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Chemical Analysis of Emu Feather Fiber Reinforced Epoxy Composites

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ABSTRACT
A composite is usually made up of at least two materials out of which one is binding material called as matrix and other is a reinforcement material known as fiber. For the past ten years research is going on to explore possible composites with natural fiber like plant fibers and animal fibers. The important characteristics of composites are their strength, hardness light in weight. It is also necessary to study about the resistance of the composites for deferent chemicals. In the present work, composites prepared with epoxy (Araldite LY-556) as resin and 'emu' bird feathers as fiber have been tested for chemical resistance. The composites were prepared by varying fiber loading (P) of 'emu' feathers ranging from 1 to 5 and length (L) of feather fibers from 1 to 5 cm. The composites thus prepared were subjected to various chemicals (Acids, Alkalis, solvents etc.). Observations were plotted and studied. The results reveal that there will be weight gain for the composite samples after three days, when treated with Hydrochloric acid, Sodium carbonate, Acetic acid, Sodium hydroxide, Nitric acid and Ammonium hydroxide. Weight loss was observed for all the samples including pure epoxy when treated with Benzene, Carbon tetra chloride and Toluene.
Key words: - Epoxy composites, Emu bird feather fibers, Chemical resistance.

I. INTRODUCTION

In the recent years, extensive studies are being carried out on Epoxy- natural fiber composites. Importance is being given by most of the researchers to the natural plant fibers like jute, bamboo, wood, sisal, coir, cotton and wheat straw etc. Studies are getting increased on usage of animal feathers as fibers in composites. The animal feathers are waste material and their disposal is also not an easy task without causing environmental pollution. Among the plant fibers bamboo fiber epoxy composites have better properties [1]. The chemical resistance of Geopolymer composites was studied by Xiem NGUYENTHANG et.al [2]. The advantages of natural fibers over traditional fibers are their strength, easy availability, light weight, high toughness low density etc., [3]. Jindal [4] produced the bamboo fiber reinforced plastic composites using araldite (CIBA CY 230) resin as matrix. Lot of work was done on the composites made with chicken feather, hemp, wool, fish shells. In the present paper, an attempt is made to use the emu feathers as fibers for producing composites and the effect of chemicals on the physical properties of composites are studied.

II. MATERIALS AND METHODS

1. Materials: For preparation of Composite, high performance epoxy resin LY556 and the curing agent HY951 is used as matrix. Waste emu bird feathers were collected from local farms to use them as fibers in the composites. Fibers of same diameter are segregated and fibers were soaked in 5% of sodium hydroxide (NaOH) solution for 30 minutes. Then, the feathers were washed with soap water and finally with distilled water to remove the impurities and finally dried under the sunrays. The cleaned fibers were cut in to small pieces of length varying from 1 cm to 5 cm to prepare the composites.

2. Preparation of Composite specimens. For making the composites, a mould of 150 mm x 150 mm x 5 mm was prepared with glass. The mould cavity was coated with a thin layer of aqueous solution of Poly Vinyl Alcohol (PVA) which acts as a good releasing agent [1]. Further, a thin coating of hard wax is laid over it. A 5 mm thick plate was made from the epoxy and hardener taken in the ratio of 100 and 10 parts by weight respectively. Then the molding box was loaded with the matrix mixture and emu feather fiber in random orientation (with varying percentage) and was placed in vacuum oven which was maintained at 70^0C for about 3 hours to complete the curing. After curing, the plate was removed from the molding box with simple tapering. It was cut into samples with dimensions of 10 mm × 5 mm × 5 mm for chemical tests.

III. CHEMICAL RESISTANCE TESTS FOR COMPOSITES

The chemical resistance of the composite was studied as per ASTM D 543-87 method. For chemical resistance test, the acids namely concentrated hydrochloric acid (10%), concentrated nitric acid (40%) and glacial Acetic acid (8%), the alkalis namely aqueous solutions of Sodium hydroxide (10%), Ammonium hydroxide (10%) and Sodium carbonate (20%) and the solvents –Benzene, Carbon tetra chloride and Toluene were selected. In each case, three pre weighed samples were dipped in the respective chemicals under study for 24 hours, removed and immediately washed thoroughly with distilled water and dried by pressing them on both sides by filter papers. Weight and thickness of the specimens were measured. The % weight loss or gain and % gain or loss in thickness was determined. The resistance test was repeated for 5 days continuously for three samples in each case and the average values were reported.

