Effect Of Chemical Treatment On Tensile Properties Of Sansevieria Cylindrica Polyester Composites

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Abstract:

The sansevieria cylindrica polyester composite slabs are made by compression molding technique using fibres treated with sodium hydroxide (NaOH), silane, calcium hydroxide ($Ca(OH)_2$) and potassium permanganate ($KMnO_4$) for optimum fibre length, optimum weight percentage and optimum curing temperature(40 mm, 40% wt, 60^0C) and their tensile properties have been studied. The inclusion of sansevieriacylindricafibre as reinforcement into polyester matrix improves the flexural and tensile strength till a certain weight percentage, then it decreases drastically by further addition of fibre.The main problem in natural fibre is water uptake which damages the fibre and thereby the strength is reduced. To improve the performance, surface modification of fibres with various chemical treatments is performed and it enhanced the properties to a greater extent. $Ca(OH)_2$ treated composites showed higher tensilestrength whereas silane treated composites showed lowertensile strength.

Keywords: Sansevieria Cylindrica fibre, compression molding technique, Chemical treatment, Curing temperature

1. Introduction

Natural fibres have received much attention of the international research community over the past decade. Natural fibres are now considered as a serious alternative to glass fibres to be used in composite materials as reinforcing agents. The advantages of natural fibres over glass fibres are their low cost, low density, high strength-to-weight ratio, resistance to breakage during processing, low energy content and recyclability. Since they are considered as waste, the utilization of such natural fibres as reinforcement for polyester composite is a best eco re-using technique. In general, natural fibre reinforcement gives poor compatibility with polymer matrix because of the surface which is waxy in nature. Moreover, the chemical treatment on the natural fibres cleans and modifies the fibre surface, prevents the moisture absorption and increases the surface roughness. Hence, researchers have concentrated on surface modification and chemical treatment of natural fibres to improve the strength and compatibility. A better interlocking can be offered by the chemical treatments of the fibre materials and better interaction between the fibre and matrix. Accordingly, many researchers have studied the effect of chemical treatment on natural fibres to explore the performance of composites in various engineering applications.

Sisal fibre reinforced epoxy composite treated with NaOH and Silane enhances the adhesion between the fibre and the matrix. Silane treatment is the most effective in reducing moisture uptake of fibres in humid environments, as reported by Bisanda et al [1]. The development of bio composites reinforced with epoxy matrix was carried out by Girisha et al [2] where arecanut fruit husk fibres and tamarind fruit fibres were reinforced with epoxy matrix and its mechanical properties had been performed with varying fibre weight percentages from 10 to 50%. The studies also carried out for NaOH treated fibres where the results showed a significant change in the tensile and flexural strength, when compared with

untreated fibreThe investigation on mechanical properties of unidirectional Roystonea regia natural fibre rereinforced epoxy composites was carried out by Govardhan Goud et al [3]. Both untreated and alkali treated fibres were prepared with varying fibre content and it was observed that the fibre content of 20% wt showed better results. At the same time, when compared with untreated, alkali treated fibre showed enhanced tensile and flexural strength due to better fibre matrix interface.The use of silane or other coupling agents reduces this effect as proved by Hill et al [4].Alkali treatment and morphological characterization studies on banana fibre reported by Julio César Mejía Osorio et al [5] revealed that the surface of the treated fibres was rougher than that of untreated fibres.Kabir et al [6] provided a comprehensive overview on surface treatments applied to natural fibres to increase the strength of the composites. The fibres were modified chemically in order to have better compatibility with the matrix which was evaluated by Laly.A.Pothan et al [7]. Various silanes and alkali were used to modify the fibre surface and their effect was analyzed by Laly.A.Pothan et al [8].Leonard et al [9] studied the alkalization of hemp, sisal, jute, and kapok fibres by using sodium hydroxide and reported enhanced strength of the composites.An analysis on the effect of chemical modification on natural fibre reinforced composites was done by Rakesh Kumar et al [10] and reported that the adhesion between the hydrophilic fibre and hydrophobic matrix increased by the chemical modifications. Among the various treatments such as alkali treatment, silane treatment, peroxide treatment and acetylation, it was evident that alkali treatment proved to be the better one.Sreenivasan et al [11] studied the influence of chemical treatment of fibre on mechanical properties of short sansevieria cylindrica composites and found that potassium permanganate treatment gives better enhancement of mechanical properties of composites.A complete review study on pretreatments of the natural fibre has been done by Susheel Kalia et al [12] and reported that the pretreatments can clean the fibre surface, chemically modify the surface, stop the moisture absorption process, and increase the surface roughness.

