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COMPUTED TOMOGRAPHY OF IMPACT DAMAGE IN HIGH-PRESSURE VESSELS: HYPACTOR PROJECT

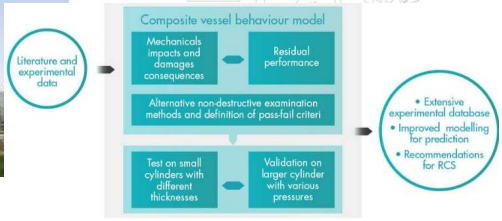
INTRODUCTION

Hydrogen is expected to play pivotal role as an energy carrier for 21st century, especially for mobile applications (vehicles).

Pre-normative research on resistance to mechanical impact of composite overwrapped pressure vessels (HyPactor) supported by FCH JTI, aims at strengthening the knowledge on influence of mechanical impact with respect to full composite (type-IV) high pressure cylinders integrity.

The most promising method of hydrogen storage seems to be in compressed form (CGH2).

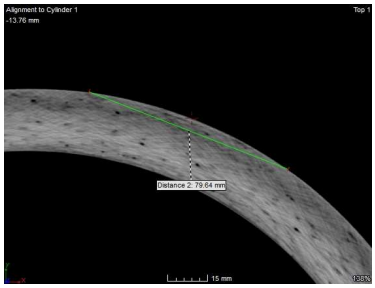
It is therefore vital to ensure the safety of composite-overwrapped pressure vessels (COPV) for hydrogen storage to promote social acceptance of hydrogen and thus its extensive use as an energy vector.



EXPERIMENTALS

36-litre commercial COPV produced by Hexagon-Lincoln company were subjected to 9 perpendicular, non-penetrating impacts of varying energy (in 1-kilojoule steps) in different spots on the cylindrical part of the vessels. The impacts were realised using a gas gun. Following impacts, vessels were sectioned and subjected to CT analysis.

Figure 1 : left: Ring-shaped specimen with damaged area. Impact energy - 1kJ, 2kJ, 3kJ; right: Sectional view image. Centre of 5kJ impact is highlighted



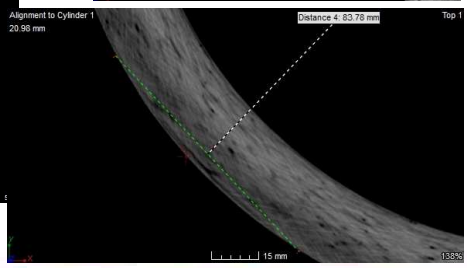
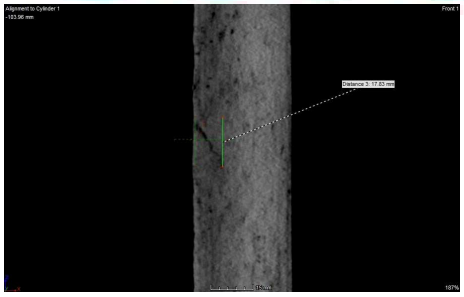
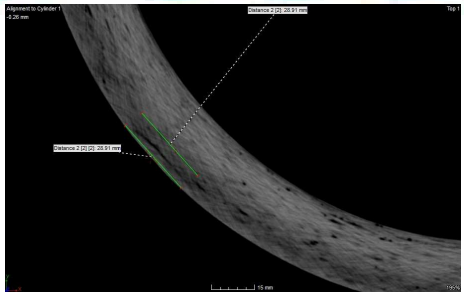


Figure 2 : above: 1kJ impact. Sectional view image X-Y, Hoop layer delamination probably due to the local fibre bundle failure. Delamination dimension is highlighted. below: 3 kJ impact. Sectional view image X-Y. Local fibre failure and macro scale oblique crack. Measurements of macro scale oblique crack are highlighted.





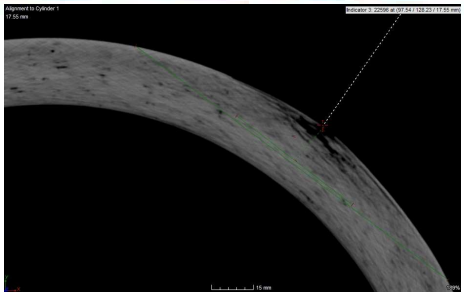


Figure 5 : left: 3 kJ impact. Sectional view image X-Z. Local fibre failure, crack goes deep into the structure of the composite. Measurements of the crack are highlighted. right: Centre of 5kJ impact sectional view images X-Y, fibre failures and delaminations are highlighted.

CONCLUSION

Computed tomography investigation of three vessels after impact allows impact identification, damage characterization and proposition of the geometry of failure mechanisms which originate from impacts.

The higher the impact energy, the more severe damage may be seen. 1 kJ impact on COPV constitutes barely-visible damage on the surface and equally unobtrusive damage in CT section, though resulting delaminations are quite extensive.

At higher impact energies, macro-scale cracks and fibre failure start to occur, and delaminations get more visible. The effect of the induced damage on residual performance of COPV will be investigated in following studies in the HyPactor project.

ACKNOWLEDGEMENTS

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