



GTR DISCUSSION: HD FCV CONSIDERATION UPPER VOLUME BOUNDARY/ GARAGE



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HD FCV STORAGE SYSTEM

- HEAVY DUTY (HD) FUEL CELL VEHICLES, SUCH AS A SEMI TRUCK, TOW PAYLOADS OF UP TO 40 METRIC TONS (GVW) OVER LONG DISTANCES
- IN ORDER TO ACHIEVE 1000+ KM WITH SUCH A HEAVY LOAD, LARGER AMOUNTS OF SYSTEM STORAGE ARE NEEDED
- HD MAINTENANCE GARAGES/STORAGE FACILITIES ARE LARGER THAN LIGHT DUTY (50M³)



HD FCV STORAGE SYSTEM

- NIKOLA MOTOR WOULD SUGGEST UP TO 80KG FOR THIS VEHICLE CLASS FOR THE GTR 13 TO ACCOUNT FOR FUTURE DEVELOPMENTS FOR HD FCVS
 - AT 70MPA, DENSITY IS 40G/L
 - THEREFORE, THE HYDROGEN STORAGE VOLUME FOR THE HD VEHICLE CLASS WOULD BE UP TO 2,000 LITERS



ISSUE WITH GTR #13 PERMEATION RATE & HD FCV

- NIKOLA MOTOR AGREES WITH THE LD UPPER LIMIT OF PERMEATION AT AN UPPER LIMIT PER STORAGE SYSTEM OF 46 ML/H/L DEVELOPED FROM EU NOE HYSAFE
- BUT THIS PERMEATION RATE ASSUMES A SYSTEM VOLUME CAPACITY OF 330L IN A 50M³ GARAGE
- THE PERMEATION RATE IS BASED ON CALCULATIONS WHERE IN A HOT GARAGE (55°C) AND AT 0.03 AIR EXCHANGES PER HOUR, 150ML/MIN YIELDS A 1% HYDROGEN CONCENTRATION IN A 30.4M³ GARAGE



SUGGESTION FOR HD DRAFT RELATED TO PERMEATION

- SEMI TRUCKS ARE MUCH LARGER AND REQUIRE GARAGES LARGER THAN $50M^3$
- SEE EXAMPLE OF SMALL TRUCK SEMI GARAGE WHICH HAS A VOLUME OF $228M^3$



SUGGESTION FOR HD DRAFT RELATED TO PERMEATION

- EXTRAPOLATING TO AN EXPECTED HD GARAGE OF 228M^3 WOULD YIELD THE FOLLOWING CALCULATION:
 - ALLOWABLE LEAKAGE RATE IN A 228M^3 GARAGE WILL BE $150 * 228 / 30.4 = 1,125 \text{ ML/MIN}$
 - ASSUME 80 KG (2,000L), AND CALCULATE THE PERMEATION RATE, PR ASSUMING A MAXIMUM ALLOWABLE LEAKAGE RATE OF 1,125 ML/MIN ($\text{PR} * 2,000 / 60 = 1,125$) WHICH IS $\text{PR} = 33.75 \text{ ML/H/L}$
- SAME LOGIC AS LD, THE HD FUEL SYSTEM PERMEATION RATE IS 33.75 ML/H/L .
- REQUEST GTR#13, TF-1 TO DO A RE-EVALUATION OF ASSUMPTIONS AND CALCULATIONS (LD 46 ML/H/L VS. HD 33.75 ML/H/L)





QUESTIONS/COMMENTS?

BACKUP: GTR #13 BACKGROUND TEXT

Page 26 (iv.) For ease of compliance testing, however, the discharge requirement has been specified in terms of storage system permeation instead of vehicle-level (iii) permeation as a means of compliance is consistent with the proposals developed by the EU NoE HySafe. In this case, the permeation limit measured at 55 °C and 115 per cent NWP is 46 mL/h/L-water-capacity of the storage system. **If the total water capacity of the vehicle storage system is less greater than 330 L and the garage size is no smaller than 50 m³**, then the 46 mL/h/L-water-capacity requirement results in a steady-state hydrogen concentration of no more than 1 per cent. (An upper limit per storage system of 46 mL/h/L (per container volume capacity) \times 330L (system volume capacity) / 60min/hr = 253 mL/min per storage system, which comparable to that derived from the alternative approach 150 mL/min \times 50/30.4 = 247 mL/min (scaling factor R=1.645), which results in a 1 per cent concentration). This permeation specification has been adopted under the assumption that storage capacity ~330L is not expected for the vehicles within the scope of this gtr, so garages less than 50m³ can be accommodated;

Page 61 5.1.3.3. Extreme temperature static pressure leak/permeation test.

- (a) The test is performed after each group of 250 pneumatic pressure cycles in paragraph 5.1.3.2.;
- (b) The maximum allowable hydrogen discharge from the compressed hydrogen storage system is 46 mL/h/L water capacity of the storage system. (para. 6.2.4.2. test procedure) ;
- (c) If the measured permeation rate is greater than 0.005 mg/sec (3.6 Nml/min), a localized leak test is performed to ensure no point of localized external leakage is greater than 0.005 mg/sec (3.6 Nml/min) (para. 6.2.4.3. test procedure).