Many researchers have studied the effect of chemical treatment on tensile properties of natural fibre composites fabricated under room curing temperature. But studies on the effect of chemical treatment on tensile properties of natural fibre composites fabricated under higher curing temperatureare very limited. Hence an attempt is made to study the same using sansevieria cylindrica fibre reinforced composites.

2. Experimental

2.1. Material used

Sansevieria Cylindrca fibres also known as marulkodi or uruvanthandu in local language in the southern part of Tamilnadu are collected from the farms near Cumbum valley and are used as reinforcement. Unsaturated isophthalic polyester (USP) resin supplied by Vasavibala resins, Chennai, India is used as the matrix material. Cobalt Naphthanate is used as an accelerator and Methyl Ethyl Ketone Peroxide (MEKP) is used as catalyst.

2.2. Fabrication of Composites

The sanseveiria cylindrica fibre is cut approximately into optimum fibre length of 40 mm. The unsaturated polyester resin grade VBR 4303 is used as a matrix. 2% cobalt naphthanate as an accelerator is mixed thoroughly in polyester resin and then 3% methyl- ethyl-ketone-peroxide (MEKP) as catalyst is mixed in the resin prior to the reinforcement (for100g resin - 1.5 ml of catalyst and accelerator is taken) to initiate the curing reaction. Fibres are arranged in random orientation. At first, polyester is mixed with catalyst and accelerator to the required proportion and poured in the mould made of EN90 steel with the dimensions of 180 x 160 x 3 mm. After placing the mould in the machine, it is compressed by applying curing pressure of 15 Mpa and optimum curing temperature (60^0C). After chemical treatment , the treated fibres are dried at room temperature for 24 hours.

3. Testing of composites

3.1. Tensile test

Tensile strength is a measure of a material's ability to resist being pulled apart. The tensile test is

generally performed by Universal Testing Machine (Instron series – 3382) with the capacity-3T. The tests are done as per ASTM D 3039. A thickness of 3 mm is maintained. A uni-axial load is applied through the ends. The tension test is performed on all the five samples and the average is taken.

3.2. Scanning Electron Microscope (SEM)

SEM studies are carried out to find the failure mechanism at the fractured surface of the composites. Prior to the analysis, the samples were coated with platinum (layer thickness ~ 30 nm) to avoid sample charging under the electron beam. The fibre surface is examined using the instrument Carl zeiss Pvt.Ltd, EVO MA15 model, UK.

