



Digital Stakeholders Workshop
HyTunnel-CS project
4-5 May 2020

Fire resistance rating of composite tank

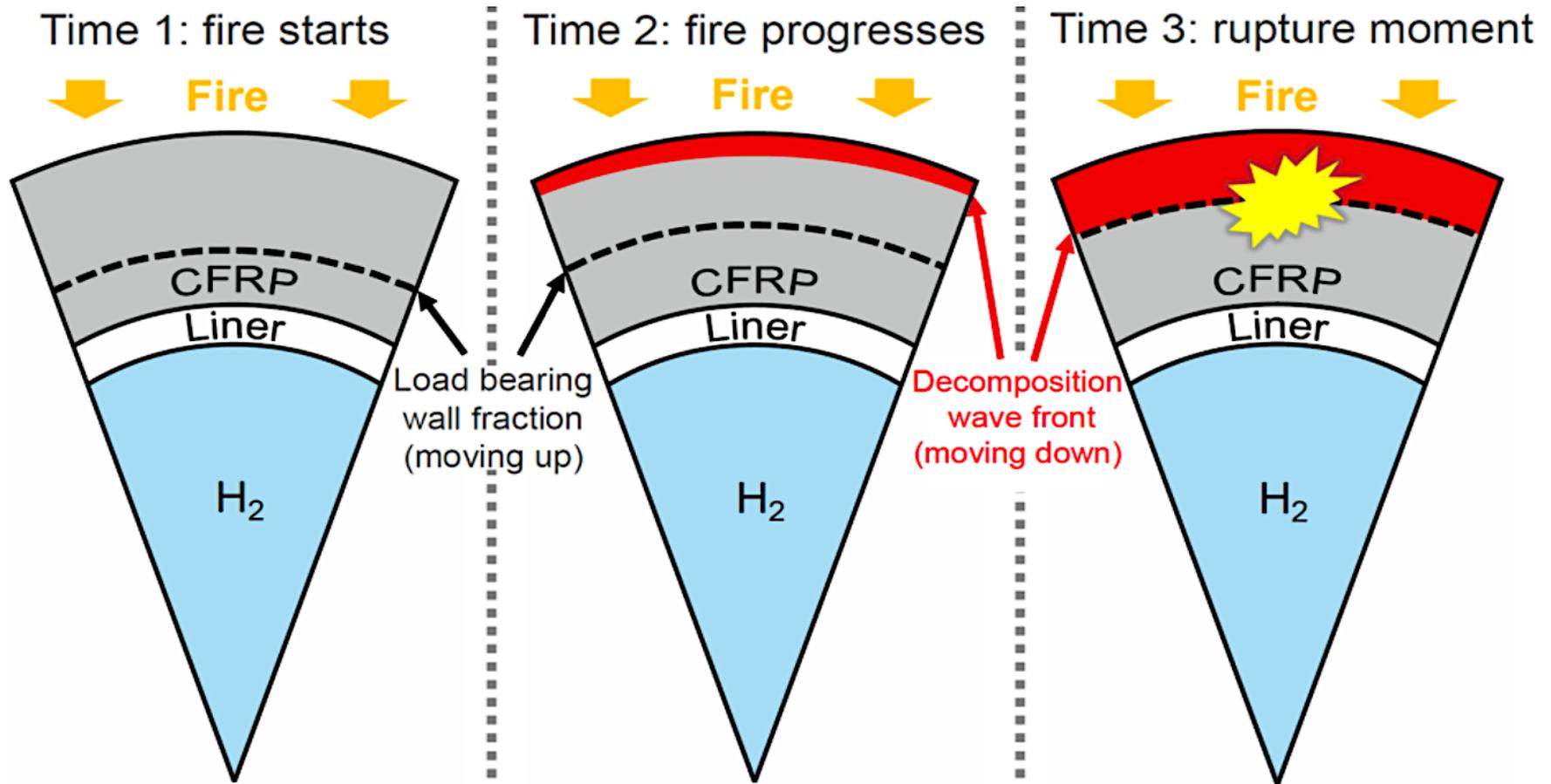
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Abbreviations

