UNIVERSITY OF CHEMISTRY AND TECHNOLOGY PRAGUE

TECHNICKÝ ÚSTAV POŽÁRNÍ OCHRANY

Introduction of Technical Institute of Fire Protection

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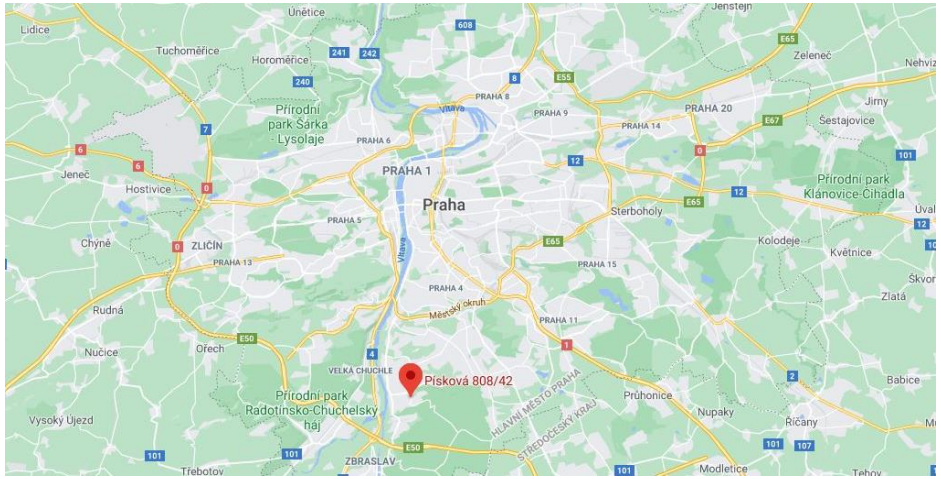
LabΠ

TIFP Prague

TECHNICAL INSTITUTE OF FIRE PROTECTION

FIRE AND RESCUE SERVICE OF THE CZECH REPUBLIC



Testing and certification of fire equipment

Fire investigation

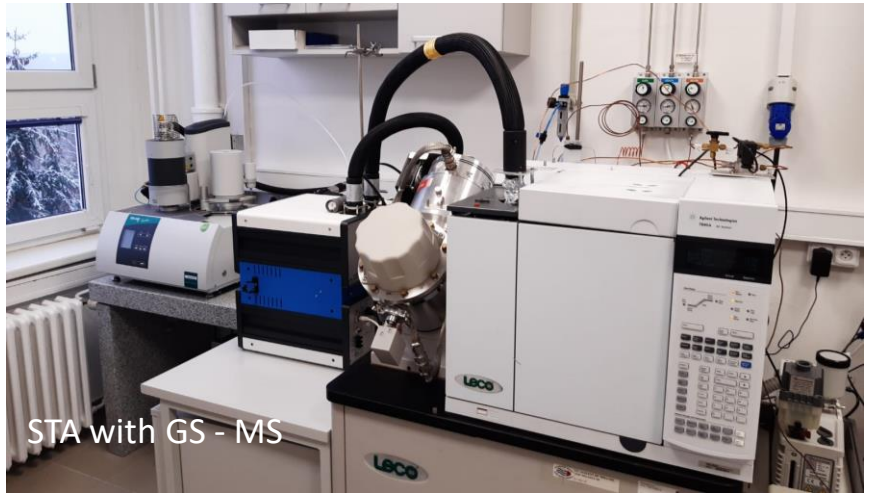
Applied R&D in Fire Science

TIFP Prague – activities

- ✓ Requests by fire and rescue service – short research projects
- ✓ Long term research projects
  - ➢ Release of CNG from vehicles
  - ➢ Thermal decomposition of wood products
- ✓ Cooperation with universities
  - ➢ University of Chemistry and Technology,
  - ➢ Czech Technical University,
  - ➢ Brno Technical University,
  - ➢ VSB – Technical University of Ostrava.
- ✓ Fire tests for customers
- ✓ computer fire modeling (CFD, zone models)
  - ➢ Research
  - ➢ Forensic analysis
  - ➢ Guidance for building designs

