HYBRID, MULTI-SCALE REINFORCED COTTON-GIN WASTE BASED COMPOSITES

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Abstract

Plant based composites, bio-composites, consisting of natural fibers in synthetic or natural polymer matrices have gained attention due to their low cost, eco-friendliness, and their potential to compete with synthetic composites in terms of cost and properties. Cotton-gin waste (seed fiber) is a by-product of cotton industry and is a renewable resource that is available in plenty in US. Cotton-gin waste biocomposites are relatively not fully exploited due to the limitations in fiber morphology, fiber-clumping and inferior properties. In this work, improved surface preparation using AFEX (ammonia fiber expansion) and reinforcement of resin (unsaturated polyester, UPE) with nanoclay (2.5 wt.% and 5.0 wt.%) was performed to overcome some of these limitations. Additionally, hemp-fiber based composites were also studied for relative comparison. Both cotton-gin and hemp fiber biocomposites were manufactured using compression molding with the final fiber volume content of ~30%. Tensile properties of the resulting biocomposites were studied and compared with baseline UPE/hemp plates. Preliminary results show that biocomposites prepared using cotton-gin waste had comparable/better tensile strength when compared to hemp fiber composites. Also, numerical models (finite element) that realistically model and predict the thermo-mechanical properties of such hybrid composites were developed. These models, once experimentally validated can be used as design tools to predict and explore material properties beyond the experimental matrix studied, and can eliminate the costly trial-and-error approach. Overall, the use of multi-scale (nanoclay + natural fiber) reinforcements with improved fiber-surface preparation show promise for use of such composites in a wide range of structural applications in automotive and structural applications.