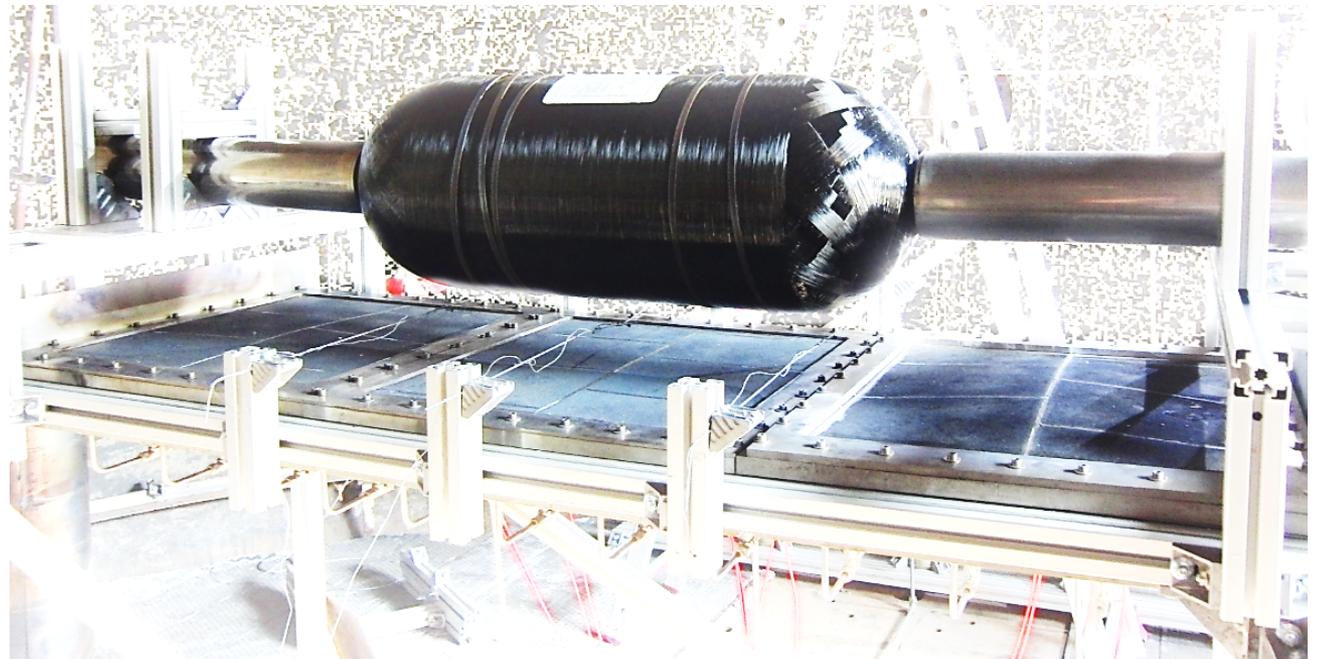
- FRR** - Time from burner ignition until tank's rupture in a fire (without TPRD or failed TPRD or localised fire far from TPRD, e.g. in a smouldering fire)
- HRR** - Heat release rate in a fire [kW] (can easily be measured by fuel flow rate to a burner).
- HRR/A** - Specific HRR in a fire - HRR divided by projection area of the fire source, A, [kW/m²].
- LNB** - Leak-no-burst safety technology, UU's IP.
- TPRD** - Thermally activated pressure relief device.

