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Preliminary Composite Overwrapped Pressure Vessel Design for Hydrogen Storage Using Netting Analysis and American Society of Mechanical Engineers Section X

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Abstract : With the move to cleaner energy applications the transport industry is working towards on-board hydrogen, or compressed natural gas-fuelled vehicles. A popular method for storage is to use composite overwrapped pressure vessels (COPV) because of their high strength to weight ratios. The proper design of these COPVs are according to international standards; this study aims to provide a preliminary design for a 350 Bar Type IV COPV (i.e. a polymer liner with a composite overwrap). Netting analysis, a popular analytical approach, is used as a first step to generate an initial design concept for the composite winding. This design is further improved upon by following the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel standards, Section X: Fibre-reinforced composite pressure vessels. A design program based on these two approaches is developed using Python. A numerical model of a burst test simulation is developed based on the two approaches and compared. The results indicate that the netting analysis provides a good preliminary design, while the ASME-based design is more robust and accurate as it includes a better approximation of the material behaviour. Netting analysis is an easy method to follow when considering an initial concept design for the composite winding when not all the material characteristics are known. Once these characteristics have been fully defined with experimental testing, an ASME-based design should always be followed to ensure that all designs conform to international standards and practices. Future work entails more detailed numerical testing of the design for improvement, this will include the boss design. Once finalised prototype manufacturing and experimental testing will be conducted, and the results used to improve on the COPV design.

Keywords : composite overwrapped pressure vessel, netting analysis, design, American Society of Mechanical Engineers section x, fiber-reinforced, hydrogen storage
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