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EFFECT OF SURFACE MODIFICATION ON THE MECHANICAL AND INTERFACIAL PROPERTIES OF CATTAIL FIBER REINFORCED COMPOSITES

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ABSTRACT

Cattail (Typha latifolia), a lignocellulosic biopolymer, recently investigated as a potential reinforcement for polymer matrix composites. However, chemical treatment is required to enhance mechanical properties as well as to decrease hydrophilicity of cattail fiber, which influences its compatibility with a polymer matrix. Cattail fiber was extracted from cattail leaves using 5% KOH. Surface modification of cattail fiber was carried out using 1,6-diisocyanatohexane (DIH) and 2-hydroxyethyl acrylate (HEA) dissolved in anhydrous ethyl acetate solution. Cattail fibers were treated by immersing them in DIH and HEA solutions at three different concentrations % (2.5, 5, and 10%) for three different immersion times (10, 20, and 30 min). Treated fibers were evaluated for change in moisture regain, mechanical properties, and chemical groups. The tensile testing data were analyzed via Weibull distribution model using estimator 1 to predict the optimum treatment conditions. Cattail fibers obtained after extraction were individualized with a carding machine and preformed into a mat using hand-layup technique. DIH-HEA solution was evenly sprayed on the mat surface and left for curing in an oven at 50^0C for 5h. Both treated and untreated nonwoven mat composites were manufactured using vacuum assisted resin transfer molding (VARTM) and were tested for density, V_f, water uptake %, and mechanical properties. FTIR results indicated the existence of carbonyl peak and isocyanate group in the cattail fiber treated with DIH-HEA. Moisture regain of cattail fiber decreased from 2.54 % (virgin fiber) to 0.93 % when treated with 10% DIH-HEA. The failure and reliability analysis revealed that 10% DIH-HEA and 30 min immersion time to be the optimum treatment conditions that resulted in the best mechanical properties. DIH-HEA treated cattail composite exhibited lower water uptake % (6.3 %) than that of untreated composite (7.9 %). The composite with DIH-HEA treated fibers, despite having lower V_f (26.1 %), exhibited a marginal increase in tensile modulus (7.2 GPa) and tensile strength (35.6 MPa) when compared to the untreated composite (modulus: 7 GPa, strength: 34 MPa) with a higher V_f (30.4 %). SEM images of the fractured surface of the composite confirmed the enhancement in fiber-matrix bonding due to DIH-HEA treatment.