Effect of state of charge on Type IV hydrogen storage tank rupture in a fire

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ABSTRACT

The use of hydrogen storage tanks at 100% of nominal working pressure NWP is expected only after refuelling. Driving between refuellings is characterised by the state of charge SoC<100%. There is experimental evidence that Type IV tanks tested in a fire at initial pressures below one-third of its NWP, depending on a fire source, were leaking without rupture. This paper aims at understanding this phenomenon and the development of a predictive model. The numerical research has demonstrated that the heat transfer from fire through the composite overwrap is sufficient to melt the polymer liner. This initiates hydrogen microleaks through the composite wall before it loses the load-bearing ability when the resin degrades deep enough to cause the tank to rupture. The dependence of tank fire-resistance rating (FRR) on the SoC is presented for tanks of volume in the range 36-244 L. The tank wall thickness non-uniformity, i.e. thinner composite at the dome area, is identified as a serious issue for tank's fire resistance that must be addressed by tank manufacturers and OEMs. The effect of the burst pressure ratio on FRR is investigated. It is concluded that thermal parameters of the composite wall, i.e. decomposition heat and temperatures, play a vital role in simulations of tank failure and thus FRR.

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