Effect of Nanoclay on the Tensile properties of Polyester and S-glass Fiber(Al)

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***Abstract* - Composite materials play a vital role in many industrial applications. Researchers are working on fabrication of new composite materials worldwide to enhance the applicability of these materials. In view of this, the objective of the present work is to analyze the effect of nanoclay content on the mechanical behavior of S-glass fiber, reinforced in Polyester with nanoclay as filler. Five different types of composites are fabricated by hand layup technique using 0%wt nanoclay ,1wt% nanoclay, 3wt % nanoclay, 5wt% nanoclay and 7wt% nanoclay with 40% wt fiber, and polyester. The results of the study show that the incorporation of nanoclay has a significant effect on the tensile behavior of composites. The optimum loading of clay in the Polyester /glass fiber composites was attained at 3wt%, where the improvement in tensile strength, tensile modulus is seen.**

Keywords – Nanoclay , S-Glass fiber (al), Polyester etc

1.INTRODUCTION

Composites: A composite material is a material made up of two or more materials that are combined in a way that allows the materials to stay distinct and identifiable. Some common composite materials include concrete, fiberglass, mud bricks, and natural composites such as rock and wood. Composites are classified into two types based on a) Matrix Material b) Reinforcing Material

Glass fiber reinforced composites have become attractive structural materials not only in weight sensitive aerospace industry but also in marine, automobile, railways, civil engineering structures, sport goods etc. This is attributed to high specific strength and specific stiffness of the glass fiber reinforced composites.

Polyester is one of most commonly used polymer matrix with reinforcing fibers for advanced composites applications due to its low cost, easy handling, rigid, flexible, corrosion resistant, weather resistant, and flame retardant.

Nanoclay has received much attention as reinforcing materials for polymer because of its potentially high aspect ratio and unique intercalation characteristics .The small amount addition of Nanoclay into polymer matrix exhibits unexpected properties including reducing gas permeability, improved solvent resistance, being superior in mechanical properties and thermal stability, and enhanced flame retardant properties.

A. B. Inceoglu and U. Yilmazer [1] studied that the tensile strength, tensile modulus, flexural strength, and flexural modulus of neat UP were improved by the presence of clay up to 5wt%. Above 5wt% of clay, tensile and flexural properties were decreased. Many researchers investigated individually Polyetser/glass fiber composites, Polyester/Nanoclay and Polyester/E-Glass/Nanoclay no investigation has been carried out on Polyester/S-glass fiber/clay composites. Literature survey indicates that very limited work has been done on tensile behavior of mat S-glass fiber reinforced polyester composite. Therefore, the aim of this work is to fabricate S-glass / polyester / Nanoclay composite of varying wt% using hand layup technique and to study the tensile properties of the composites.

2.MATERIALS

2.1 Materials

Polyester resin of grade ECMALON 4411, methyl ethyl ketone peroxide and cobalt naphthanate were purchased from Ecmass resin (Pvt) Ltd., Hyderabad, India. Nanoclay, which has its surface modified with 25-30wt% methyldihydroxyethyl hydrogenated tallow ammonium is obtained from Sigma aldrich Banglore.

2.2 Fabrication

Firstly,Polyester/Nanoclay composites ,with different clay wt% (1, 3, 5, and 7 wt%),were prepared by mixing the desired amount clay with Polyester in a suitable beaker. Then the mixture was placed in a high intensity ultra-sonicator for 30min with pulse mode (15s on/15s off). Once the process was completed Polyester/Nanoclay/ S-glass fiber composites were prepared by hand layup method. Four plies of glass fiber were cut as per the required dimensions. A layer of Polyester/clay mixture which was mixed and kept was applied on a mold. The first ply was laminated until it became entirely wetted by the resin. Additional Polyester/clay mixture was added, and the second ply was laminated until complete wetting. This procedure was repeated until four plies were superimposed. Then, the sample was pressed with a metal roller to find the thickness of approximately 3 mm. The composites samples were cured at room temperature for 24 hours. The cured composites then were cut in a suitable geometry per ASTM standards

Fig 1: *Cured composite*

Fig 2: *Samples after cutting*

2.3 Mechanical testing of Composites

A 2 ton capacity - Electronic tensometer, Its capacity can be changed by load cells of 20Kg, 200Kg & 2000 Kg. A load cell of 2000 Kg. is used for testing composites. A digital micrometer is used to measure the thickness and width of composites.. The tensometer is fitted with a fixed self aligned quick grip chuck and other movable self aligned quick grip chuck. The movable chuck is adjusted to accommodate 25 mm wide and 3mm thick specimen. The specimen was held in fixed grip and the movable grip is manually moved until the specimen is held firmly without slackness. The power supply is switched on