4. Results and Discussion

4.1. Tensile strength

The effect of chemical treatment on tensile strength and modulus of treated sansevieria cylindrica fibre reinforced polyester composites fabricated with higher curing temperature is shown in figure 1.Sansevieria cylindrica fibre is subjected to different chemical treatments like alkalization, permanganate treatment, and silane to modify the surface and to remove the wax, hemicelluloses etc to make it a rough topography. Among the chemically treated fibre composites fabricated with optimum conditions, $Ca(OH)_2$ treated composites show higher tensile strength of 55 MPa compared to all other treatments followed by $KMnO_4$ treated composites with a tensile strength of 50 MPa. This may be due to improved polymerized network between the fibre and matrix holding them together compared with other treatments. During $KMnO_4$ treatment, an increase in porous nature of sansevieria cylindrica fibre is compared with other treatments. Hence, the matrix tends to penetrate inside the porous of the fibre resulting in less fibre pull out. Manganese is highly reactive with polyester resin and makes good bonding strength between fibre and matrix. Normally, fibre pull out is minimum for all treated composites, as there is an increase in porous size of the fibres. When the composite is subjected to tensile load, cracks are initiated and propagate along the matrix and interphase. It leads to lowering the tensile strength of the matrix. The maximum load is carried by $Ca(OH)_2$ treated fibre composites compared with all treatments.Generally, the use of $Ca(OH)_2$ promotes the removal of acetyl group from hemicelluloses and contributes to enhance the cellulose digestibility with lower cost and less safety requirements compared to sodium and potassium hydroxides despite the slow action on lignin. However, the tensile strength of all the treated composites cured at 60^0C is found to decrease compared to untreated one. This may be attributed to the removal of hemicelluloses and other cementing material. The amorphous cellulose content of the fibre is directly exposed to higher curing temperature which could have caused damage to the fibre core leading to its breakage and hence, affects its load carrying capacity.As a result, better bonding between the fibre surface and matrix may not be effected and moreover high resin flow may occur which could have affected the bonding phenomena. Hence, the tensile strength could have shown a decline value compared with untreated one.It may be concluded that the effect of chemical treatment on composites fabricated with higher curing temperature fails to enhance the tensile strength of the composites compared with untreated one.

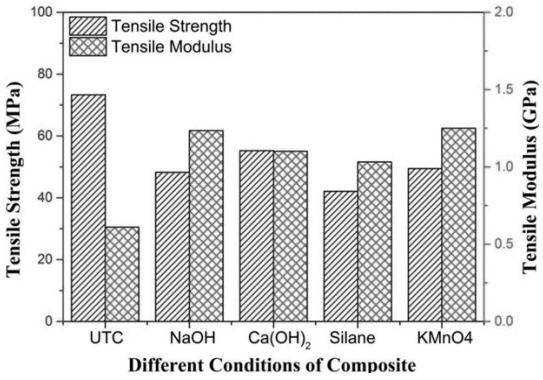


Figure 1 Effect of chemical treatment on tensile strength and modulus of treated sansevieria cylindrica fibre (40 mm, 40% wt, 60^0C) reinforced polyester composites

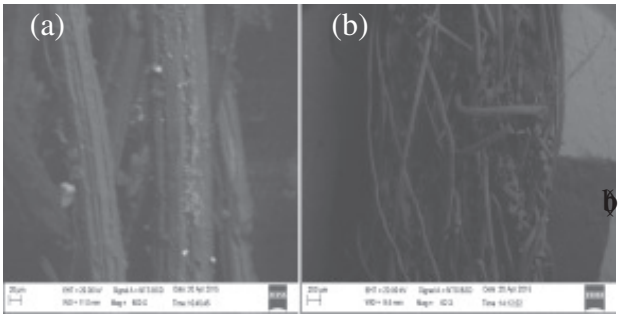


Figure 2 (a),(b) SEM studies of $Ca(OH)_2$ treated specimen on tensile strength of treated sansevieria cylindrica fibre (40 mm, 40% wt, 60^{0}C) reinforced polyester composites

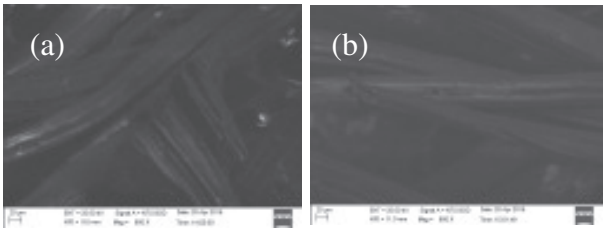


Figure 3 (a),(b) SEM studies of silane treated specimen on tensile strength of treated sansevieria cylindrica fibre (40 mm, 40% wt, 60^{0}C) reinforced polyester composites

4. Conclusions

The untreated sansevieria cylindrica fibre reinforced composites fabricated with optimum conditions exhibit higher tensile strength of 73 MPa.Among the treated composites,$Ca(OH)_2$ treated shows higher tensile strength of 55 MPa.Higher tensile modulus is exhibited by $KMnO_4$ treated composites.

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6. References

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