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Environment effect on impact strength of Pistachio shell filler based epoxy Composite

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Abstract

This paper studies the effect of pistachio shell micro fillers on the Impact strength of epoxy composites. Pistachios shell filler based composites were developed by varying the content of fillers (0, 5, 10, and 15 wt. %) Charpy impact test and moisture absorption test were carried out on composite specimen. An increase in moisture absorption was observed with the incorporation of filler. For impact strength effect of different environments i.e. water, petrol, kerosene on impact strength were also studied and test results of specimen were compared with the neat epoxy composite. An increase in impact strength is observed with filler incorporation of about 36.56 % and further decrease was observed for sample subjected to different environment condition in which water absorption shows the largest decrease in impact strength as compare to ambient condition. The study revealed that the pistachio shell filler has got potential to be a successful filler in developing epoxy composites.

***Keywords*:** Composite, Pistachio shell, Impact strength.

1. Introduction

Over the last two decades natural fibers/fillers are being extensively used in polymer based composites as a reinforcement. These post agricultural waste has various environmental and economic benefits [1]. In addition of this natural fibers/fillers as a reinforcement in composites are environment friendly, renewable, cost effective and abundant in nature. Due to these advantages natural fillers became a potential reinforcement in polymer matrix composite. Incorporation of these fillers results in lower the processing cost and increase the physical, mechanical properties of polymer matrix composite. Pistachio shell, ground nut shell, rice husk, peanut shell, cashew nut shell, and wall nut shell have been extensively used as a potential filler. It has been reported that incorporation of these natural filler in polymer matrix composite gives a remarkable change in the mechanical and physical properties of the composites [2-7]. In this study pistachio shell filler is used as reinforcement with the epoxy matrix and their impact behaviour and moisture absorption is studied. Chemical configuration of lignocellulose pistachio shell fillers is consist three main components: cellulose (42%) hemicellulose (3.11%), and lignin (13.5%), which are known to present very complex structure. The cellulose content of pistachio shell filler is much more than that of, coconut coir, and bamboo, hemp, kenaf and sisal fibers which is responsible for its greater hydrophilic nature [8]. The study of environment effect on properties of composite also play an important role in order to elaborate the complete behaviour of composite material under different circumstances. It has been reported that under different exposure of environment i.e. humid, aqueous solution, petrol, vegetable oil significantly affect the mechanical properties of natural reinforcement polymer composites [9-11].

2. Experimental details

2.1. Material & Methods

Epoxy LY 556 which is a bi-was used as resin along with hardener HY 951 in 10:1 ratio. Pistachio shell fillers were obtained by grinding the pistachio shells in a kitchen grinder (Make: Maharaja White line 500 watt). Before grinding the pistachio shell fillers were kept in a hot air oven (Make: Apollo Lab India) for 24 hours at 80 ^{0} C. After grinding the fillers in particle form was sieved through a 500 micron sieve in order to get uniform size filler material. Pistachio shell filler based epoxy composites were fabricated using casting method. Pistachio filler is mixed with the epoxy with 5, 10, and 15 wt %. The mixture is stirred for 20 minute in order to get a homogeneous mixture. This mixture was then poured into a glass mold of size 200×200×5 mm^3. The mixture was left to cure for 24 hours at room temp of about 23±2 °C.

Fig.1. Mixing and pouring of mixture

Table.1. Samples with different specification

Sample No.	Specification	Designation
1.	Neat Epoxy	S_1
2.	Epoxy + 5% filler	S_2
3.	Epoxy + 10% filler	S_3
4.	Epoxy + 15% filler	S_4