IV. RESULTS

The chemical resistance tests were conducted for various fiber loadings of epoxy- emu fiber composites with various chemicals. The effect of acids, alkalis, and solvents like acetic acid, nitric acid, hydrochloric acid, sodium hydroxide, sodium carbonate, ammonium hydroxide, benzene, toluene, and carbon tetra chloride on emu fiber epoxy composites was studied. The effect of each chemical on the composites has been observed. The observations were plotted and shown in the following graphs.

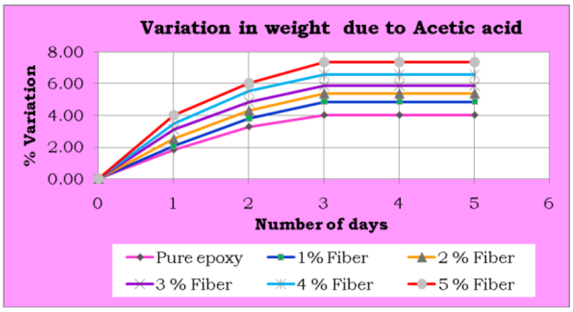

Fig 1. Variation in weight due to 8% Acetic acid

About 7% of weight gain was observed for the 5% fiber loading sample and about 4% weight gain was observed for pure epoxy when treated with 8% Acetic acid for five days.

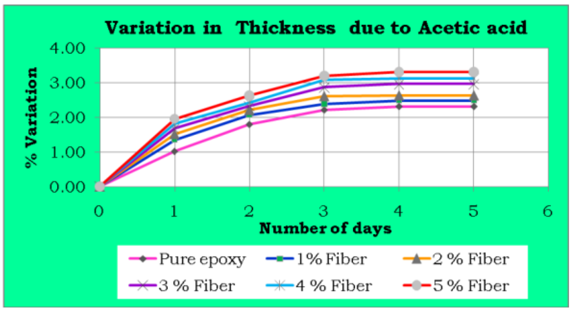

Fig 2. Variation in thickness due to 8% Acetic acid

Approximately 3.3% of increase in thickness was observed for the 5% fiber loading sample and approximately 2.3% of increase was observed for pure epoxy when treated with 8% Acetic acid five days.

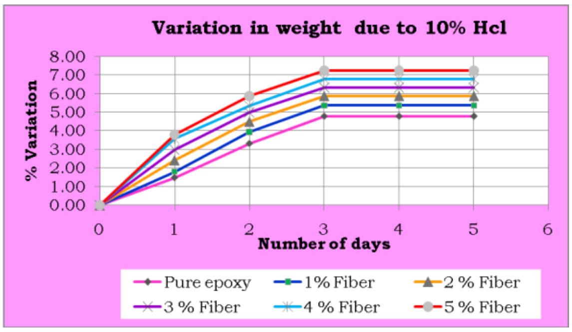

Fig 3. Variation in weight due to 10% HCl

About 7% of weight gain was observed for the 5% fiber loading sample and approximately 5% weight gain was observed for pure epoxy when treated with 10% HCl for five days.

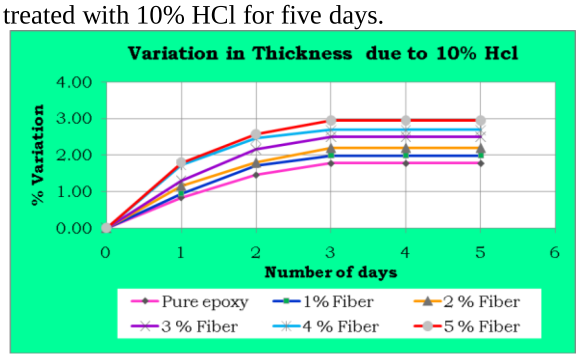

Fig 4. Variation in thickness due to 10% HCl

About 3% of increase in thickness was observed for the 5% fiber loading sample and approximately 1.8% of increase was observed for pure epoxy when treated with 10% HCl five days.