2.4 Calculations:

Tensile Strength: It is defined as the maximum Stress that a material can withstand while being stretched or pulled before failing or breaking

Tensile Strength: P/A

Where P=Maximum Load

A= Area

Tensile Strain= dl/l

Where dl=change in length(mm)

L= original length(mm)

Tensile Modulus= Stress/Strain

3. RESULTS AND DISCUSSION

3.1 Load and elongation values

	Polyester		0%N		1%N		3%N		5%N		7%N	
No	E (mm)	L (kg)	E	L	E	L	E	L	E	L	E	L
1	10.2	9.2	8.0	14.0	7.0	16.0	8.7	17.8	7.6	14.5	7.4	12.6
2	8.2	8.9	8.2	14.7	7.4	15.2	9.6	18.1	7.4	15.1	7.0	8.4
3	8.0	8.1	8.4	14.3	7.6	14.8	9.0	18.0	6.8	13.6	7.2	13.0
4	9.6	8.6	7.2	14.4	8.0	15.0	5.4	17.7	6.8	11.7	7.0	10.4
5	9.6	7.4	7.0	13.8	8.6	15.7	5.6	20.2	6.6	12.3	5.6	11.3
avg	9.12	8.44	7.76	14.24	7.72	15.3	7.66	18.3	6.98	13.4	6.84	11.14

3.1.1 Average Load Values

Wt% of Nanoclay	Load(kg)
Polyester	78.6
0%N	310
1%N	335.4
3%N	352
5%N	294.2
7%N	271.4

3.2. Tenile strength and Tensile Modulus values

3.2.1 Tenile Strength

Wt% of Nanoclay	Tensile Strength(Mpa)
Polyester	19.76
0%N	77.9
1%N	84.36
3%N	88.54
5%N	74.002
7%N	68.26

3.2.2 Tensile Modulus

Wt% of nanoclay	Tensile modulus(mpa)
Polyester	236.26
0%n	1139.49
1%n	1195.82
3%n	1449.31
5%n	1130.5
7%n	1078.2

3.3 Results and Discussions

From fig 3.3.1 The maximum load carrying capacity is observed for 3wt% Nanoclay and the maximum load obtained is 352 Kg.

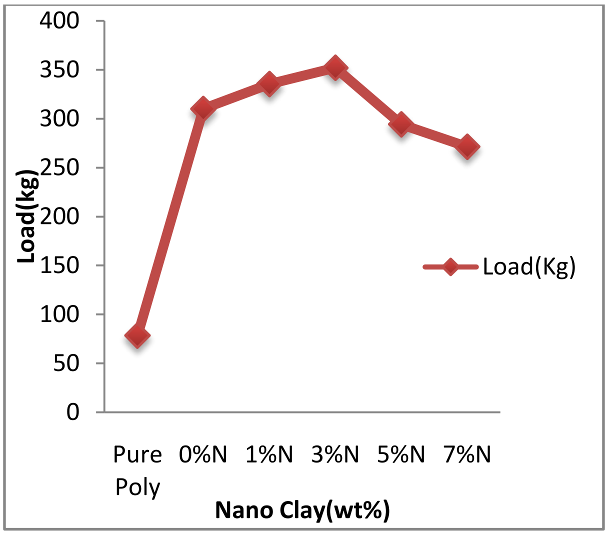

Fig 3.3.1: *Load variations for different wt% of nanoclay*

From fig 3.3.2The maximum elongation that is observed for 1wt% Nanoclay and the maximum elongation obtained is 3.88

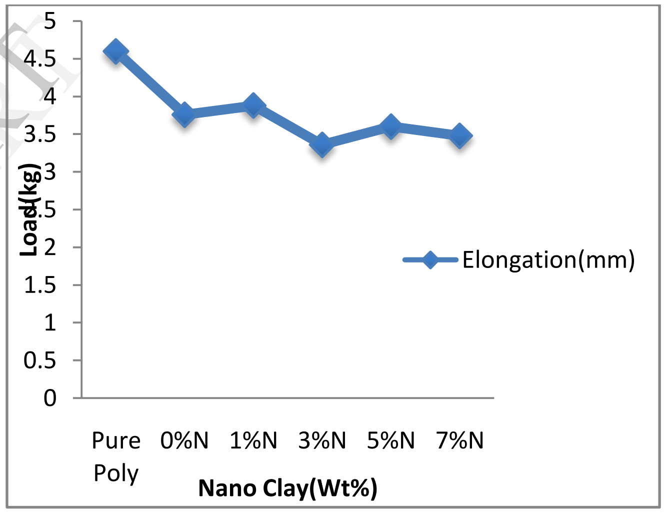

Fig 3.3.2: *Elongation variations for different wt% of nanoclay*

From fig 3.3.3The maximum value of tensile strength obtained is 88.54Mpa at 3wt% Nanoclay

