SUSTAINABLE COMPOSITE MATERIALS FOR MARINE APPLICATIONS

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Abstract

The use of fiber reinforced plastic (FRP) composites for marine applications has been ongoing for several decades and is steadily increasing[1,2], where the main advantages are low weight which enables emission reductions during operation and corrosion resistance[3].
The increase in production and sales volume of FRP materials is accompanied by an increase of production waste and a looming explosive increase in FRP products reaching their end-of-life. The total combined volume of end-of-life and production waste generated by the glass thermoset composites market in Europe was 304,000 tons in 2015 where the major source of FRP end-of-life waste is the marine industry. Common leisure boats structures are made of sandwich panels with glass or carbon fiber and a Polyvinyl chloride PVC foam core. The purpose of the core is to add stiffness, absorb energy and provide impact resistance, which in boating can be global due to slamming waves, or local with for example the hull hitting stones, rocks, or debris. Although balsa and cork materials are sometimes used in marine applications, PVC offers low density and for that reason it is the most used core. However, PVC is not recyclable.

One of marine industries goals is to make the boat more sustainable. In this paper we focused on the following challenges:

- Change the non-recyclable PVC core to a more sustainable core.
- Replace glass fiber (GF) by Natural Fiber (Flax fibers) in some parts of the boat.
- Increase the performance of natural fibers and protect them from the environment by coating them with graphene.
- Investigate the applicability of instant forming methods to impact manufacturing efficiency andimprove work environment.

Several samples (sandwich panels which consist of two skins (fibers), adhesive and a core) were manufactured with PVC and PET cores. The same prepreg, glass fiber woven was used, and all samples were manufactured using the same process. More samples were also manufactured where one of the GF layers was substituted by Flax fibers. All samples were tested. The results were compared to determine how similar the properties of the PET were compared to PVC as well as if natural fibers could be used.

Composite laminates were also manufactured using graphene coated natural fibers to study the performance of natural fiber composites as well as investigate their sensitivity to external factors.
The manufacturing system was mapped and areas that are labor intensive with potential issues for scaling up production volumes was identified. Such an area was the manual layup, which with increasing volumes would demand a lot more operators. As this operation is both skill-based and potentially a work environment issue, it is especially important for future automation efforts. Instant forming with diaphragm forming was suggested, and a future state mapped. After this, a representative geometry was identified and forming tests conducted. The results from the test are promising, but more development and research is needed to investigate the best route forward to achieve stable production and understand the impact on the design of the product.

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