gives a variety of eco-friendly products suitable for industrial and domestic uses. Banana fibre is a natural fibre with high strength and can be blended easily with cotton or other synthetic fibres to products blended textiles. Natural fibre apart from low cost eco-friendly and renewable in nature, it is more attractive as nonwoven and as a reinforcing material in composites says Billie. J. Collien et al. (2001). Viriginia Henckon (2005) views that since the last decade, a great deal of emphasis has been focused on the development and application of natural fibre nonwoven reinforced composite materials in many industries. The demands of these industries are weight retention and fuel economy and several automobiles have been constructed using natural fibre nonwoven with epoxy resins. Hence the investigator selected the natural fibres such as Jute, Coir and Banana to prepare nonwoven and to develop a suitable composite which could be considered for the construction of country boat. The developed nonwoven and composites were subjected to saline water treatment which are given in result and discussion

RESULTS AND DISCUSSION

Technological advancement paves the way for the production and processing of blends from three eco-friendly and biodegradable natural fibres that is blending of jute, coir and banana. The jute, coir, banana fibres were the materials selected for the production of nonwovens and to develop composites. The quality of the composite depends up on the type of fibre, its inherent characteristics, the quality of nonwoven. Nonwovens are usually made from fibrous materials and therefore most of these properties will depend upon the product of fibrous web and the bonding agents present.

Table I. Properties of Natural Fibres

Property	Jute	Banana	Coir	Pinapple
Width or Diameter (mm)	-	80-250	100-450	20-80
Density (gms / cc)	1.3	1.35	1.15	1-44
Volume Resistivity at 100 Volts (Wcm x 10^5)	-	6.5-7	9-14	0.7-0.8
Micro – Fabrillar Angle (Degree	8.1	11	30-49	14-18
Cellulose / Lignin Content (%)	61/12	65/5	35/45	81/12
Elastic Modulus (GPa)	-	8-20	4-6	34-82
Tenacity (MPa)	440-533	529-754	131-175	413-1627
Elongation (%)	1-1.2	1.0-3.5	15.40	0.8-1.6

Presented by Sangeetha Nangia et al. (2000) in www.worldjute.com

With the advent of fibre composites, new light weight structures of Warfare ships have been introduced which are fuel efficient, fast, fire resistant, non magnetic and with a minimum cost of maintenance. These ships can easily receive and send radar waves. Key fixtures and fittings of the boat are now being made from these materials. Steering wheels and wind transducers are some of the most recent areas of application (Micheal, 1999).

Treating the fibres, nonwovens and Composites with Marine water

To find out the characteristics of the selected fibre samples in saline water, fifty grams of jute, coir and banana fibres were taken separately on a basin and soaked in 1000 ml of saline water for 24 hours. The water was changed daily. Seventh sample were taken with a sample size of 20/15 cm. The selected needle punched nonwovens were soaked in saline water for 24 hours. The water was changed daily. This treatment was given for 10 days. The change of colour, appearance, texture, luster, feel were observed. The soaked samples were dried in sunlight. The colour fastness test was done to find out the fastness to washing and sunlight. The composites made of resin were cut in small size. A size of 25/17.5 cm was taken from all the sample, and the weight was taken before treating them with sea water. The cut samples such as jute (J), coir (C), banana (B), jute coir (JC) (50:50), coir banana (CB) (50:50), jute banana (JB) (50:50), and jute coir banana (JCB) (33:33:33) were subjected to sea water treatment at the room temperature. The water was replaced every 8 hours. At the completion of eight hurs, the readings were taken to find out the weight gain of the composite as well as the colour change. The seawater treatment was carried out to see the rot resistance property.

The weight of the selected fibres were treated with saline water and the study showed that there is slight increases in the weight of coir banana and coir after treating with saline water is given in Table II. The study revealed that when nonwoven was treated with saline water, the weight had increased specially the nonwoven prepared with coir had absorbed more water when compared banana and jute. There was a slight increase in coir banana and jute coir. Hence it was concluded that the presence of coir in nonwoven has increased the absorption of water which is given in table III. It is revealed that the weight of the nonwoven has increased after treating with saline water. Specially the nonwoven prepared with coir has absorbed more water when compared to banana jute and coir banana jute. The weight of the composite treated in saline water was studied and the table IV states that the composite made up coir and their combination like coir banana, coir jute had absorbed more water and increased in the weight. Jute had increased in weight 0.6 when compared to coir and their combination.

