

Secondary Identification of H2 Vehicle at Dispenser

Introduction

Hydrogen vehicles are a growing alternative for mobility in various regions in the world and namely Europe. Refuelling infrastructure has been deployed in some countries and the EU Directive on Alternative Fuels is paving the way to establishing a network of refuelling stations to allow its citizens to own and use Fuel Cell Vehicles or FCVs throughout the entire European community. While those vehicles are scarcely deployed to date, interoperability standards govern already their design to ensure that connection to dispensers, quality of fuel and protocol for fuelling are common and suitable for all EC-79 approved vehicles. However, as various compressed gases (compressed natural gas or CNG, hydrogen or H₂) and nominal pressures are established for fuelling, the consequences of misuse are to be assessed across the whole alternative fuels market. In particular, it is identified that fuelling of a vehicle with lower service pressure than the selected dispenser poses safety concerns that are to be carefully addressed. It has also been observed recently that Hydrogen Refuelling Stations or HRS may be used to fill unknown vessels equipped with receptacles allowing them to connect to the dispenser's nozzle. This document discusses the degree of risk and mitigation that have been identified.

Rise of Hydrogen vehicles

In the 20+ years development of the hydrogen Fuel Cell vehicle technology, the storage tank pressure has increased from initial 25MPa to up to 70MPa with the aim to improve driving range. Those vehicles now provide satisfactory range for the targeted markets, and fuelling time is in line with equivalent gasoline based vehicles.

In the specific case of passenger cars, the range requirement has directed design towards storage pressure of 35 and 70MPa to be compared with 25 to 35MPa for natural gas. This has been standardised through the industry by joint industry effort and in particular by the Society of Automotive Engineers (SAE) with the development of refuelling protocol SAE J2601 and associated standards for vehicle design and interfaces.

Risk analysis of existing systems

1. Vehicle pressure system design

In order to accommodate varying ambient temperatures as well as the heating effect that occurs during gas compression in tank vessels, hydrogen tanks are allowed to be filled to 125% of service pressure with a target settled pressure at 15°C. Thus, a 35 MPa hydrogen tank can be filled to about 44 MPa at 85°C.

The vehicles storage systems for compressed gas are designed in accordance with SAE J2579 for hydrogen and those define a minimum burst ratio of 2,25 times the service pressure.

The following table describes the maximum filling pressure and minimum associated burst pressure for the various fuelling pressures identified.

	H25	H35	H70
Nominal fuelling pressure at 15°C (MPa)	25	35	70
Maximum allowed fuelling pressure (MPa)	31	44	88
Minimum burst pressure (MPa)	56	79	158

Typically, the only pressure protection for the vehicle storage system is provided by the fuel dispenser. According to standards, protection such as relief devices should be set at the Maximum Working Pressure of the lowest rated device in the system and in any case shall be set no higher than 140% of the tank service pressure, or about 48 MPa for a 35 MPa dispenser in order to meet the fuelling protocols requirements. The vehicle storage tank is not equipped with any pressure relief devices that would activate to protect it from overpressure.

2. Potential consequences of misuse

Fuelling a vehicle with the incorrect gas would create potential mechanical damage to the vehicle or propulsion system. This should be prevented but may not create a direct catastrophic event.

However, overpressure scenarios are more critical. The consequence of using a 70 MPa hydrogen dispenser to fill a 25 or 35 MPa hydrogen vehicle, any CNG vehicle, and virtually any industrial gas cylinder is likely to create an immediate safety hazard through leakage and/or the potential for catastrophic rupture.

Failure of a storage vessel has severe consequences. Modelling of the effects of a tank burst indicates a risk for multiple fatalities in the immediate vicinity of the vehicle. The identified zone for potential injury in case of burst at approximately 70 MPa would be as large as 50m radius.

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