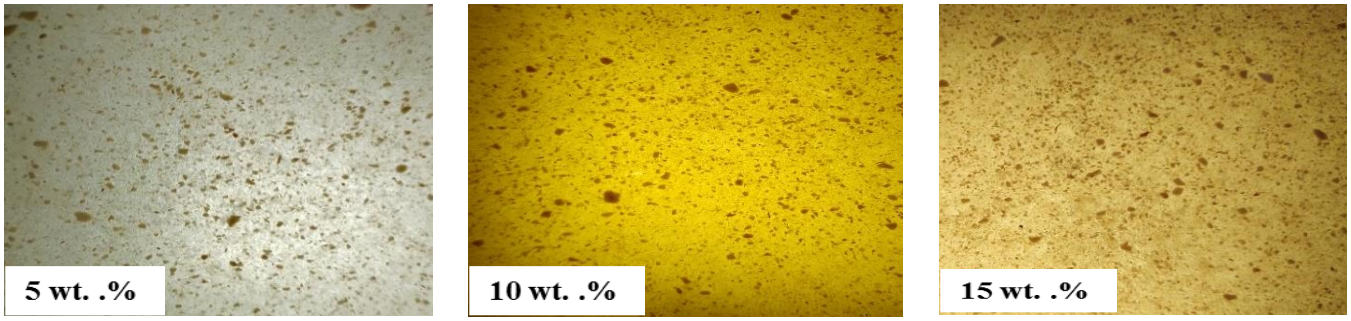

Fig. 2. Optical micrograph of samples

3. Testing and Analysis

3.1 Moisture Absorption test

Moisture absorption test were performed according to ASTM D 570-98 standard for moisture absorption of plastics. The samples were dipped into plain water .samples are taken out time to time and after wiping out the water from the surface of the sample Absorption is reported by weighing initial (W_i) and final weight (W_f) immediately, using a precise balance machine. The weight percentage change is measured by the given equation.

$$W\ \% = \frac{Wf - Wi}{Wi} \times 100$$

Table. 2. Moisture absorbed by the samples

Sample	Weight(gm)						
	0	**24 (hrs)**	**% change**	**48 (hrs)**	**% change**	**72 (hrs)**	**% change**
S_1	8.72	8.725	0.057	8.728	0.092	8.729	0.10
S_2	9.73	9.736	0.06	9.741	0.13	9.743	0.30
S_3	7.24	7.36	1.657	7.42	2.486	7.46	3.038
S_4	9.141	9.143	0.0218	9.146	0.0546	9.146	0.0546

3.2 Impact test

The Impact test is carried out according to ASTM-256D Impact testing machine. The samples are also subjected to different environmental condition (i.e. plain water, kerosene, petrol) for 10 days. For each sample 3 specimen are tested and there average values are tabulated in Table 3.

Table. 3. Impact strength of samples

Specimen	Average Impact Strength(kJ/m^2)			
	Ambient	**Water**	**Petrol**	**Kerosene**
S_1	16.60	16.62	16.61	16.60
S_2	19.21	20.28	16.70	18.84
S_3	22.67	16.62	22.72	22.64
S_4	20.17	19.90	17.77	22.98

4. Results and Discussion

From moisture absorption test as shown in Fig-3, it is revealed that rate of water absorption solely depends on the filler content. As the filler contain increase moisture absorption increase and further decrease after 10 % filler. The reason of this may be due to the fact that as content of natural filler increases, the number of free OH groups present in cellulose also increases in the composite. These free OH groups are results in weight gain in the composites due to come in contact with moisture and form hydrogen bond[13]. It is also observed that maximum moisture is absorbed by sample of 10 wt. % filler. This is caused due to presence of large amount of filler and void present in it which absorbed more water. The void get reduced in case of 15wt. % filler that's why showing reduction in moisture absorption inspite of high filler contain [11].