Composite tank failure mechanism



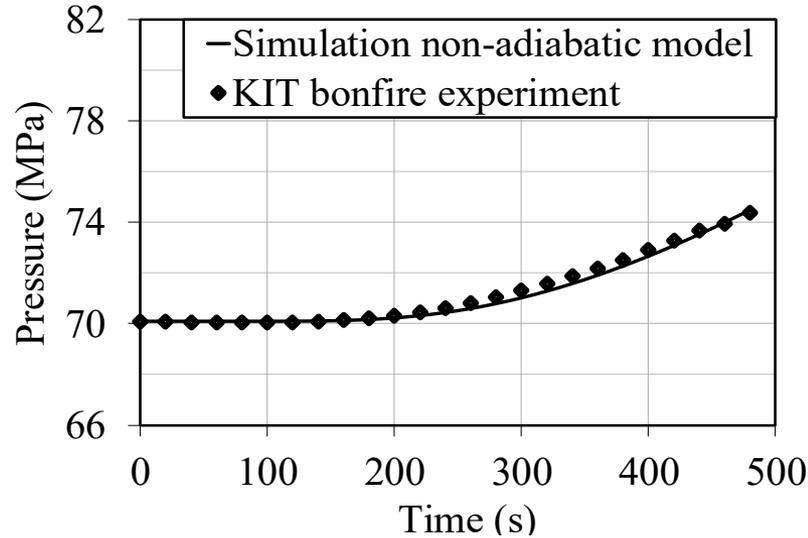
Fire test description

- Type IV tank, $P=700$ bar, $V=36$ L
- Premixed burner, CH₄-air (1:10 v/v), $HRR/A= 0.62$ MW/m²
- Testing facility is the vessel ($V=220$ m³) designed to withstand 10 bar of static overpressure
- 2 tests with identical conditions, FRR= 8 min and 9 min 40 s