Evaluation of the Nonwoven Treated with Saline Water

It was clearly understood that the general appearance of nonwoven was good, fair and poor stated by 49, 38 and 13 percent. 55, 37 and 8 percent stated that the lustre of the jute was low, medium and high respectively. The colour of the jute

Table II. Weight of the Fibre Treated with Saline Water

S.No	Name of the Sample	Weight of the Fibre Before Treatment (gms)	Weight of the Fibre After Treatment with Seawater (gms)	Percentage Increased (gms)
1.	Jute	50	50	0
2.	Coir	50	52	4
3.	Banana	50	50	0
4.	Coir Banana (50:50)	50	53	6
5.	Banana Jute (50:50)	50	50	0
6.	Jute Coir (50:50)	50	51	2
7.	Coir, Banana Jute (33:33:33)	50	51	2

Table III. Weight of the Nonwoven Treated with Saline Water

S.No.	Name of the Sample	Size of the Nonwoven		Weight of the Nonwoven Before Treatment (gms)	Weight of the Nonwoven After Treatment (gms)	Percentage Increase (gms)
		Length (mm)	Weight (mm)			
1.	Jute	20	15	40	42	5.00
2.	Coir	20	15	55	62	12.73
3.	Banana	20	15	45	48	6.67
4.	Coir Banana (50:50)	20	15	52	57	9.62
5.	Banana Jute (50:50)	20	15	49	54	10.20
6.	Jute Coir (50:50)	20	15	53	58	9.43
7.	Coir, Banana Jute (33:33:33)	20	15	49	54	10.20

Table IV. Weight of the Composites Treated with Saline Water

S.No.	Name of the Sample	Size of the Sample		Weight Before Treatment (gms)	Weight After Treatment (gms)	Percentage Increase (%)
		Length (mm)	Weight (mm)			
1.	Jute	25	17.5	199.4	200.6	0.60
2.	Coir	25	17.5	241.0	248.9	3.28
3.	Banana	25	17.5	207.5	210.3	1.35
4.	Coir Banana (50:50)	25	17.5	343.0	351.5	2.48
5.	Banana Jute (50:50)	25	17.5	206.3	208.4	1.02
6.	Jute Coir (50:50)	25	17.5	199.4	205.7	3.16
7.	Coir, Banana Jute (33:33:33)	25	17.5	234.0	236.6	1.11

Table V. Evaluation of the Nonwoven Treated with Saline Water

Name of the Selected Samples	General Appearance			Lustre			Colour			Texture			Feel		
	Good	Fair	Poor	High	Medium	Low	Dark	Light	Dull	Fine	Rough	Smooth	Poor	Fair	Good
Jute	49	38	13	8	37	55	36	64	-	10	78	12	23	46	31
Coir	23	62	20	4	10	86	84	16	-	-	84	16	64	36	-
Banana	74	26	-	76	24	-	-	31	69	21	26	53	2	43	55
Jute Coir	26	34	40	-	23	74	46	-	54	20	68	12	65	29	6
Coir Banana	13	23	64	28	32	40	43	26	21	8	79	13	71	19	10
Jute Banana	60	21	19	58	32	10	17	73	10	49	-	51	65	29	6
Jute Coir Banana	60	23	17	53	41	6	-	67	33	39	16	45	16	38	46

Table VI. Evaluation of the Composites Treated with Saline Water

Name of the Selected Samples	General Appearance			Lustre			Colour			Texture			Feel		
	Good	Fair	Poor	High	Medium	Low	Dark	Light	Dull	Fine	Rough	Smooth	Poor	Fair	Good
Jute	63	37	-	80	20	-	-	89	11	44	-	66	7	40	53
Coir	-	29	7	-	20	80	78		22	33	67	-	76	24	-
Banana	58	38	9	88	12	-	-	92	8	43	-	57	49	41	10
Jute Coir	10	64	26	-	28	72	64	-	36	5	81	14	12	68	20
Coir Banana	19	69	12	12	62	26	56	28	16	11	67	22	23	56	21
Jute Banana	55	35	10	79	21	-	-	61	39	51	16	33	38	52	10
Jute Coir Banana	63	37	-	39	48	13	31	41	28	30	26	44	29	46	25