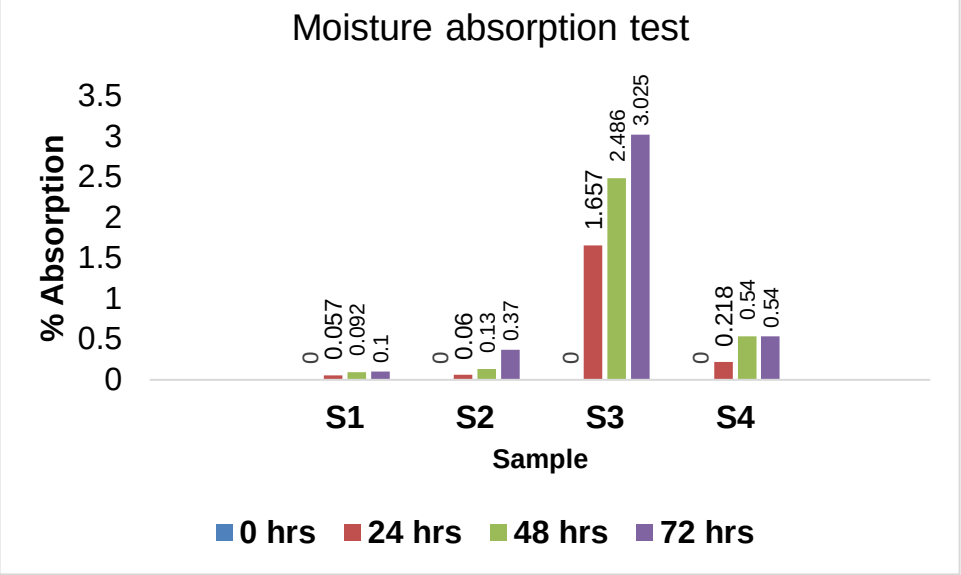

Fig. 3. Moisture absorption with varying filler content.

As shown in Fig.4, the Impact strength in ambient condition firstly increase about 15.72 % at 5% pistachio shell filler content, going maximum for optimum filler content of 10 wt. % and then started decreasing at higher content. The highest impact strength of 22.67 kJ/m2 observed for 10 % wt., while that of unfilled epoxy was 16.6 kJ/m2 corresponding to an increment of 36.56%. This indicates that pistachio shell filler potentially can improve the impact strength significantly. When samples are subjected to different environmental condition then decrease in Impact strength is observed for sample dipped in water but not much affected by other medium, the reason may be due to increase in hydroxyl group present in water and hydrophilic nature of filler, which is not present in other Liquid and therefore reduce the compatibility between filler and matrix [12-13].

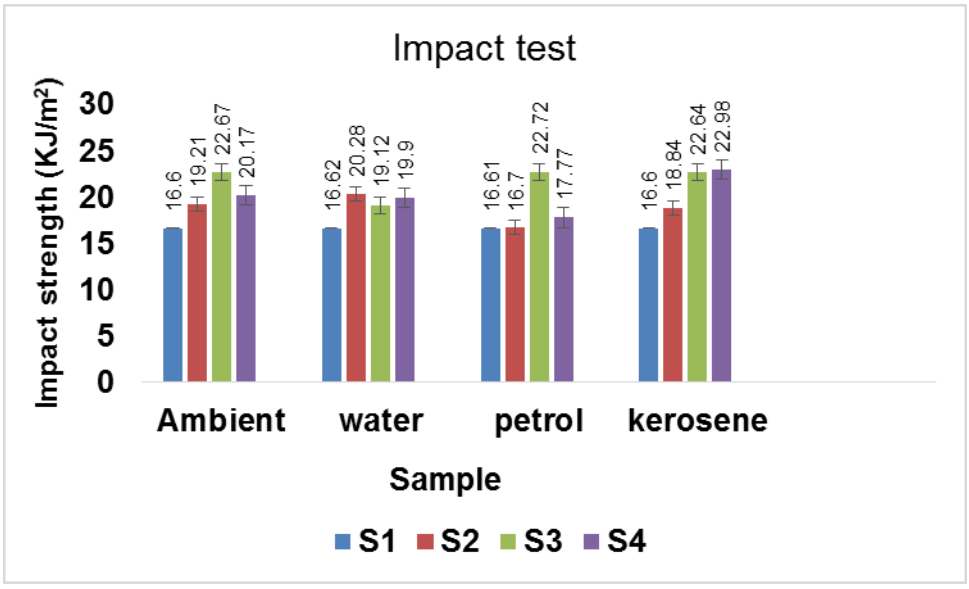

Fig. 4. Impact strength with varying filler content.

5. Conclusion

The addition of pistachio shell powder significantly affects the impact property of the developed epoxy composites. It is concluded that the energy reached a maximum value with 10 wt. % pistachio shell filler content and then decreased with increasing content. So the use of pistachio shell as a filler results in getting composites with improved impact properties also as a waste filler it can be utilized for developing bio-friendly composites, as reducing the percentage of epoxy will result in reducing plastic consumption which will lead towards green manufacturing.

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