TIFP Prague – test lab

- **Bench-scale fire tests:**
  - Cone calorimeter with enclosed box and soot sampler,
  - Smoke chamber,
  - Oxygen index,
  - Setchkin furnace,
  - Explosion characteristics.
- **Material analysis:**
  - FTIR,
  - GC – MS,
  - HP – DSC,
  - STA with connection to GS – MS



STA with GS - MS

FTT iCONE

NITROGEN GENERATOR

UNIVERSITY OF CHEMISTRY AND TECHNOLOGY PRAGUE

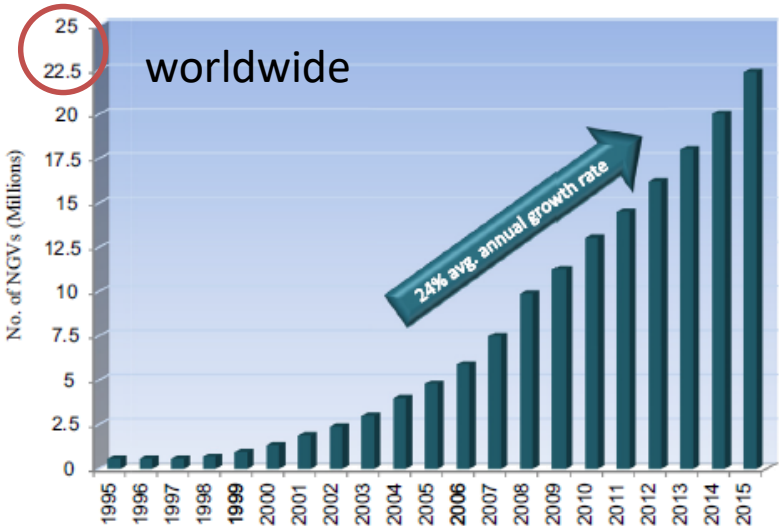
TECHNICKÝ ÚSTAV POŽÁRNÍ OCHRANY

Accidental release of CNG from passenger vehicles

Václav Vystrčil

LabΠ

Motivation



- Czech Republic: August 2017 – 18 000 CNG powered cars
- Goverment donations for cars with alternative power - compensation of higher price
- CNG buses for public transport (Ostrava, Brno)
- Truck are next in future?
- Hydrogen is next in future?

Benefits of CNG?

- Tax advantage for both CNG and LPG
- Lower carbon footprint
- Less noise
- Smaller operational costs

CNG vessels max. 200 bar

SAFETY ISSUES?	
ACCIDENTS ➢ Tank rupture ➢ Release of CNG ➢ Fire, explosion	FIRE BRIGADES
CLOSED PARKING SPACES ➢ CNG accumulation ➢ Danger of explosive atmosphere ➢ Emergency ventilation	BULDING SAFETY

Aims

- Experimentally study and determine appropriate boundary conditions (release rate) for different accident scenarios
- General guidance for **C**omputional **F**luid **D**ynamics usage for such applications

Prediction of CNG release in different accidental scenarios

Possible scenarios:

1) Release from open **P**ressure **R**elief **D**evice – jet fire?
2) Leakage from fuel delivery system
   – loose fittings/malfunction of valve
3) Stress corrosion crack of CNG tank
4) External corrosion of tank
   – complete rupture of CNG tank

