VSB TECHNICAL UNIVERSITY OF OSTRAVA | FACULTY OF SAFETY ENGINEERING | DEPARTMENT OF OCCUPATIONAL AND PROCESS SAFETY

Hydrogen Fuel Risks

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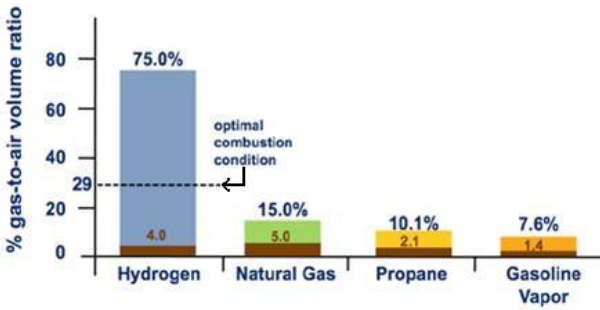
Introduction

Introduction

- Hydrogen is presented as the future source of energy because of its high energy potential and clean combustion.
- Energy released almost 3 times more than gasoline.
- Flame almost invisible with naked eye during daylight.
- Hydrogen has a broad flammability rate from 4% to 75%



Hydrogen technologies are expected to be used widely for smart cities or regions

The Czech Republic's Hydrogen Strategy

- European Climate Law 2021: sets out a binding objective of climate neutrality including net-zero greenhouse gas emissions in the EU by 2050.
- Ministry of Industry and Trade has developed Hydrogen Strategy to step forward to implement European Climate Law
- Czech government in 2021 has approved the strategy in same year.

The Czech Republic's Hydrogen Strategy

- Covers the proposed application of Hydrogen in different industrial sectors.
- Consists of 4 main sections:
  - Analytical section,
  - Strategic section,
  - Implementation section,
  - Strategy development process.

The Czech Republic's Hydrogen Strategy

- Implementation section: Sequential steps by area of hydrogen use in different sectors
  - Transport (mobility) sector,
  - Chemical industry sector,
  - Iron and steel sector,
  - Electricity and heat production.

