2020-07-07

Recyclable structural composites for marine renewable energy

Summerscales, John

http://hdl.handle.net/10026.1/15831

Most renewable energy devices must be constructed with strong stiff materials for optimum performance. In the marine environment, metals corrode, wood rots and polymers do not have the required mechanical properties. The plastics can be reinforced by continuous fibres to achieve stiffness and strength comparable with metals on a weight for weight basis. Fibre-reinforced plastic composites have a long history of successful use in the marine environment, notably as yacht hulls and naval vessels up to 75 m long. The latest generation of wind turbine blades, at over 100 m length, are only commercially possible when manufactured in carbon fibre composites.

The matrix which transfers load into and between the fibres may be either thermoset or thermoplastic. The current default for large composite structures are the thermosetting resins, e.g. unsaturated polyester, vinyl ester or epoxy. The manufacture of large structures often uses expensive preimpregnated (abbreviated to prepreg) reinforcements which require elevated temperatures to cure /crosslink. A popular alternative is resin infusion under flexible tooling (abbreviated to RIFT) where dry fabrics are loaded into the mould before liquid resin flows to fill the porespace between the reinforcement fibres. The thermosets can be produced at relatively low temperatures when they will be used at or close to ambient temperature, However, thermosets can become a problem at end-of-life as the materials cannot easily be recycled.

The thermoplastics normally require melt processing at temperatures ~200°C above the intended use temperature, with consequent high energy input at the production stage. A number of monomers do exist which can be polymerised in situ during the infusion process.

The University of Plymouth composites engineering research team, funded by Interreg 2 Seas, is a partner in the SeaBioComp project. This project seeks to develop "sustainable" natural fibre-reinforced bio-based thermoplastic matrix composites. Other partners will make composites using compression moulding or additive manufacture. Plymouth is studying monomer infustion under flexible tooling. The initial selection of infusible monomers suggests methyl methacrylate or lactic-acid are the only systems suitable for the manufacture of natural fibre reinforcements to be used in the marine environment.

Current research is seeking the optimal process parameters for composite production. The latter stages of the project will produce demonstrator components. Suggestions for such parts would be most welcome. The project will conclude with Life Cycle Assessment (LCA) using SimaPro and can offer University of Plymouth personnel access to the software.