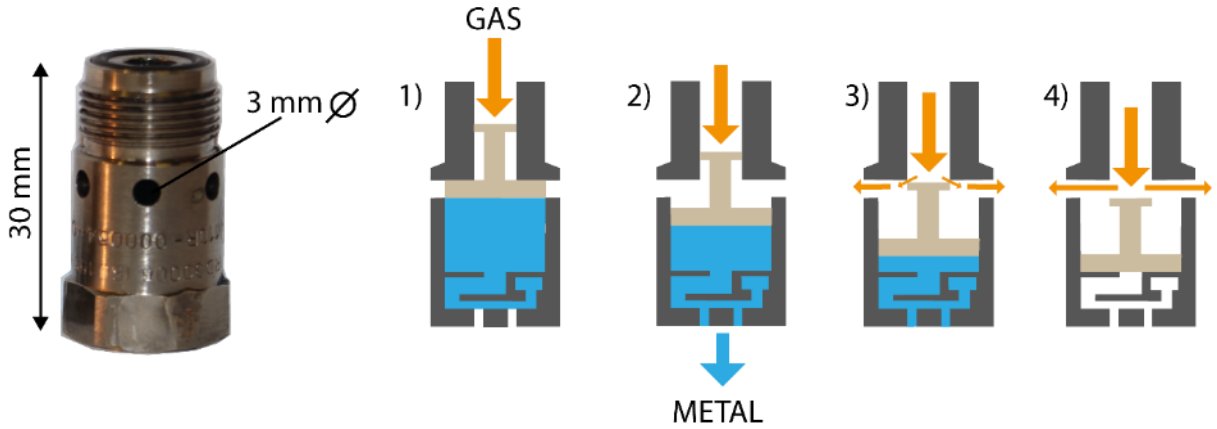
Workflow

Experiments:

- Test of PRD opening temperature
- Release of gas trough fully open PRD (AIR)
- Release of gas through heated PRD (AIR)
- Release of gas trough fully open PRD. (METHANE)
- Release of gas through fully open PRD (AIR)
- Release of gas throuh different sized leaks (AIR)

Test of PRD opening temperature

- **tPRD** is safety device mandatory on each pressure vessel.
- Contains fusible metal.
- Should open at 110 ± 10°C.



- Test done with load corresponding 200 bar
- Temperature declared by the manufacture confirmed

Release of gas through fully open PRD (AIR)

- Experiments with air (air used due to safety reasons)
- Goal of the experiments = obtain data to set boundary condition for CFD

Measured quantities:

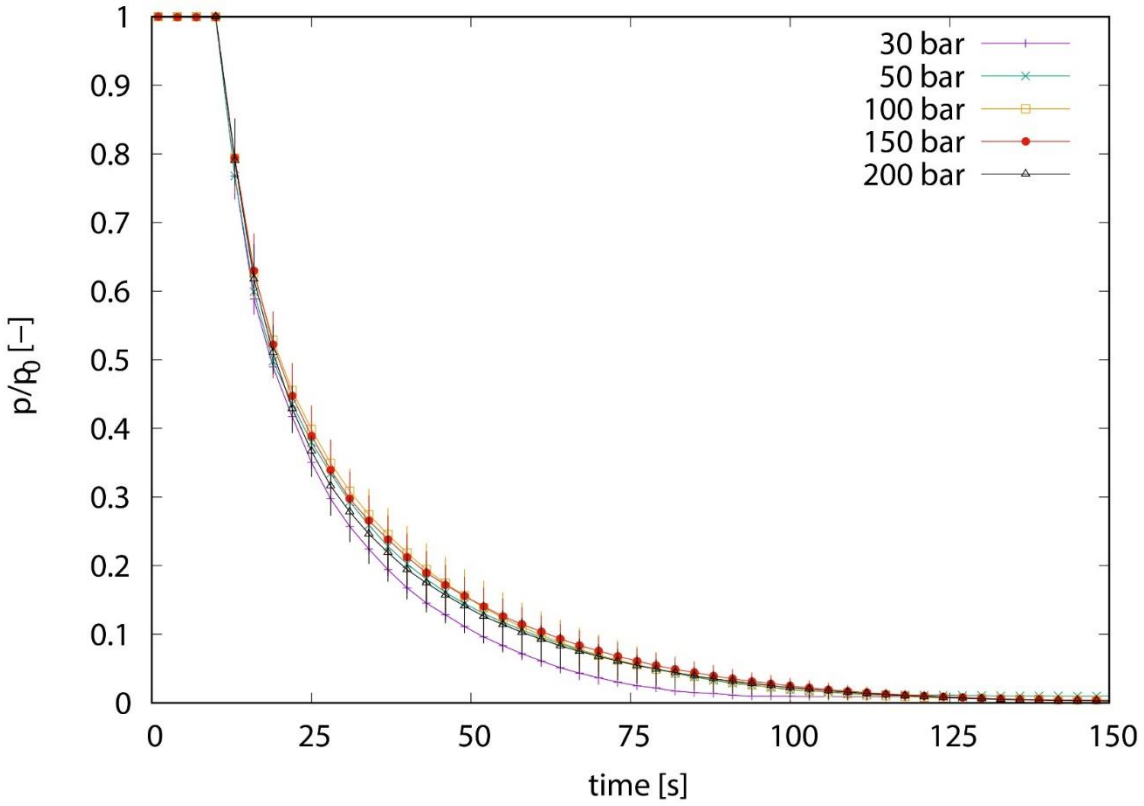
- Mass loss rate
- Pressure loss rate
- Temperature of the leaking air
- Temperature inside the vessel

