STUDY OF MECHANICAL PROPERTIES AFTER AGING IN 5% NaCl AQUEOUS SOLUTION OF NATURAL FIBER / UNSATURATED POLYESTER RESIN COMPOSITE

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Abstract: *In this research paper are presented some aspects about the mechanical properties of green composites after immersion in 5 % NaCl aqueous solution for 3 months at room temperature. Three-point bending test was performed for some aspects concerning the characteristics of the cotton tissue and unsaturated polyester resin composites.*

Keywords: natural fibres, unsaturated polyester resin, water uptake, three-point bending test

1. INTRODUCTION

Natural fibers found within lignocelluloses and are made up of cellulose, hemicellulose, pectin, lignin and water mainly. The application of natural fibers to component design through polymers is limited by hydrophilic natural of the cellulose [1]. At the present there is a number of mechanical characteristics available for cellulose by natural fibers in literature. Many of the cited values for tensile strength, breaking strain, Young's Modulus vary dramatically from scattered sources [2]. Natural fibers are very attractive for study because it is possible to create composite growing the characteristics that meets and needs of the product [3]. The use of natural fibers as reinforcement in polyester resin composites has a contributory factor to the environmental friendly economic viability low density, reduced tool wear, enhanced energy recovery reduced dermal and respiratory irritation and good biodegradability [4]. Because of the hydrophilic nature of the cellulose fibers, the moisture knows to diffuse into compact polymer composites by a Fickian diffusion process, is influenced by the internal and external factors fiber nature [5].The objectives of this work are to determine the absorption of the friendly composites in 5 % NaCl aqueous solution, the effect of the 5 % NaCl aqueous solution treatment on the flexural properties and to compare the mechanical characteristics of untreated and treated composites.

2. MATERIALS AND METHODS

By hand lay-up method was performed an eco-friendly cotton tissue/unsaturated polyester resin composite plate with seven layers. In Figure 1 is presented the schematic principle to obtain the eco-friendly composite by using lay-up method.

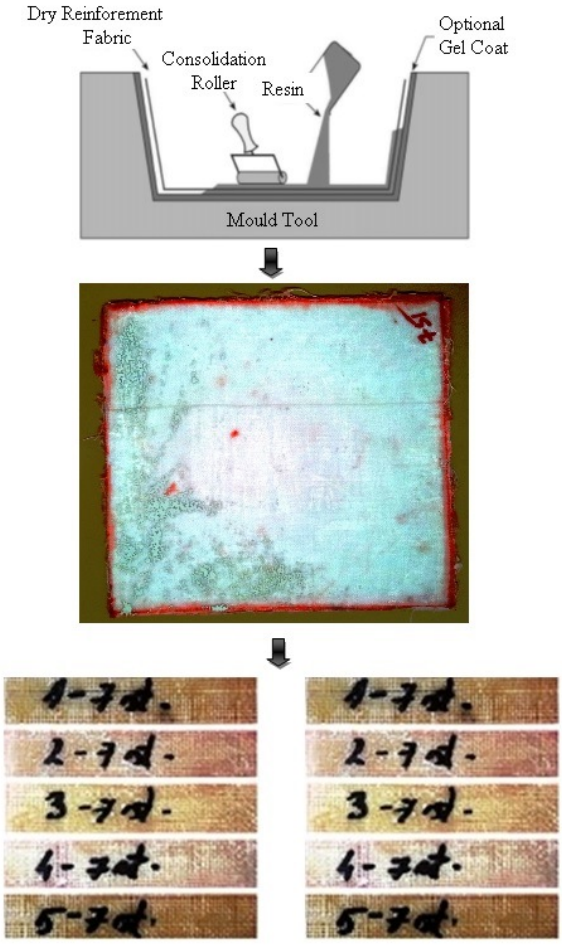

Fig. 1. Schematically principle to obtain eco - friendly composite

2.1. Water uptake

In Figure 2 is presented the cotton tissue/unsaturated polyester resin composite left to soak at room temperature in 5 % NaCl aqueous solution for 90 days.

Fig. 2. Specimens immersed in 5 % aqueous solution

For several days the specimens were weighed with a precise electronic balance, every 24 hours, for monitoring the variation of the composite mass and the absorption process was expressed with the relation (1) [6]:

$$Water\ uptake = (P_w - P_o / P_o) * 100\ [\%] \qquad (1)$$

where: P_w - is the wet weight;
P_o - is the dry weight of the specimen

The Figure 3 reports the average of 5 cotton tissue / unsaturated polyester resin specimens immersed in 5 % NaCl aqueous solution 90 days.