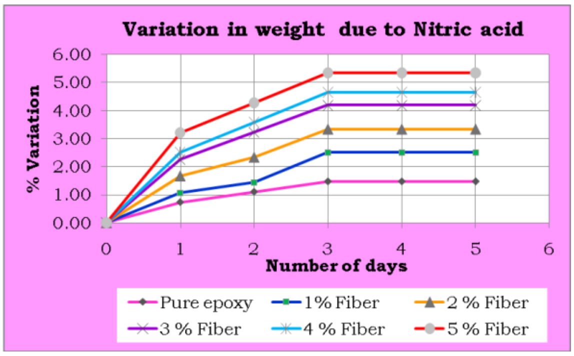

Fig 5. Variation in weight due to 40% Nitric Acid

Approximately 5.4% of weight gain was observed for the 5% fiber loading sample and approximately 1.5% weight gain was observed for pure epoxy when treated with 40% Nitric Acid for five days.

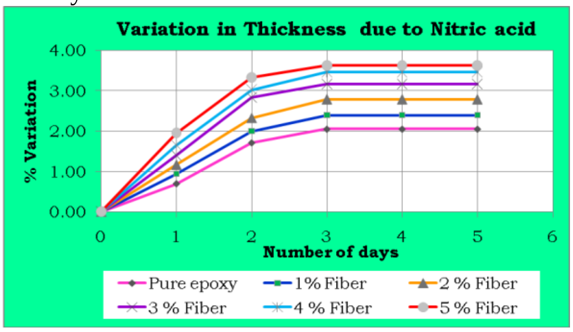

Fig 6. % Variation in thickness due to 40% Nitric acid

Approximately 3.5% of increase in thickness was observed for the 5% fiber loading sample and about 2% of increase was observed for pure epoxy when treated with Nitric Acid five days.

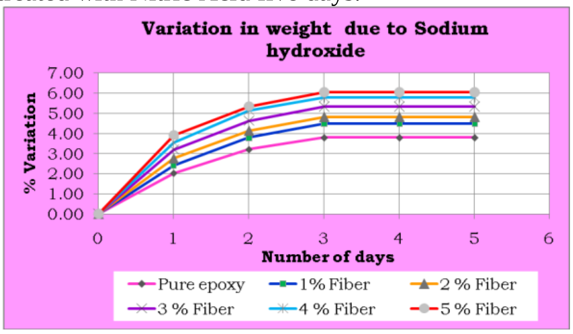

Fig 7. Variation in weight due to 10%Sodium hydroxide

About 6% of weight gain was observed for the 5% fiber loading sample and about 4% weight gain was observed for pure epoxy when treated with 10% Sodium hydroxide for five days.

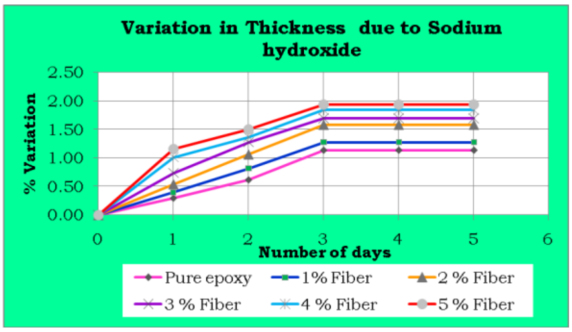

Fig 8. Variation in thickness due to 10% Sodium hydroxide

About 2% of increase in thickness was observed for the 5% fiber loading sample and approximately 1.1% of increase was observed for pure epoxy when treated with 10% Sodium hydroxide five days.

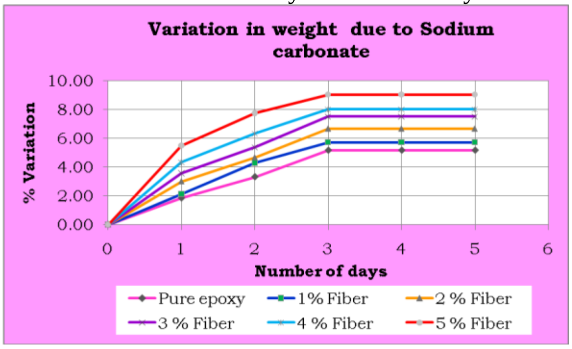

Fig 9. Variation in weight due to 20% Sodium carbonate

About 9% of weight gain was observed for the 5% fiber loading sample and about 5% weight gain was observed for pure epoxy when treated with Sodium carbonate for five days.