Different initial pressures

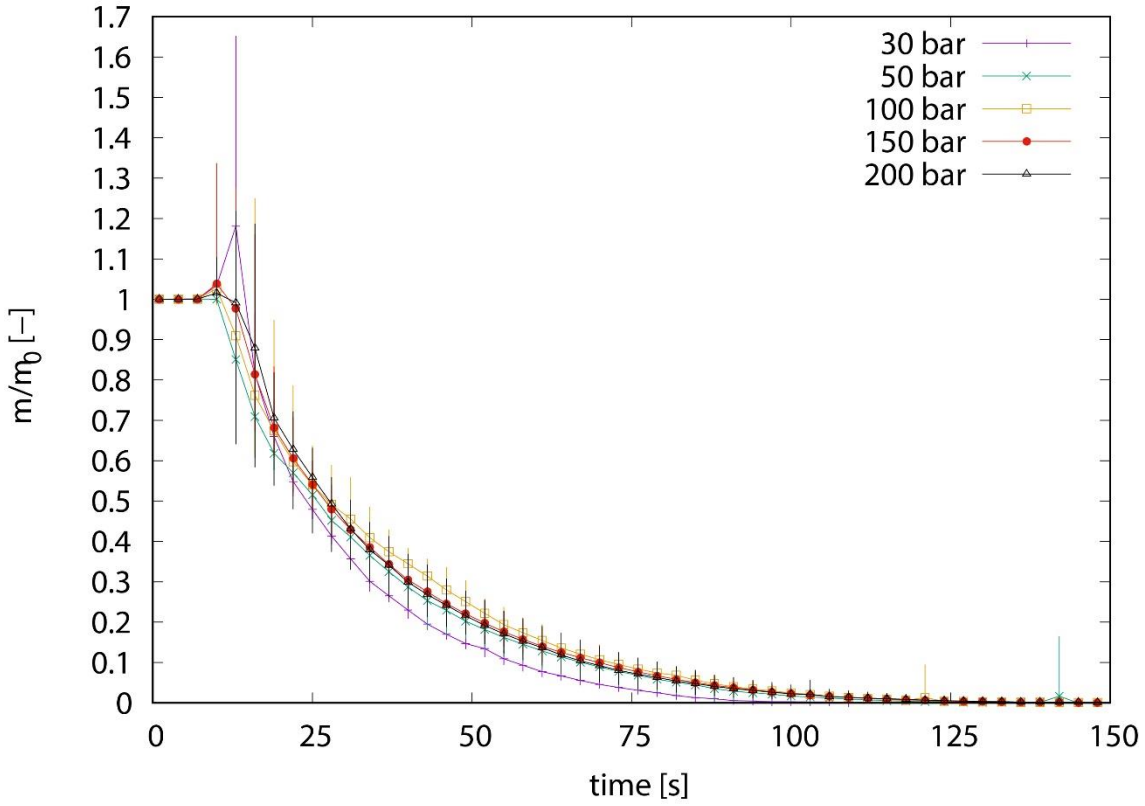
- 200 bars
- 150 bars
- 100 bars
- 50 bars
- 30 bars