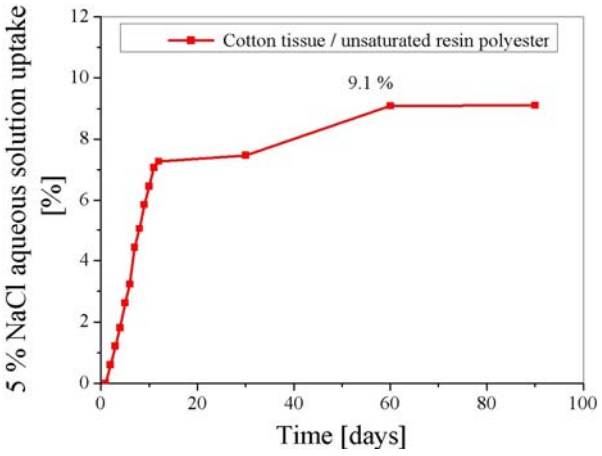

Fig. 3. Average uptake of 5 specimens

From the absorption curves, it is shown that absorbed 5 % NaCl aqueous solution increased with increasing immersion time up to approximately two months, with a significant linear sharp in the first days. In fact the presence of NaCl molecules on the fibers makes the absorption to increase to 9.1 %. The presence of NaCl molecules in the cell walls of fibers has capacity to create more space by hydrodilatation, to accommodate more solution and to affect the interfacial bonding between matrix and fibers, decreasing the mechanical characteristics.

2.2. Flexural tests

In Figure 4 are presented the flexural tests produced by LR5K Lloyd's Instruments apparatus, which provides a maximum force F_{max}= 5KN.

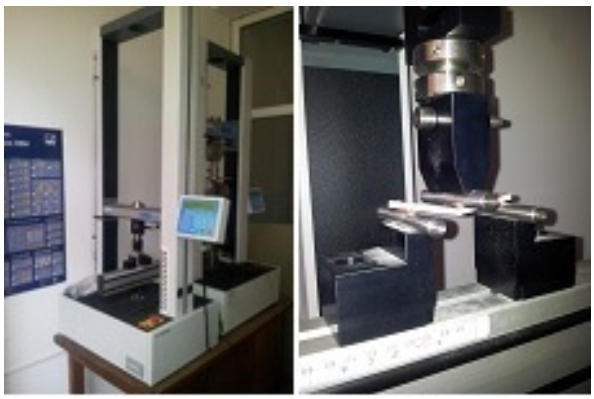

Fig. 4. LR5K Lloyd's apparatus

The untreated and treated specimens in 5 % NaCl aqueous solution presented in Figure 1 were subjected to flexural tests with a constant speed of 5 mm/min until fracture. The treated and untreated specimens dimensions are presented in Table 1.

Table 1. The dimensions of untreated and treated specimens

	Cotton/unsaturated polyester resin specimens with 7 layers				
Sample no.	*Untreated*				
	1	2	3	4	5
L_2 [mm]	80	80	80	80	80
b_1 [mm]	15	15	15	15	15
h [mm]	3,57	4,16	3,37	3,50	3,57
A [mm^2]	53,55	62,4	50,55	52,5	53,55
	Treated 5% NaCl				
	1	2	3	4	5
L_2 [mm]	80	80	80	80	80
b_1 [mm]	15	15	15	15	15
h [mm]	3,73	3,57	4,21	4,13	3,33
A [mm^2]	55,95	53,55	63,15	61,95	49,95

The average of mechanical characteristics of cotton / unsaturated polyester resin composites are presented in Table 2.

Table 2. The mechanical characteristics of untrated and treated cotton tissue / unsaturated polyester resin composites

Characteristics	*Units*	*Average values of cotton / unsaturated polyester resin composites*	
		Untreated	*Treated 5% NaCl*
Stiffness	[N/m]	17349	17796
Young's modulus	[MPa]	1437,4	1474,4
Maximum Load	[kN]	0,1437	0,1448
Max. Bending Stress at Max. Load	[MPa]	65,486	65,943
Extension at Max. Load	[mm]	15,3	27,6
Max. Bending Strain at Max. Load	[-]	0,0839	0,1514
Load at Break	[kN]	0,1375	0,0899
Max. Bending Stress at Break	[MPa]	62,579	40,934
Max. Bending Strain at Break	[-]	0,0999	0,188

In Figure 5 and Figure 6 are presented by comparing the load – deflection and stress-strain curves of untreated and treated cotton / unsaturated polyester resin composites.

