ABSTRACT

The research work aimed at improving the mechanical properties of vinyl ester polymer by the addition of natural fibers. The mechanical properties of vinyl ester resin lies between polyester and epoxy. The natural fibers such as sisal and coir were used in this study. Physico-mechanical properties of raw fibers were analyzed.

An enhancement in the mechanical properties of natural fiber reinforced vinyl ester composites strongly depended on interfacial adhesion between the matrix and fiber. Surface treatment of the fibers had been carried out to enhance its interfacial adhesion with the matrix. Alkali (NaOH) treatment was carried out for sisal and coir fibers with varying concentrations (2, 4, 6 and 8 wt.% ) and soaking time (24, 48, 72, 96 and 120 h). The morphology of the fiber surface before and after alkali treatments was examined through scanning electron microscopy (SEM). Alkali treated sisal and coir fiber with concentration of 6 wt.% and soaking time of 72 h depicted highly rough surface morphology.

Initially, vinyl ester composites had been prepared using raw sisal fiber, coir fiber and with the combination of sisal and coir fibers by hand-layup method. The weight percentage of fibers in the resin was 15, 22.5 and 30. Three different fiber lengths of 10, 30 and 50 mm were used. The tensile, flexural and impact strength of the developed raw sisal, coir and sisal-coir fiber reinforced vinyl ester composites had been analyzed. Fibers containing the length of 30 mm and weight percentage of 22.5 in the vinyl ester matrix showed an increase in tensile, flexural and impact strength when compared to other compositions and pure resin. The fiber when added upto 30 wt.%, it led to poor wetting and non-homogeneous distribution of fibers with vinyl ester matrix. Moreover, increasing the fiber length to 50 mm led to curling of fibers in the base matrix. Hence the properties of the
vinyl ester composites with the fiber length of 50 mm length and 30 wt.% loading showed a drop in mechanical properties.

Alkali treated sisal, coir and sisal-coir fiber reinforced vinyl ester composites were prepared using an optimum fiber length of 30 mm and 22.5 wt.%. The mechanical properties of the treated fiber reinforced vinyl ester composites had been analyzed. Vinyl ester composites containing treated fiber showed a significant increase in the mechanical properties when compared to untreated fiber reinforced vinyl ester composites. Alkali treatment on fibers led to rough fiber surface, which indeed formed a strong interfacial bonding with the vinyl ester matrix.

In comparison with the various fibers used for the preparation of vinyl ester composites, treated sisal fiber reinforced polymer composites showed a remarkable increase in tensile, flexural and impact strength followed by sisal-coir fiber system when compared to coir fiber-vinyl ester composites and pure polymer. Among the fibers used, sisal possessed high mechanical properties, which upon alkali treatment formed better physical interaction with the matrix. This had improved the mechanical properties of the vinyl ester composites.

Dynamic mechanical thermal analysis of coir, sisal and coir-sisal hybrid polymer composites had been analyzed. The maximum enhancement in storage modulus and reduction in tan δ peak were obtained for sisal fiber reinforced composites followed by coir-sisal hybrid when compared to coir fiber composites and neat vinyl ester resin. The reduction in tan δ peak proved maximum heat build up which resulted in better damping characteristics of fiber reinforced polymers.

Vinyl ester composites containing fiber length of 30 mm and 22.5 wt.% showed a maximum storage modulus value. Further increase in fiber length to 50 mm showed a drop in storage modulus when compared with 30 mm fiber length.
The increase in fiber length led to curling which reduced the effective length of fiber and lessened the bonding between fiber and matrix. This might be a reason for the decrease in storage modulus of composite containing 50 mm fiber length.

Varying the diameter of drill, spindle speed and feed rate, the thrust force, torque and delamination were studied for the treated and untreated coir-sisal hybrid fiber reinforced composites during drilling operations. The thrust force and torque showed an increase with increasing feed. The fact might be the increase of the cross sectional area of the un-deformed chip. The effect of cutting speed on delamination showed a decreasing trend with increasing cutting speed. The optimum machining parameters for the minimum drilling induced damages were determined.