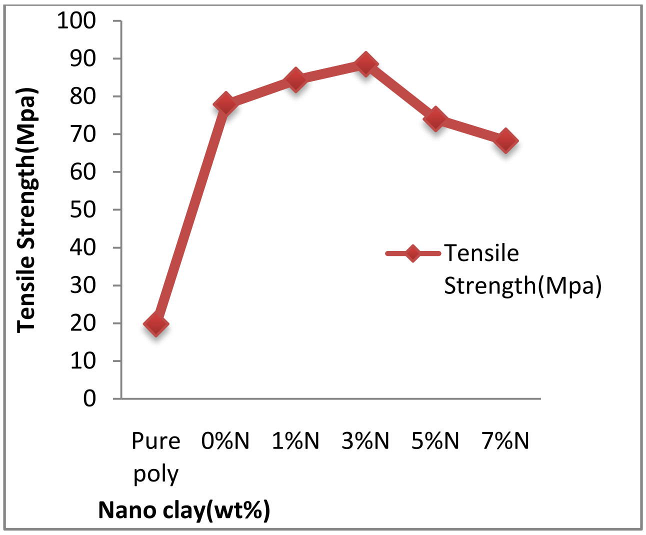

Fig 3.3.3 :Tensile strength variations for diferrent wt% of nanoclay

From fig 3.3.4 The maximum value of tensile modulus obtained is 1449.3Mpa at 3wt% Nanoclay

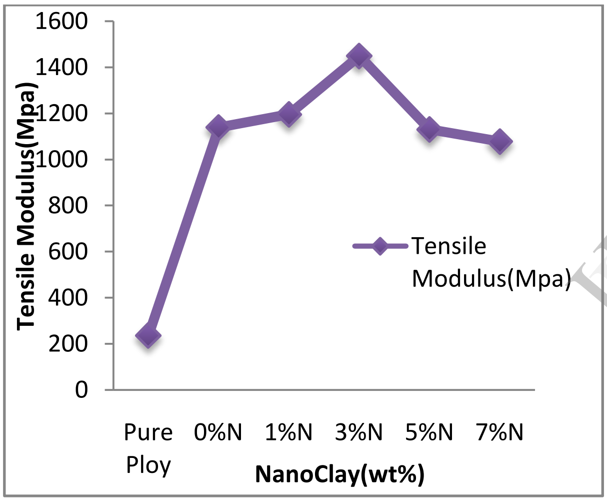

Fig 3.3.3 :Tensile modulus variations for diferrent wt% of nanoclay

From the tensile test results , as the weight percentage of nanoclay increased, the tensile strengths of the samples also increased. 3 wt% samples showed the maximum tensile strength and modulus. But it was not the case for 5 wt% and 7 wt%, instead they tended to break apart before the peak, which meant they were brittle. It was because when the nanoclay weight percentage increased, the mixture itself became too viscous, sluggish and more void formations in the samples of high wt%. The more the nanoclay added, the more viscous of the clay–resin mixture. This is the reason for which the higher wt% samples failed. Another reason for failure of higher clay loading is low aspect ratio of clay particles and low contact surface area resulting in weak adhesion between polymer matrix and clay. This subsequently lowers their tensile strength. In addition, at high clay loading this behavior was probably attributed to the filler-filler interaction which resulted in agglomerates, induced local stress concentration, and finally reduced tensile strength of the nanocomposites

4.Conclsion

S-glass / Polyester composite of nanoclay is prepared with five different wt% of nanoclay, ie 0wt%, 1wt%, 3wt%, 5wt%, 7wt%. From the study, following observations were made. The tensile strength and tensile modulus for 3wt% nanoclay composite is more compared to other clay loadings. The optimal clay loading obtained is 3wt%.The maximum tensile strength obtained is 88.54mpa at 3wt% and the maximum tensile modulus obtained is 1449.3mpa.

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