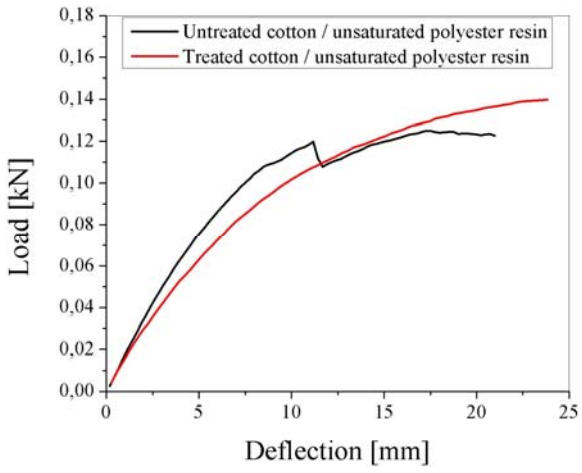

Fig. 5. Average values of load - deflection curve of untreated and treated specimens

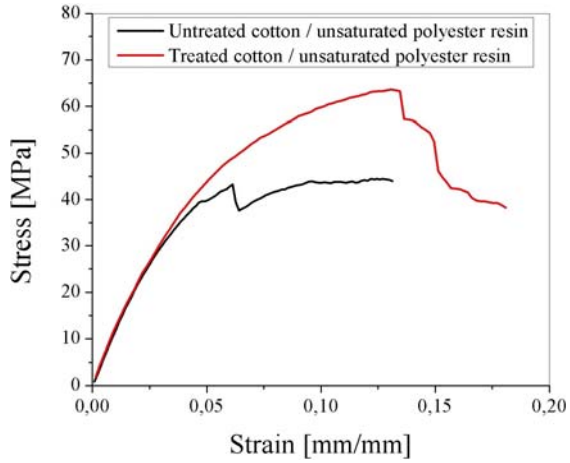

Fig. 6. Average values of stress-strain curves of untreated and treated specimens

In Figure 7 and Figure 8 are presented the distribution of stiffness and the Young's Modulus of cotton tissue / unsaturated polyester resin specimens.

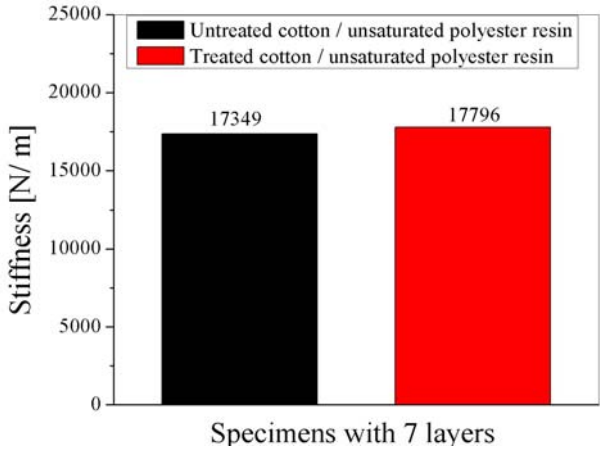

Fig. 7. Average of stiffness between untreated and treated cotton tissue /unsaturated polyester resin composites

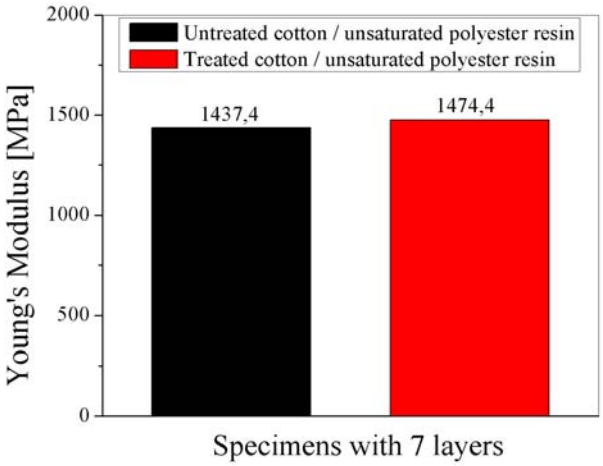

Fig. 8. Average of elasticity modulus between untreated and treated cotton tissue /unsaturated polyester resin composites

3. CONCLUSIONS

In this work the effect of aging condition by immersion of cotton tissue / unsaturated polyester resin with 7 layers in 5 % NaCl aqueous solution for 90 days reported that absorption reaches to equilibrium after 60 days and solution uptake it is 9.1 %. Exposure to moisture results a reduction of maximum load at break but increase the stiffness and the flexural modulus. The higher values of the treated specimens are attributed to plasticization effect.

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