ABSTRACT

Global energy crisis and environmental pollution have compelled the scientists and engineers to develop alternative materials. Natural fibers reinforced polymer composites have attracted the attention of many researchers worldwide, owing to their potential as substitutes for artificial fiber composites. The present work aims at studying the mechanical properties and machinability of chopped and randomly oriented roselle fiber and roselle/sisal fiber polyester hybrid composites. Composites were prepared for different weight percentage of fiber and matrix and for different fiber length and tested. The mechanical properties (Tensile, flexural and impact strength) of roselle and roselle/sisal fiber polyester hybrid composite were determined under three conditions; Dry composite specimen, Wet composite specimen and Composites reinforced with fibers treated with NaOH solution. As a novel attempt, the machinability of roselle and roselle/sisal fiber polyester hybrid composites has been examined.

Initially, the fiber separation process and its physical and mechanical properties were studied. From the test it was observed that the fiber size and the strength were not uniform. The moisture absorption characteristics of the fiber were also studied. The mechanical properties of the matrix material were studied. For alkali treatment of fibers, the roselle and sisal fibers were immersed in 10% NaOH solution for 2 h at 30°C. To study the influence of alkali-treated fibers on the mechanical properties and
machinability, the roselle and sisal fibers of length of 100 mm were soaked in a 10% NaOH solution at 30°C. The fibers were kept immersed in the alkali solution at different duration of 2, 4, 6 and 8 h. For moisture absorption study, the composite specimens were immersed in distilled water at 30°C for about 5 days.

Chopped roselle fiber and roselle/sisal fiber hybrid composites were prepared with the fiber contents ranging from 10wt% to 55wt%. The effects of fiber contents on the mechanical properties of the composites were determined. The fiber content required to get the best combination of strength properties was identified. The effects of hybridization of sisal fibers with roselle fibers in the composites were observed. The properties of the dry composites specimens were compared with other two conditioned composites. The strength values of roselle/sisal fiber hybrid composites are higher when compared with roselle fiber composites at three conditions. The fractured surfaces of the composite specimens were studied in detail using scanning electron microscope (SEM). The experimental results were compared with theoretical and empirical or statistical results and found to be in good agreement.

Randomly oriented long roselle fiber and roselle/sisal fiber hybrid composites were prepared with the fiber contents of 10wt% to 30wt% and the fiber lengths of 50mm to 150mm. To understand the effects of fiber length and content on the mechanical properties of the composites, this range of fiber contents and lengths were selected. Fiber content and length required to get the optimum strength properties were identified. The strength values of
Roselle fiber composites were compared with roselle/sisal fiber hybrid composites at three conditions. The strength values of randomly oriented long roselle/sisal fiber hybrid composites are higher when compared with randomly oriented long roselle fiber composites at three conditions. Surface Morphology of water immersed composite specimens, alkali treated fibers and fractured surface of the composites specimens during mechanical tests is studied using scanning electron microscope. The percentage of moisture absorption is determined during the test time period. The experimental results were compared with theoretical results and found to be in good agreement.

For the machinability study, the roselle fiber and roselle/sisal fiber hybrid composites are fabricated in the form of cylindrical rod. The machinability of the composites was studied based on the delamination, thrust force and torque. The optimum and most contributive machining parameter for delamination factor, thrust force and torque are identified using Taguchi, analysis of variance (ANOVA) method. A correlation between the feed rate, spindle speed and drill diameter with the induced thrust force, torque and delamination factor in drilling composite were established by multi-variable regression analysis and are compared with the experimental results. Confirmation tests are also carried out. A comparative study for thrust force and torque was carried out for the case of drilling of roselle/sisal fiber hybrid composites using artificial neural network (ANN) and non-linear regression (RM) models.