RISE research on gas containers

CNG and H2

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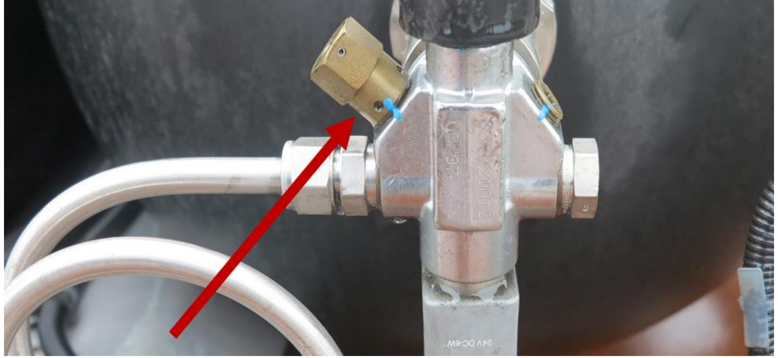
Presented by Haukur Ingason

Background (2019 tests)

- 2019: Tests with CNG steel and composite tanks using local fires
  - Thermal device (TPRD) activated in 6 out of 8 tests
  - One pressure vessel explosion
  - RISE Report 2019:120: ”CNG vehicle containers exposed to local fires” Gehandler and Lönnermark



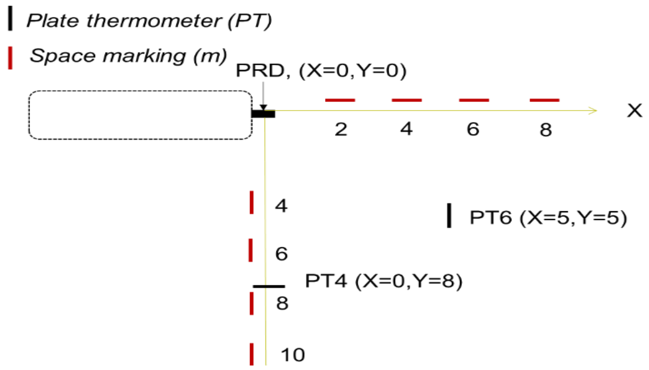
Eight gas containers were used in the fire tests 2019

- 4 bus conatiners in composite (Type 4)
- 4 car containers in steel (Type 1)
- Different starting pressure between 50 and 170 bar

2019 tests of 4 CNG Composite tanks (type 4) and 4 steel tanks (type 1)

Conclusions 2019 tests

- Five out of six containers handled the local fire
- Jetflame:
  - Length: 1 – 3 – 10 m
  - Heat flux at 5 m: 2 – 4 – 5 kW/m^2
- Pressure vessel explosion pressure wave:
  - 5 m: pressure 1.1 bar, impulse 3.0 bar×ms
  - 10 m: pressure 0.21 bar, impulse 0.59 bar×ms
- Fire exposed containers have a margin of safety against rupture



Background 2021 tests

- Effects of water cooling on TPRD
- In the context of sprinkler application and fire fighting.
- Focus on tunnel and maritime applications
- 2 x H_2 and 5 x CNG tanks

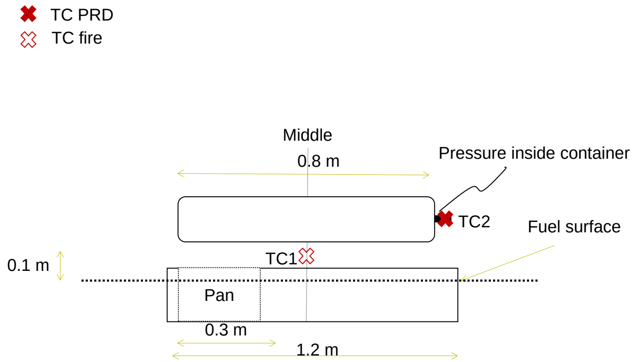
Background 2021 tests

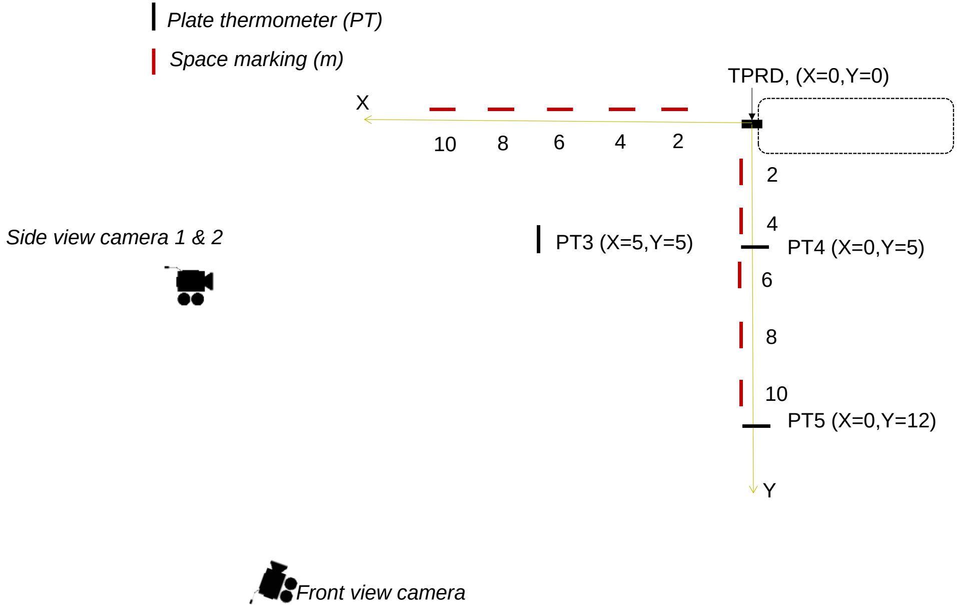
- Method to savely depressurize H2 tanks (700 bar) is not available
- First steps or attempt to safely depressurize H2 tanks taken using civilian rifles