Each pressure was measured 5 times

Release of gas through fully open PRD (AIR)



Pressure loss rate



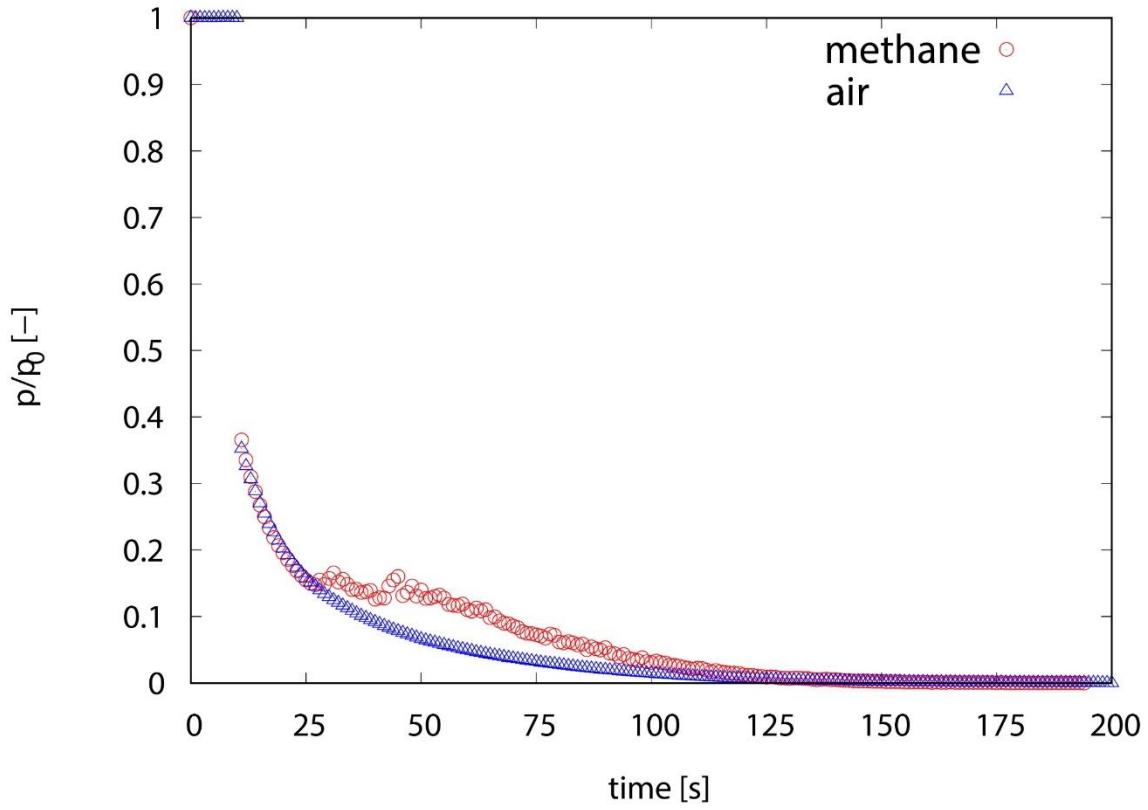
Mass loss rate

Release of gas trough fully open PRD. (METHANE)