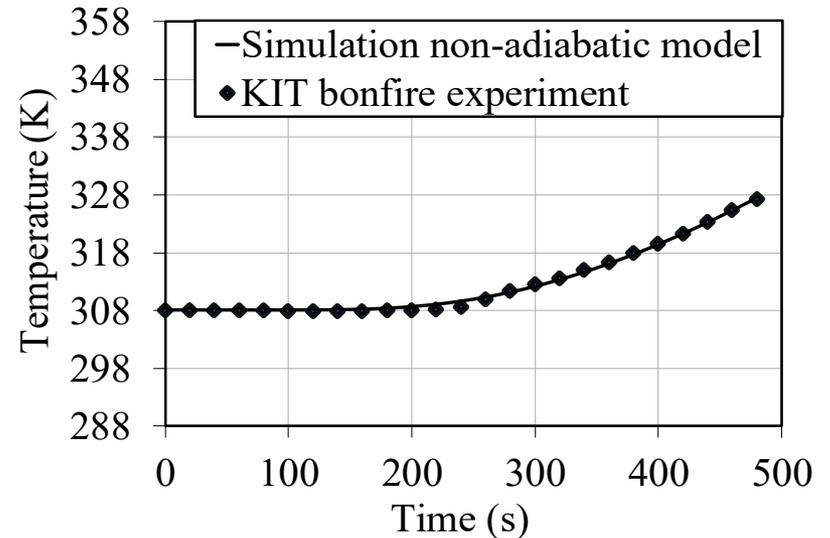


Tank failure in a fire

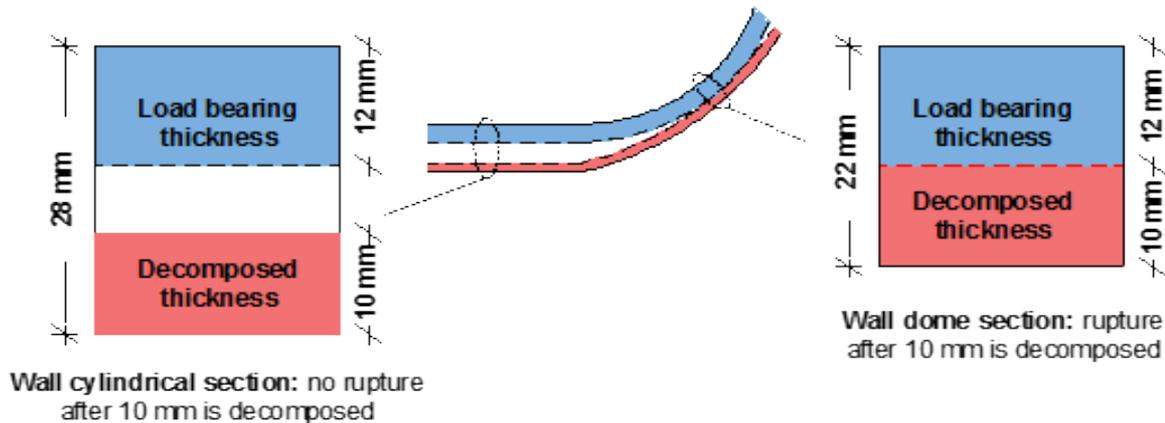
Validation



Pressure simulation vs experiment



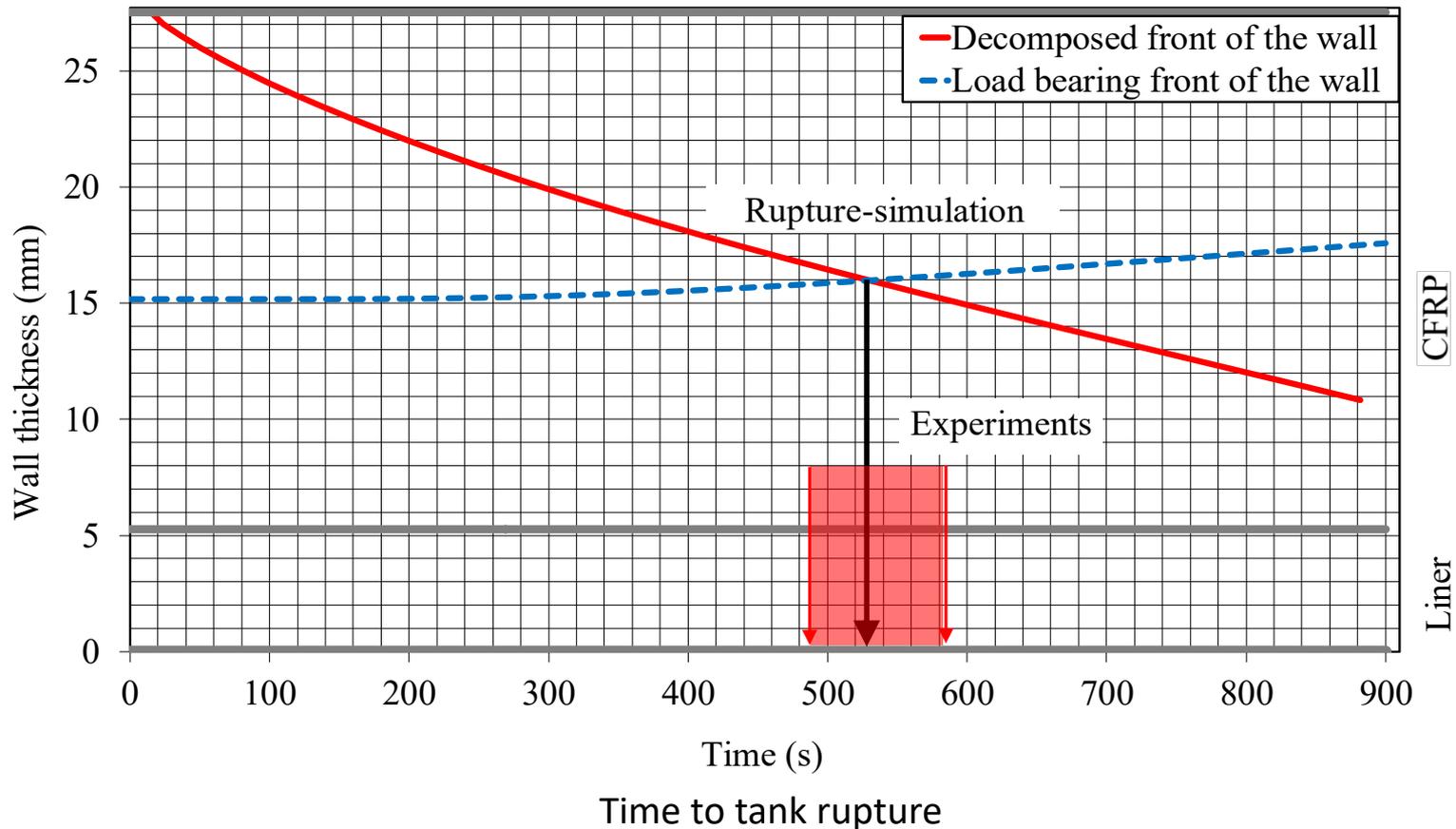
Temperature simulation vs experiment



Tank wall thickness at the cylindrical and the dome section

