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Ageing of SiC Filled CF Reinforced Epoxy Hybrid Composites

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ABSTRACT: The effect of water absorption and chemical resistance behavior of materials against acids and alkali solutions was investigated for a carbon fiber polymer matrix composite material. The specimens were immersed in acids and alkalis for several hours and chemical resistance was calculated. The sample specimen carbon fiber materials were filled with filler materials in different ratios. The filler materials are Sic and graphite materials. The behavior against weathering conditions was studied by swelling behavior in toluene solvent with 10% sodium chloride solution at room temperature.

KEYWORDS: carbon fiber, effect of filler on ageing resistance, swelling behavior.

I. INTRODUCTION

The composite materials have wide variety of applications in many fields. One of the most commonly using composite materials are polymer matrix composites. These polymer matrix composites (PMC) are available in different forms. They provided better strength to weight ratio, good corrosion resistance, durability, outstanding insulating properties. This type of polymer composites were easy processing and require material property can be achieved with suitable materials. Carbon fiber is one of a polymer matrix composite which provide excellent mechanical properties. Nowadays carbon fiber is widely using in many fields for their mechanical properties. The carbon fiber along with epoxy resin and filler provide better strength than carbon epoxy material. In this work several types of ageing test were carried out. The ageing is the process that determines the material quality in all dimensions. The accelerated ageing test was conducted on materials to determine the quality of materials in their entire lifespan. The ageing test was conducted on material like water absorption test, chemical resistance, swelling behavior test.

II. EXPERIMENTAL METHOD

A.Materials and Processing

The carbon fiber material is reinforced with epoxy resin matrix material and curing hardener. The six specimens were manufactured for ageing of material studies. The manufactured six specimens are carbon fibre – epoxy resin, 5% Sic carbon fiber – epoxy resin, 10% Sic carbon fiber – epoxy resin, 5% graphite carbon fiber – epoxy resin, 10% graphite carbon fiber – epoxy resin, 5% Sic 5% graphite carbon fiber – epoxy resin. The materials were manufactured by hand layup method and then by compression moulded method.

B.Measurement of Water Absorption Test

The water absorption test denotes the amount of water that absorbed by the material when heated to certain temperatures. Specimens were made in a size of 20 mm x 20 mm x 3 mm and immersed into distilled water at a temperature of 95°C. Before soaking the materials into distilled water, the specimens were to be weighed on an balance. The accuracy of weigh balance is about ±0.001 g. the weight gain of material is by moisture absorption using the following formula,

$$\mathrm{Wt} = \frac{\mathrm{Wf} - \mathrm{Wi}}{\mathrm{Wf}} * 100$$

Where, W_i is the initial weight of specimen, W_f is the weight of the specimen after immersion and W_t is the percent moisture content of specimen.

C.Chemical Resistance Test

The specimen dimensions of 20 mm x 20 mm x 3 mm were immersed in 100 ml of 1N NaOH and 1N HCL for 48 hours. After this the samples were filtered out, dried

and weighed. The percent chemical resistance (P_{cr}) was calculated in terms of weight loss in following manner:

$$Pcr = \frac{Wi - Wa}{Wi} * 100$$

Where Wi is the initial weight of specimen and Wa is the final weight of specimen from acid and alkali solution and Pcr is the percent chemical resistance.

D.SwellingBehavior of Material

The behavior against weathering conditions was studied by swelling behavior. The swelling behavior of material is studied by soaking the material into a 100 ml of toluene solvent with 10% sodium chloride solution at room temperature for 7 days. The samples were filtered out and excess solvents were removed and weighed by using following equation,

$$\text{Percent swelling (Ps)} = \frac{Wf - Wi}{Wi} * 100$$

Where W_f is the final weight of specimen and Wi is the initial weight of specimen.

III. RESULT AND DISCUSSION

A.Water Absorption Test

The specimen is immersed in distilled water for 120 hours at temperature of 90^{o}C. The materials weight was differ from weigh before immersing and after immersing in distilled water. The water absorption test was carried out for following specimens are,

TABLE 1

Water absorption test

Material	Initial weight	Final weight	Percent moisture content (W_t)
Carbon fiber	2.338	2.339	0.0427
5% Sic, carbon fiber	1.752	1.755	0.1709
10% Sic, carbon fiber	2.130	2.134	0.1874
5% Graphite, carbon fiber	2.076	2.081	0.2402
10% Graphite, carbon fiber	1.866	1.886	1.0604
5% Sic, 5% graphite, carbon fiber	1.602	1.605	0.1869

B.Chemical Resistance Test

The materials were immersed in acid and alkali solution for several hours and weighed. The materials are immersed in 100 ml of 1N HCL and 1N NaOH solutions for 48 hours. The materials are weighing before and after immersing in solutions. The samples were filtered out, dried and weighed. The percent chemical resistance (Pcr) was calculated in terms of weight loss. The following table shows the chemical resistance of materials in acid solution.

TABLE 2

Chemical resistance test for 1N HCL

Material	Initial weight	Final weight	Percent chemical resistance
Carbon fiber	2.406	2.405	0.0415
5% Sic, carbon fiber	1.762	1.761	0.5675
10% Sic, carbon fiber	2.041	2.024	0.8329
5% Graphite, carbon fiber	1.912	1.911	0.5230
10% Graphite, carbon fiber	1.815	1.810	0.2754
5% Sic, 5% graphite, carbon fiber	1.656	1.655	0.0603

The following table shows the chemical resistance of materials in alkali solutions.

TABLE 3

Chemical resistance test for 1N NaOH

Material	Initial weight	Final weight	Percent chemical resistance
Carbon fiber	2.263	2.262	0.0441
5% Sic, carbon fiber	1.623	1.622	0.0616
10% Sic, carbon fiber	2.103	2.102	0.4755
5% Graphite, carbon fiber	1.964	1.957	0.3564
10% Graphite,	1.821	1.820	0.0549

carbon fiber			
5% Sic, 5% graphite, carbon fiber	1.760	1.754	0.3409

C.Swelling Behavior Test

To calculate the swelling behavior of materials, the material is soaked in toluene solvent with 10% sodium chloride. The material is allowed at room temperature for 7 days. The weight of material before and after soaking in solvent solution gives the material behavior against weathering conditions. The swelling behavior of materials is given in an following table,

TABLE 4

Swelling behavior of materials

Material	Initial weight	Final weight	Percent swelling
Carbon fiber	2.329	2.350	0.9016
5% Sic, carbon fiber	1.767	1.787	1.1318
10% Sic, carbon fiber	2.123	2.125	0.0942
5% Graphite, carbon fiber	2.390	2.394	0.1673
10% Graphite, carbon fiber	1.924	1.966	2.1829
5% Sic, 5% graphite, carbon fiber	1.850	1.852	0.1081

IV. CONCLUSION

The materials are tested in various conditions for different resistance test. In water absorption test the material absorbs distilled water at 95^{o}C most of materials absorbs below 1 percent whereas 10% graphite filled carbon fiber absorbs water more than 1 percent. In chemical resistance test when materials are immersed in HCL and NaOH solutions, the materials chemical resistance is found very high than the 10@ Sic filled material. Its chemical resistivity is nearly 0.8 percent than the other materials. The swelling behavior test shows the materials in weathering conditions. From swelling behavior test, the other materials resistivity against weathering conditions is excellent than the 10% graphite and 5% Sic filled carbon fiber material.

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