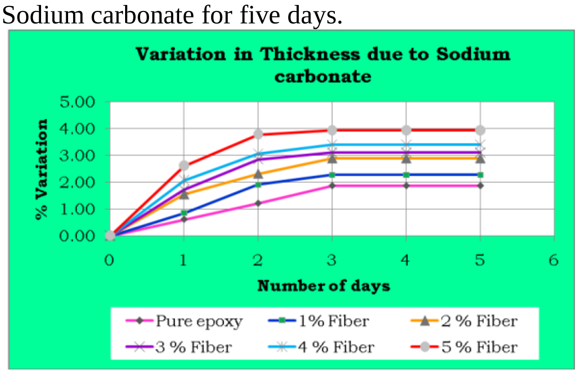

Fig 10. Variation in thickness due to 20% Sodium carbonate

About 4% of increase in thickness was observed for the 5% fiber loading sample and about 2% of increase was observed for pure epoxy when treated with Sodium carbonate five days.

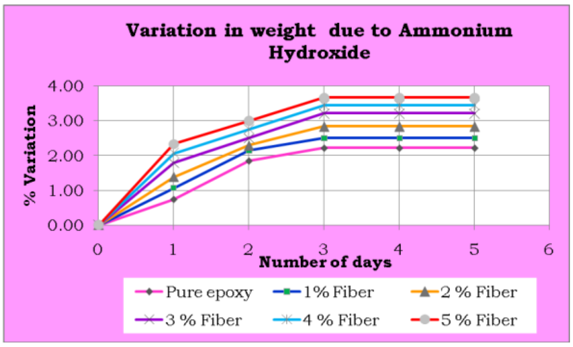

Fig 11. Variation in weight due to10% Ammonium Hydroxide

Approximately 3.5% of weight gain was observed for the 5% fiber loading sample and approximately 2.2% weight gain was observed for pure epoxy when treated with Ammonium Hydroxide for five days.

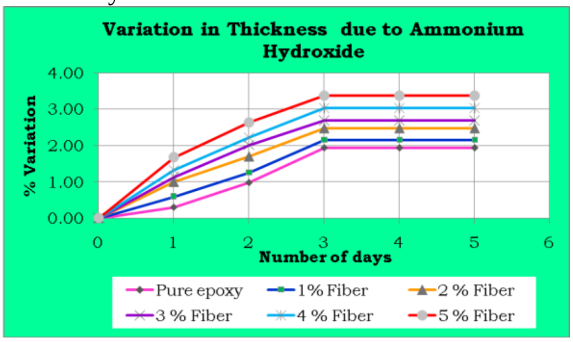

Fig 12. Variation in thickness due to Ammonium Hydroxide

Approximately 3.4% of increase in thickness was observed for the 5% fiber loading sample and about 2% of increase was observed for pure epoxy when treated with Ammonium Hydroxide five days.

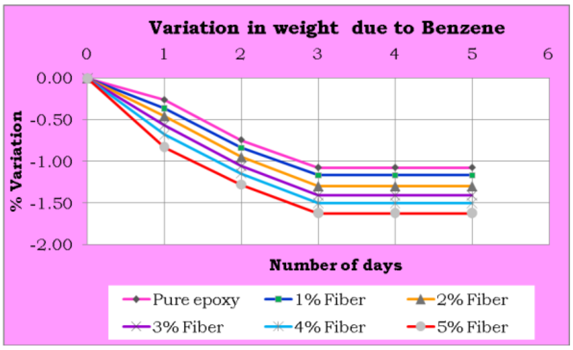

Fig 13. Variation in weight due to Benzene

About 5% of weight gain was observed for the 5% fiber loading sample and about 2% weight gain was observed for pure epoxy when treated with Benzene for five days.

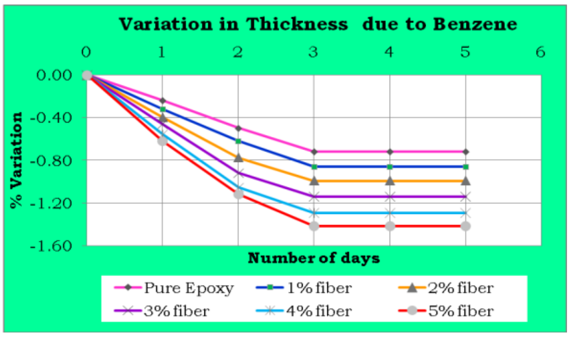

Fig 14. Variation in thickness due to Benzene

About 2% of increase in thickness was observed for the 5% fiber loading sample and approximately 0.8% of increase was observed for pure epoxy when treated with Benzene five days.