Tank failure in a fire

Validation



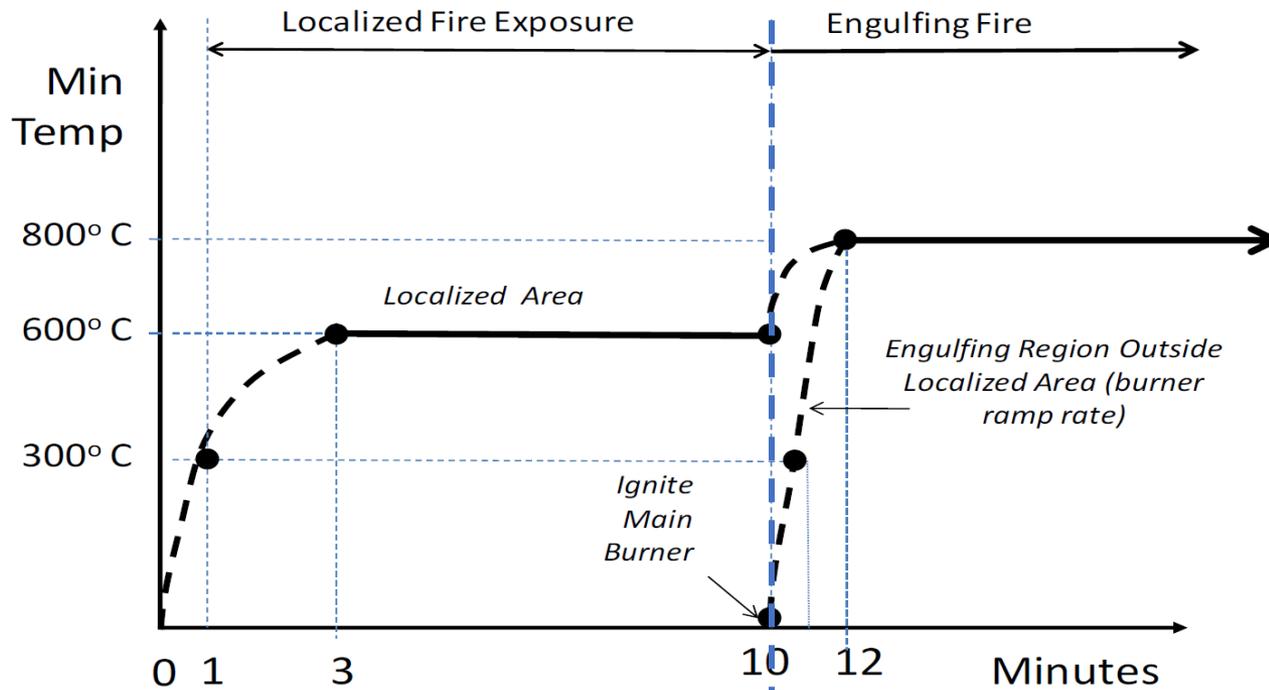
Type IV tank, 70 MPa, 36 L, no TPRD.

Rupture time: Test 1: 483 s; Test 2: 582 s; Model: 536 s.

Reference: Dadashzadeh et al., 2019, *ICHES*, Sep. 24-26, Adelaide, South Australia.

