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RESEARCH ARTICLE

Mechanical, free vibration, electrical, and water absorption properties of vinyl ester composites reinforced with *Phoenix* sp. fibers: Influence of eco-friendly sodium bicarbonate treatment

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Abstract

Environmentally sustainable and eco-friendly natural fiber-reinforced polymer composites have become the materials of interest in replacing synthetic fibers. However, weak interfacial interaction between hydrophilic natural fibers and hydrophobic polymer matrix limits their commercial applicability. Improving the interfacial interaction using environmentally friendly chemical treatments would be beneficial for both industries and the environment. In this study, vinyl ester-based composites were made by incorporating *Phoenix* sp. fibers in different content (5, 10, 15, 20, and 25 wt%) and lengths (5, 10, 15, and 20 mm). To improve the interfacial interactions, the fibers were treated with eco-friendly sodium bicarbonate solution at different durations (24, 120, and 240 h) prior to reinforcing. The fabricated composites were characterized by mechanical, free vibration, electrical resistance, and water uptake properties. The results reveal that both fiber content and fiber length have a significant effect on the above properties. Specifically, the composites incorporated with 20 wt% of 15 mm length fibers offered better properties. Further, the composites added with 120 h treated fibers have the maximum tensile strength (61.35 MPa) and modulus (4.13 GPa), flexural strength (152.63 MPa) and modulus (10.24 GPa), impact strength (24.67 kJ/m^2), and natural frequency (56.72 Hz). This improvement is mainly due to the improved interfacial bonding, which was evidenced in morphological analysis. Based on the findings, the eco-friendly treated sustainable *Phoenix* sp. fibers could be used as a promising reinforcement material for fabricating light weight polymer composites for various industrial applications.

Highlights

- Various properties of *Phoenix* sp. fiber/epoxy composites were investigated.
- Interfacial bonding is enhanced through eco-friendly chemical treatments.
- Vibration behavior of composites improved due to high stiffness of treated fibers.