Three testparameters

- Type of tank:
  - CNG composite (150-170 bar)
  - CNG steel (170 – 180 bar)
  - H2 composite (400 – 410 bar)
- Fire source:
  - wide (0.36 m * 1.2 m)
  - small (0.3 m * 0.3 m)
- Water application:
  - yes
  - yes with protection
  - no

Measurements / documentation





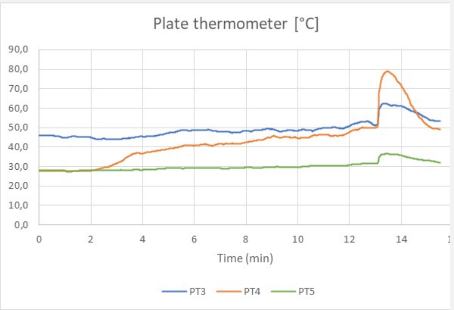
Fire test plan 2021

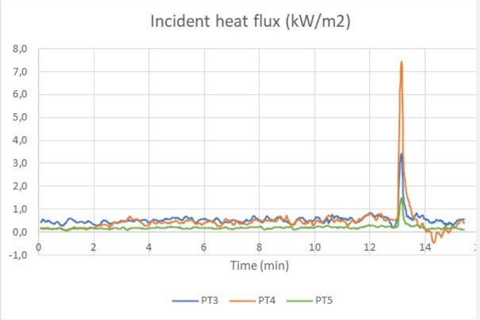
Test	Tank design	Pan size	Water discharge	Comment
1	CNG composite	Widespread	Yes	Water was on throughout the test
2	CNG steel	Widespread	Yes, with hood	The pan was not horizontal. Some fuel was leaking.
3	CNG steel	Small	Yes, with hood	Water is applied during 20 min.
4	CNG composite	Widespread	Yes, with hood	Water is applied during 20 min.
5	CNG composite	Small	No	
6	H2 composite	Widespread	Yes	Water is applied during 20 min.
7	H2 composite	Widespread	No	

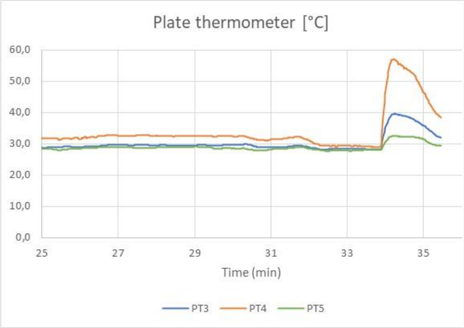
Results 2021 tests

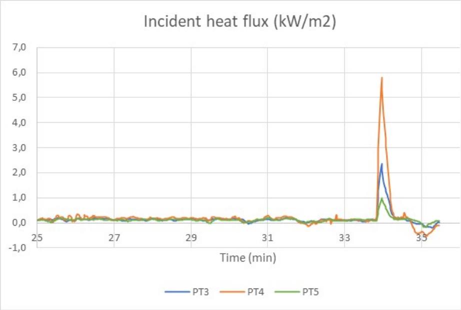
CNG composite tanks

- In test 1 and 4 water cooling resulted in no activation of TPRD
- Test 5 was a copy of the pressure vessel explosion in 2019
- Container “fail safely” due to increased porosity of the tank due to the fire









Water application on CNG steeltanks

- In test 2 TPRD released after 11 min exposure (403 bars pressure)
- In test 3 TPRD released after 25 min fire exposure (365 bars pressure)

H2 without water application

H2 with water application


03:01

H2 without water (3 min, 411 bar)

H2 with water (22 min, 490 bar)

Shooting a H2 tank with fire rescue services rifle

Conclusions 2021 tests

- TPRD can be cooled efficiently with water from sprinklers or manual fire fighting
- However, this did not jeopardize the safety of the three different types of gas tanks examined
- CNG / H2 jet flames are quite "cold" and give a relatively low incident heat radiation a few meters from the flame.
- Quick action can entail the lowest risks
- Next project is to develop education material based on the experiments, as well as technical reports

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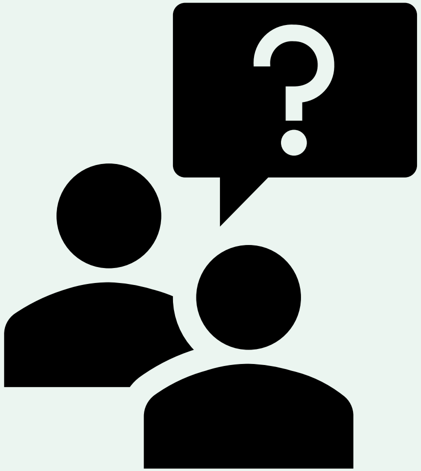

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