TECHNICAL BULLETIN

Prepared by WG-2

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Safety Considerations in Case of Fire of Composite Cylinders or Tubes Used in Trailers

Introduction

Composite cylinders/tubes represent a step forward in the transport of bulk compressed gases, especially for compressed gaseous hydrogen, as their weight permits loading more gas than comparable conventional seamless cylinders/tubes (Type 1). This should proportionally reduce the number of trailers on the road. Composite cylinders /tubes are more sensitive to fire than steel cylinders. This technical bulletin highlights the main aspects that have to be considered prior to deciding whether or not to use pressure relief devices.

Definitions

Type 1 cylinder

Full metal cylinder with no overwrap.

Type 2 cylinder

Hoop wrapped cylinder with a load-sharing metal liner and composite reinforcement on the cylindrical portion only.

Type 3 cylinder

Fully wrapped cylinder with a load-sharing metal liner and composite reinforcement on both cylindrical and dome ends.

Type 4 cylinder

Fully wrapped cylinder with a non-load sharing liner and composite reinforcement on both the cylindrical portion and the dome ends.

Pressure relief device (PRD)

Collective term which includes bursting disk, fusible plug and pressure relief valve for protecting the pressure receptacle against vessel failure in case of fire or over pressurization.

Thermally activated relief device (TRD)

Type of pressure relief device that activates (vents the product) in response to excess temperature.

Present situation

- Composite cylinders/tubes mounted on vehicles such as compressed natural gas (CNG) buses are required to have TRDs, due to the automotive regulation ECE R110 *Uniform provisions concerning the approval of I. specific components of motor vehicles using compressed natural gas (CNG) in their propulsion system; II. vehicles with regard to the installation of specific components of an approved type for the use of compressed natural gas (CNG) in their propulsion system,* www.unece.org.

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- PRDs are not required by European regulations dealing with transport of dangerous goods in battery vehicles or multi element gas containers, (MEGC).
- Firefighting organizations consulted have no uniform position on the use of PRDs including TRDs.

Challenges

Due to these cylinders/tubes being used for transportation, a road accident followed by a fire cannot be excluded. In the event of fire, there are concerns that the burst pressure x volume (P(burst) x V) of product release, could have a direct impact on the affected blast zone. These effects would include both the pressure wave, possible fragments and the fire hazard.

Emergency response strategy in the event of fire includes consideration of:

- Time to organize the evacuation of the public to a safe distance from the incident scene;
- Safety distances required for emergency responders; and
- Failure mode of the cylinders/tubes.

To help avoid catastrophic failure of composite cylinders/tubes the use of PRDs are an option. However, some PRDs are not effective, for example, a bursting disk as there is only a marginal increase in internal pressure before a composite cylinder/tube exposed to fire fails due to loss of integrity. Consequently, if a PRD is chosen, it is recommended to use a TRD. [1)] If TRDs are considered their positioning is critical as depending upon the fire event or incident they may not be in the correct position to provide the required protection especially in the event of a roll overs, and do not offer protection from impingement flames which heat/damage the cylinder/tube locally. In addition, TRDs can have a premature/spurious failure rate that can present operational hazards. This is because hydrogen flames are not always visible.

As a result, there is no clear evidence whether or not TRDs provide additional safety for battery vehicles or MEGCs, and other mitigation measures can be equally effective.

Some mitigation measures that can be considered include:

- Training of drivers (e.g. defensive driving) and/or dispatchers (routing trip management);
- Increased risk awareness for emergency responders;
- Technological options such as roll stability system, tyre pressure monitoring system, and lane departure warning;
- Battery vehicle design, for example, steel lateral protection plates to avoid direct flame impingement; and
- Cylinder/tube burst management, for example, fire retardant shielding, preventing direct contact of fire with composite cylinder/tube (efficiency to be verified) and/or fire protective coatings to minimize heat transfer to the cylinder or tube.

[1)] For such applications more reliable device than fusible plug shall be used.

Recommendations

For safe transportation of compressed gaseous hydrogen in battery vehicles and MEGCs using composite cylinders or tubes, EIGA recommends to perform a risk analysis of possible events and mitigation measures as configured on the vehicle, including various fire scenarios. This includes:

- Testing / evaluation of composite cylinders/tubes in a fire situation. The tests are performed to evaluate / understand their behaviour in a fire;
- A quantitative analysis of the possible failure modes and consequences, such as blast wave modelling; and
- Ensuring that the other mitigation measures are considered as alternatives or to supplement if TRDs are fitted.

These approaches can also be used as best practice for other compressed gases.

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