High pressure gas storage vessel based on carbon fiber braided architectures for hydrogen fuel cell vehicle application.

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Objectives and Challenges

- First demonstrator : 1L – 100 bars
- Final demonstrator : 100L – 700 bars

700km autonomy

Carbon Vessel Demonstrator Manufacturing

Braid lay up

PA liner and aluminum connectors

Carbon braid

Carbon braid lamination over the PA liner

Resin Transfer Molding : Fabric impregnation with epoxy resin

RTM process

The impregnation of the fabric by the resin is driven by DARCY’S LAW.

\[
\nu = - \frac{K \cdot \rho \cdot \Delta P}{\eta}
\]

The Permeability is linked to the fabric type and architecture. As well as to the Volume fraction. Pressure in the mold can be adjusted.

The Viscosity is a resin property driven by temperature. Curing time of the resin is also shortened as the mold is heated.

- RTM rate of production is higher than concurrent method.
- Composite material of high quality is achieved :
  - Low porosity content
  - High Fibre Volume fraction (55%)

Material properties

Mechanical analysis

Elastic and breaking behavior were determined both by testing and calculation for several braid configurations. These results are then injected in the numerical model.

Braid angle

The braid angle is strongly dependent of the geometry. Abacus were obtained from angle measurement along the vessel and the data injected in the numerical model.

Conclusions & Future work

- Manufacturing process with braid architecture was demonstrated.
- A method was implemented to simulate the braid including variable VI and orientation
- An optimal braid will be designed and produced by a braider.
- Cost modelling will be performed for evaluation with existing solutions.
- Self sensing liner will be integrated.

Numerical simulation

Mechanical properties, fibers angles and volume fractions are injected in a numerical model. ACP, the composite module for ANSYS was used.

Demonstrator simulation

Result comparison between the model and the demonstrator

Belenos full size demonstrator

Research of an optimal shape for the final demonstrator with an axisymmetric model.

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