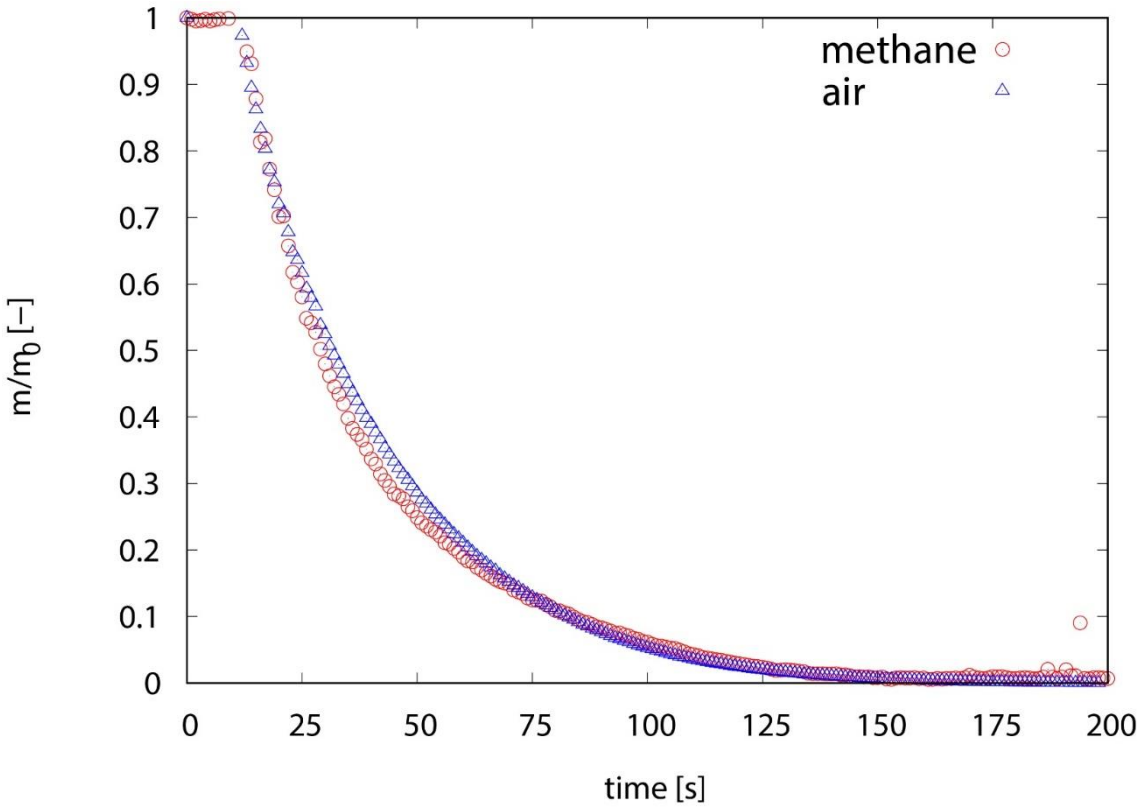
setup for METHANE

setup for AIR

Release of gas trough fully open PRD. (METHANE)



