

Type IV Hydrogen Storage Vessels: Liner-Boss processing challenges by rotational moulding

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Abstract:

Type IV hydrogen storage vessel is a compact and light weight structure used to store hydrogen gas under very high pressure, commonly at 700 bar, making it suitable for transport applications like fuel cell electric vehicles. It is typically constituted of a polymeric liner, which acts as a gas barrier, surrounded by a carbon fibre-reinforced polymer composite overwrap that provides mechanical strength, and a metal component, the boss, which connects the interior of the tank to the supply system. The interface between the polymeric liner and the metal boss is one of the critical points in tank design as it must ensure a complete seal to prevent hydrogen leaks. However, factors such as high fuelling pressures, liner permeability to hydrogen, and differences in the mechanical and thermal properties of polymers and metals can induce internal stresses, leading to cracks and adhesion failure. The liner's manufacturing process also plays a significant role. Rotational moulding, widely used for producing hollow structures, allows direct integration of metal inserts into the mould, enabling a direct bond with the molten polymer. The aim of the study is to analyse the liner-boss interface achieved by rotational moulding. The focus regards the geometry of the boss, its position towards the mould and also the influence of polymeric material. Liners were produced with varying boss geometries and varying positioning (gap) between the boss and the mould. Results indicated that a larger opening angle of the boss surface and a lower metal mass facilitates polymer melt to flow in those regions, helping on the fulfilment of the metal insert part and reducing defects such as voids and local depressions. To better understand the polymer-metal adhesion, it was developed a hybrid specimens test, where polymer was deposited onto metal plates with different textures. Polymer-metal adhesion was assessed through single lap-shear testing. The results indicate a better performance in adhesion strength of the PA11 (Rilsan Roto 11 Natural, gently provided by Arkema), compared to HDPE (TP-Seal M4743 UV black, gently provided by Total Energies).

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