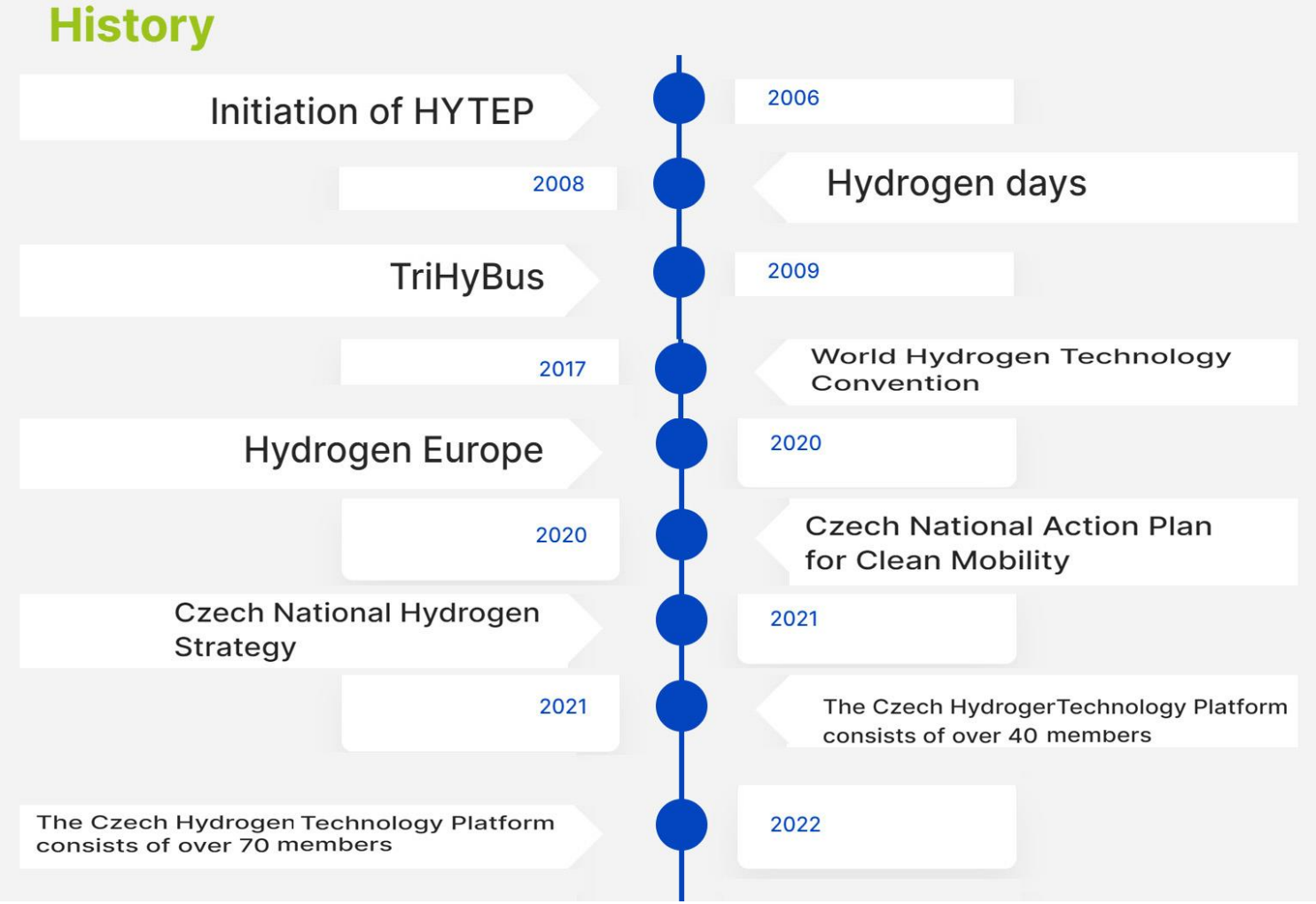
Czech Hydrogen Technology Platform

- Ministry of Industry and Trade considered as the relevant authority.
- Take the initiation to link the cooperation between academia and business sectors
- Czech Hydrogen Technology Platform since 2007. https://www.hytep.cz

Czech Hydrogen Technology Platform

- here over 70 members including
  - Technical University of Ostrava VSB-TUO,
  - Czech Technical University,
  - University of Chemistry and Technology,
  - České dráhy (Czech Railways),
  - Škoda Electric.

Czech Hydrogen Technology Platform



Hydrogen filling station in Czech Republic

- First public - since 2022 in Vítkovice, Ostrava
- Capacity is to fill up to 40 hydrogen cars., so far about 10 cars per day are expected to be filled.
- Took 2 months to complete the project, the Cost was 600,000 Euros.
- Based on https://h2.live/en/, - 2 stations in service, and 4 stations are under construction.

Hydrogen filling station in Czech Republic

- Trial operation is planned for 2025, and start full-scale operation of the station in 2026.
- Close to VSB-TUO campus to ensure connection between research activities and public accessibility.
- Production, compression, storage and distribution of 100-150 kg of green hydrogen/day.
- Charging up to 10 electric cars at the same time and 1 quick-charging station for electric buses.

Risk Analysis Case Study

Ecological filling station for vehicles with an alternative energy source

- Personal cars, public buses

Production
Storage
Use

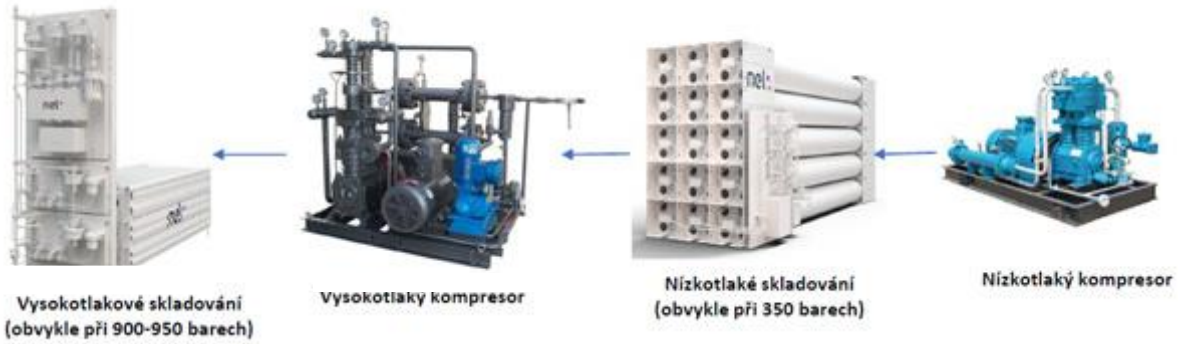
- Dangerous substance - Hydrogen

Risk analysis according to Major accident Prevention (SEVESO Directive)

- Dangerous zones (fire, explosion)