Table VII. Tensile Strength of the Nonwoven Tested in Machine Wise Direction

Type	Tensile Strength (KN/m^2)		Tensile Elongation (%)		Initial Modulus (KN/m^2)	
	Machine Direction	Cross Direction	Machine Direction	Cross Direction	Machine Direction	Cross Direction
Jute	15.0787	6.8632 to 8.6088	22.8 to 28.5	22.8 to 29.925	45.08	23
Coir	11.28 to 12.125	2.0832 to 2.9109	16.235 to 18.28	26.2625 to 31.0375	39.06	14.88
Banana	10.681	1.5895 to 3.09485	10.8 to 16.0032	6.8676 to 16.16	61.88	18.5
Jute Coir	9.12 to 12.85	1.5895 to 3.09485	19 to 25.33	6.8676 to 16.16	43.1	11.28
Jute Banana	5.499 to 7.3639	1.425 to 1.7765	16.8 to 22.59	28.5866 to 34.93	45.36	9.45
Banana Coir	3.458 to 3.8855	0.062075 to 0.94545	16.88 to 19.1	21.7488 to 24.625	28.8	8.55
Jute Banana Coir	5.5385 to 8.474	0.4992 to 0.6432	19 to 26.82	10.7217 to 18.9783	41.85	9.55

was dark stated by 36 percent and light stated by 64 percent. 10 percent stated that the texture of the jute was fine, 78 percent stated that the texture of the jute was smooth. 23 percent stated that the feel of the jute was poor, 46 percent stated that the feel of the jute was fair and 31 percent stated that the feel of the jute was good which is stated in Table V and VI. Hence it could be concluded that the general appearance of banana, jute banana and jute coir banana was good, and coir banana had poor appearance. Banana had highest lustre and coir had lowest lustre. The colour of the coir was dark, jute and banana had a light colour and jute coir had dull colour. The texture of the jute banana was fine whereas coir had rough texture and banana had smooth texture. The feel of the banana was good, the feel of the jute was fair and coir banana had poor feel.

Effect of Saline water on mechanical properties of nonwovens and composites

The advantages of natural plant fibres over traditional glass fibres are the good specific strengths and modulus, economical viability, low density, reduced tool wear, enhanced energy recovery, reduced dermal and respiratory irritation and good biodegradability. All polymer composites absorb moisture in humid atmosphere and when immersed in water. The effect of absorption of moisture leads to the degradation of fibre-matrix interface region creating poor stress transfer efficiencies resulting in a reduction of mechanical and dimensional properties. The composites were tested for its mechanical properties such as tensile, flexural and impact properties after immersion in saline water. There is a overall drop in the mechanical properties of the composites. This is due to water molecules act as a plasticizer agent in the composite material, which normally leads to an increase of the maximum strain for the composites after water absorption. The decrease in mechanical properties with increase in moisture content is may be caused by the formation of hydrogen bonding between the water molecules and cellulose fibre. The characteristics of water immersed specimens are influenced not only by the nature of the fibre and matrix materials but also by the relative humidity and manufacturing technique, which determines factors such as porosity and volume fraction of fibres. Water uptake can be advantageous for some natural fibres (such as Duralin fibre) at 66 % relative humidity as can fibre plasticizing effect as a result of from the presence of free water. Excessive water absorption, however, leads to an increase in the absorbed bound water and a decrease in free water. In this situation, water can penetrate into the cellulose network of the fibre and into the capillaries and spaces between the fibrils and less bound areas of the fibrils. Water may attach itself by chemical links to groups in the cellulose molecules. The rigidity of the cellulose structure is destroyed by the water molecules in the cellulose network structure in which water acts as a plasticizer and it permits cellulose molecules to move freely. Consequently the mass of the cellulose is softened and can change the dimensions of the fibre easily with the application of forces.

Conclusion

The study revealed that the nonwovens and composites showed a slight increase in the weight especially in coir and their combination. Other materials such as jute had taken less moisture. Thus it was concluded that the presence of coir in all the nonwovens and composites had absorbed the moisture when treated with saline water. Treatment with saline water has led to a drop in tensile modulus, tensile strength, flexural modulus and flexural strength of all composites. Impact strength of the composites also had shown a drop in saline water. Jute / banana blend was least affected by saline water treatment. Saline water treatment did not have any effect on the areas density of the fibre whilst for nonwovens an increase was noticed. Weight increase in the composite was less in saline water in comparison with the nonwovens.

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