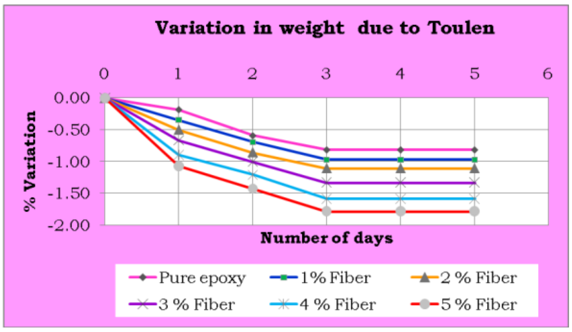

Fig 15. Variation in weight due to Toulen

Approximately 1.8% of weight loss was observed for the 5% fiber loading sample and approximately 0.8% weight loss was observed for pure epoxy when treated with Toulen for five days.

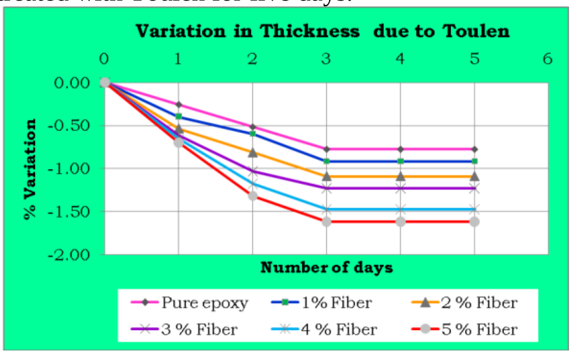

Fig 16. Variation in thickness due to Toulen

Approximately 1.7% of decrease in thickness was observed for the 5% fiber loading sample and approximately 0.8% of decrease was observed for pure epoxy when treated with Toulen five days.

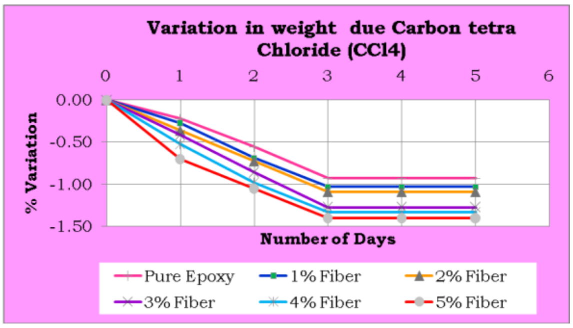

Fig 17. Variation in weight due to Carbon tetra Chloride (CCl_4)

Approximately 1.4% of weight loss was observed for the 5% fiber loading sample and approximately 0.9% weight loss was observed for pure epoxy when treated with Carbon tetra Chloride (CCl_4) for five days.

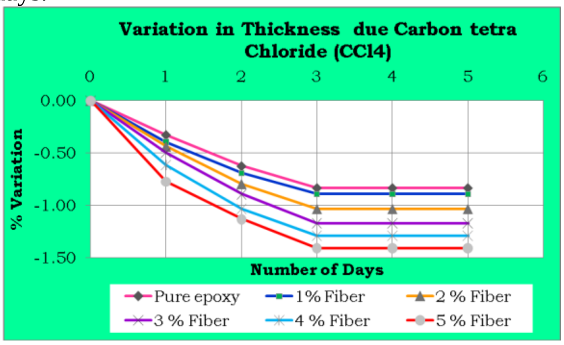

Fig 18. Variation in thickness due to Carbon tetra Chloride (CCl_4)

Approximately 1.4% of decrease in thickness of increase in thickness was observed for the 5% fiber loading sample and approximately 0.3% of decrease was observed for pure epoxy when treated with Carbon tetra Chloride (CCl_4) five days.

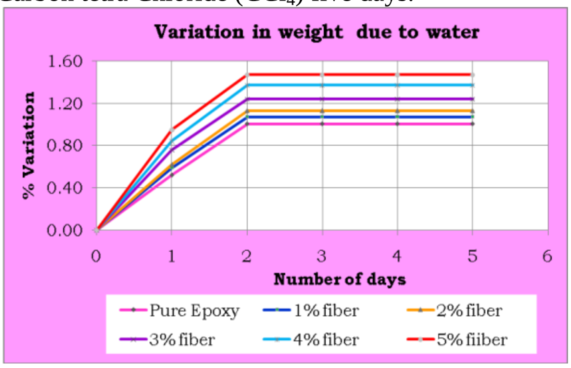

Fig 19. Variation in weight due to Water

Approximately 1.5% of weight gain was observed for the 5% fiber loading sample and about 1% weight gain was observed for pure epoxy when immersed in water for five days.