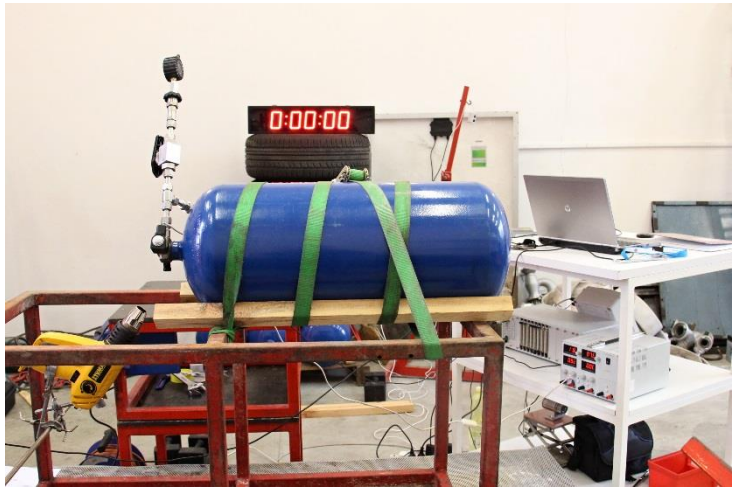
Pressure loss rate



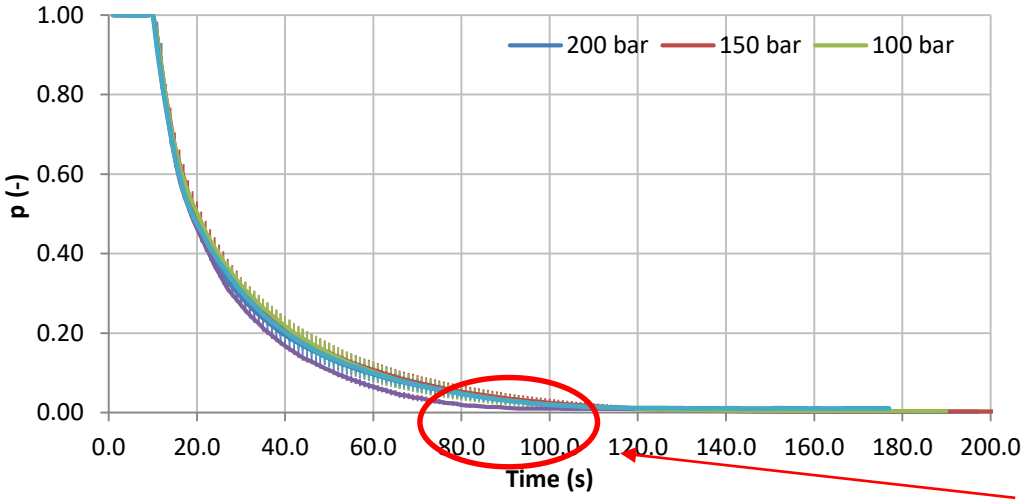
Mass loss rate

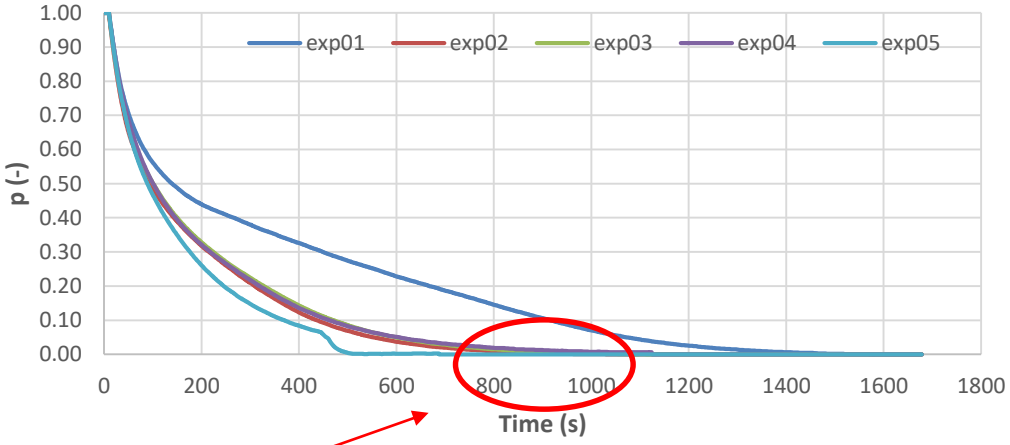
Release of gas through heated PRD (AIR)

Fully opened



Heated





ten times longer !

Release of gas through heated PRD (AIR)

Release of gas through heated PRD (METHANE)

- Model of rear part of a vehicle.
- Real geometry – two vessels.
- Only one vessel full of CNG.

- Oscillations of the flame?

Release of gas through heated PRD (METHANE)

00:47 – activation of tPRD, 2:35 – increase of fire intensity

CONLUSION:

- Boundary condition for PRD fully open obtained.
- Release rate strongly influenced by heating profile.
- PRD almost never fully opened.

FUTURE WORK:

- Run the set of experiments to obtain boundary condition for leak scenario.
- Set the guidance how to use obtained data in prescriptive code or PBD
- Continue with presenting the data to first-responders.

Thank you for your attention!

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