Application of hydrogen storage alloy at high pressure over 30MPa

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Recently Al-CFRP (Aluminum-liner and Carbon Fiber Reinforced Plastics) high pressure vessels have been incorporated in most of FCVs demonstrated in the world. This vessel consists of the Al-liner to hold hydrogen inside it and the CFRP layer wound around the Al-liner to balance tension of carbon fiber and pressure of hydrogen (Figure 1). The total weight of the Al-CFRP vessel, for example, about 115kg at 35MPa and 298K for 5kg of hydrogen, is much lighter than that of a metal hydride vessel, over 200kg, using a hydrogen storage alloy with 3wt%. However, the total volume of the Al-CFRP vessel for 5kg of hydrogen, about 270L at the same condition, is too large for passenger cars.

We will report an estimation of hydrogen storage potential for a novel hydrogen storage vessel, "hybrid hydrogen storage vessel". The vessel consists of an Al-CFRP vessel and relatively small amount of a hydrogen storage material in the vessel (Figure 2). Smaller total volume than that of the Al-CFRP vessel is expected because of higher volumetric hydrogen density of hydrogen storage material over 100kg-H_2/m^3 than that of high pressure hydrogen, 39kg-H_2/m^3 even at 70MPa and 298K. When we assume a combination of an 34L-size Al-CFRP vessel with 4.2wt% and an hydrogen storage alloy with 2.7wt% and 5g/cm^3 which occupies 15% of the internal volume of the vessel, we expect the total weight and volume of 168kg and 162L for 5kg of hydrogen at 298K (Figure 3)[1]. Roughly speaking, appreciable advantage in system weight at relatively lower volume ratio of hydrogen storage material (<20%) than typical volume ration in a metal hydride vessel (40%) is expected for the hydrogen pressure over 30MPa. The hybrid hydrogen storage vessel is expected to be better volumetric hydrogen density than a Al-CFRP high pressure vessel and better gravimetric hydrogen density than a metal hydride vessel (Figure 4).

REFERENCES

1. N. Takeichi et al, Int. J. Hydrogen Energy, 28, 1121-1129 (2003).

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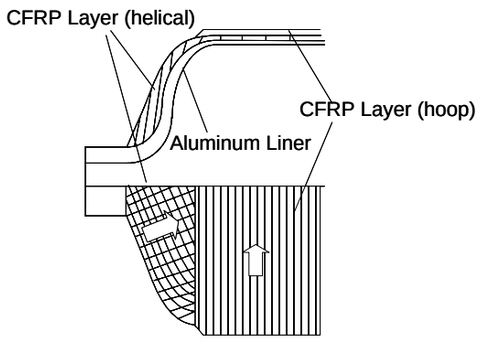

Figure 1. A partial cross-sectional figure of an Al-CFRP (Aluminum-liner and Carbon Fiber Reinforced Plastics) high pressure vessel.

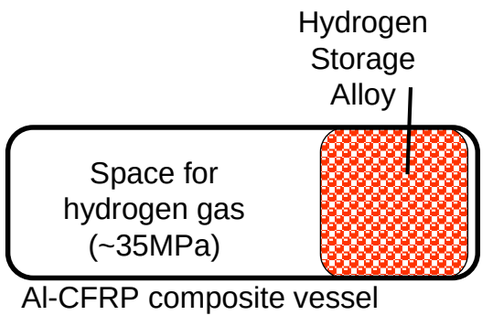

Figure 2. A schematic figure of "Hybrid Hydrogen Storage Vessel" which consists of an Al-CFRP light weight high pressure vessel and hydrogen storage material in the vessel.

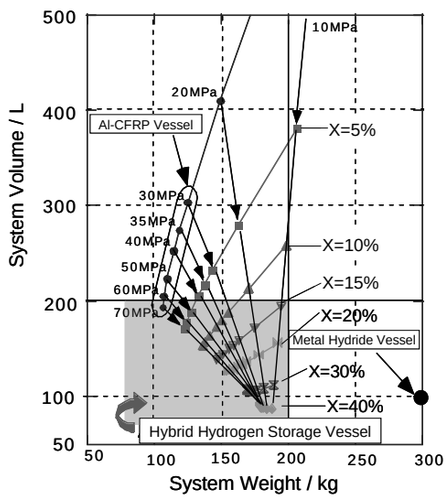

Figure 3. Estimation of the volume and weight of the hybrid hydrogen storage vessel for various hydrogen pressure and volumetric ratio of hydrogen storage material.

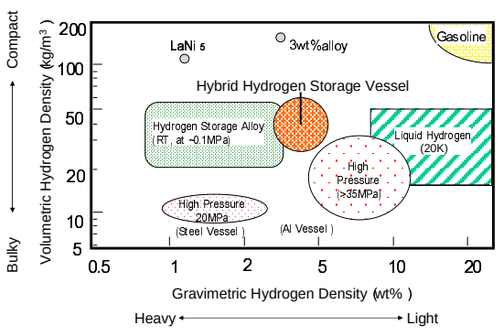

Figure 4. Comparison of hydrogen storage methods in gravimetric hydrogen density and volumetric.