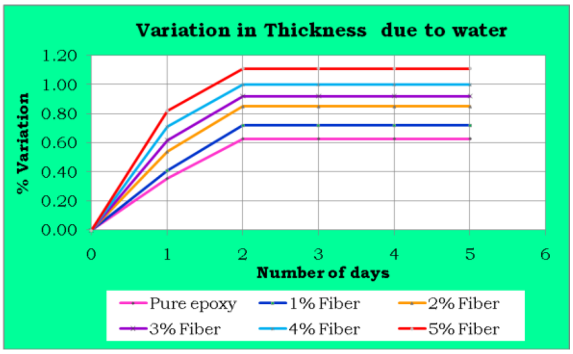

Fig 20. Variation in thickness due to Water

Approximately 1.1% of increase in thickness was observed for the 5% fiber loading sample and approximately 0.6% of increase was observed for pure epoxy when immersed in water five days.

When the samples were immersed in the acids and alkalis, they might have absorbed the moisture present in them and as a result, their weights might have been increased. It is observed that pure epoxy shows more resistance to all the chemicals.
The weight loss was observed for all the samples including epoxy, when treated with Toluene and Carbon tetra Chloride. The percentage of weight loss is less for pure epoxy and it increases as the percentage of fiber is increasing upto 3 days and after 3 days, the % weight loss is almost stable.

V. CONCLUSIONS

In general, all the samples including pure epoxy are getting reacted for all the chemicals. Pure epoxy shows more resistance to chemicals when compared to Emu feather fiber composites of varying fiber loading. It is clearly evident that the weight gain was observed when treated with acids and bases irrespective of their concentration. But weight loss was observed for all the composites when treated with solvents like Toulen, Benzene and Carbon tetra chloride. The percentage variation in weight is getting increased with increase in percentage fiber in the composites. But loss in weight of the emu feather fiber epoxy composites when treated with toluene, benzene and carbon tetra chloride is also increasing with increase in fiber loading and number of days. The details of % variation in weight and thickness of 5%fiber loading composites and epoxy samples when treated with chemicals are presented in table 1.

Table 1. % variation in weight and thickness of samples subjected to chemicals

Sl. No.	Name of the Chemical	% Variation in weight		% Variation in thickness	
		5% fiber loading	Pure epoxy	5% fiber loading	Pure epoxy
1	Acetic acid	7.0	4.0	3.3	2.3
2	Hydrochloric acid	7.0	5.0	3.0	1.8
3	Nitric acid	5.4	1.5	3.5	2.0
4	Sodium hydroxide	6.0	4.0	2.0	1.1
5	Sodium carbonate	9.0	5.0	4.0	2.0
6	Ammonium hydroxide	3.5	2.2	3.4	2.0
7	Benzene	5.0	2.0	2.0	0.8
8	Toulen	-1.8	-0.8	-1.7	-0.8
9	Carbon tetra chloride	-1.4	-0.9	-1.4	-0.3
10	Water	1.5	1.0	1.1	0.6

Note : "-ve" sign indicates Weight loss or decrease in thickness.

A graphical representation of the above results has been presented in fig.21.

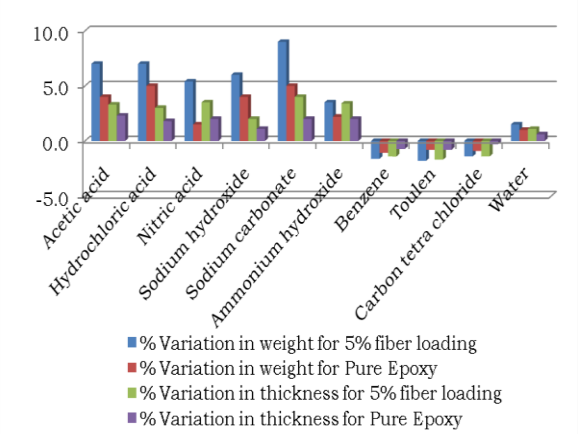

Fig 21. Graphical representation of the Chemical test results.

More or less the similar trend is observed for % variation in weight for the glass/bamboo hybrid composites [1]. The above results are similar to the observations made by Varada Rajulu et al. [5-8].

The % variation in weight and thickness for 1% to 4% fiber loading composites was observed to be between the % variation in weight and thickness of pure epoxy and 5% fiber loading composites.

ACKNOWLEDGMENTS

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