Tank performance in a fire with non-adiabatic blowdown

Fire test description



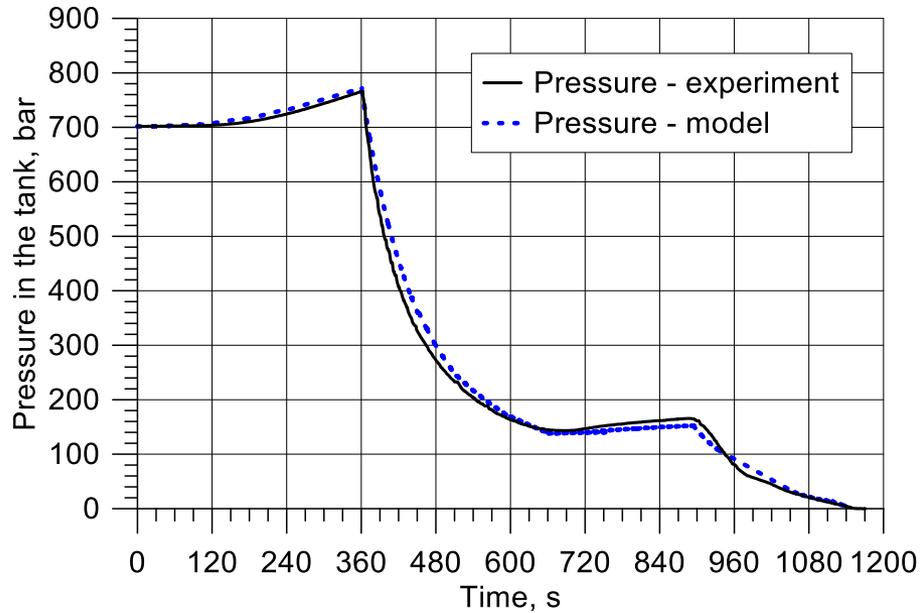
Tank and burner description

- Tank $P=700$ bar, $V=7.5$ L
- Tank dimensions 521x186 mm
- LPG burner $HRR/A=1$ MW/m²

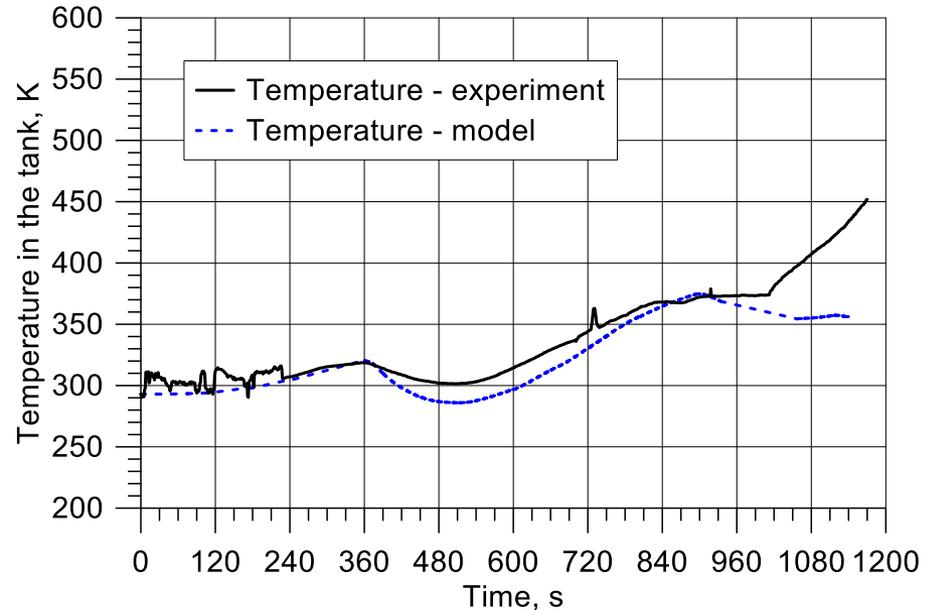


Tank in fire with blowdown (LNB tank)

Comparison with experiment



Pressure simulation vs experiment



Temperature simulation vs experiment

Concluding remarks

- The model for tank rupture in a fire was developed and validated.
- This model together with non-adiabatic blow-down model is the part of a bigger model for hydrogen safety engineering, to simulate tank performance in a fire together with blow-down.
- The test of LNB tank in a fire with simultaneous hydrogen release was simulated and results were compared with experiment.
- This tool can be used for development of a safety strategy to avoid rupture in a fire by using different TPRD orifice sizes, times to initiations and fire intensities.



Acknowledgements

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Technical University of Denmark



International Fire Academy



SAPIENZA UNIVERSITÀ DI ROMA