Technology

- Hydrogen generation
- Hydrogen cleaner
- Low pressure compressor
- Low pressure hydrogen storage 350 bar
- High pressure compressor
- High pressure hydrogen storage 900 – 950 bar

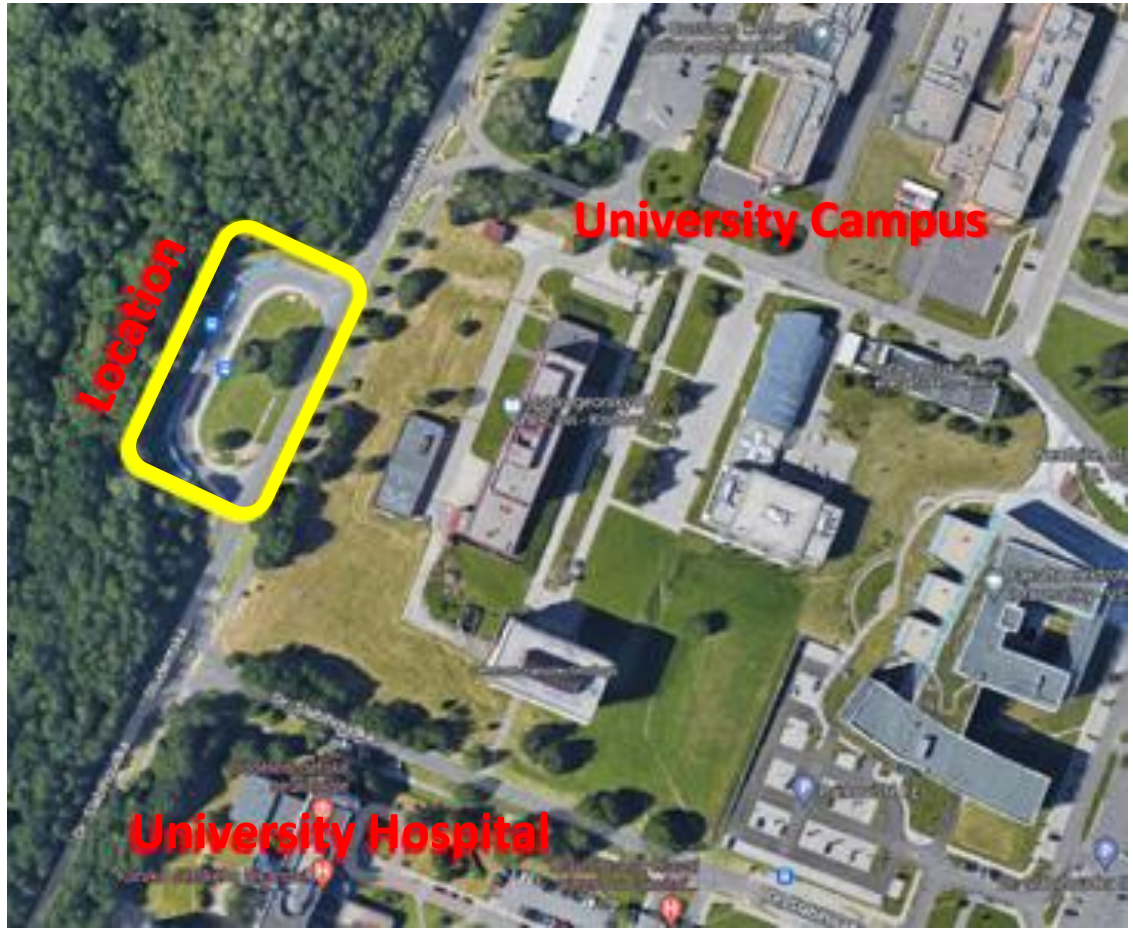


Identification of sources of risks

Combination of countryside and built – up area

Dangerous substance – hydrogen

- Storage stack
- Pipelines
- Filling stand



Dangerous substance in the subject

Label of risk source	Facility	Dangerous substanvce, clasification	Quantity [Kg]	Physical form
Z1	High pressure storage H_2	Hydrogen – H220, H280	350	Compressed gas
Z2	Low pressure storage H_2	Hydrogen – H220, H280	100	Compressed gas

Risk analysis – identification of possible accidents

Possible situation inside the object

- Leakage of flammable gas, subsequent fire or explosion
  - Scenario: Continuous hydrogen leakage from the high pressure storage, dispersion to surrounding, potential ignition and fire / explosion

Possible situation outside the object

- Human activity
- Natural effects

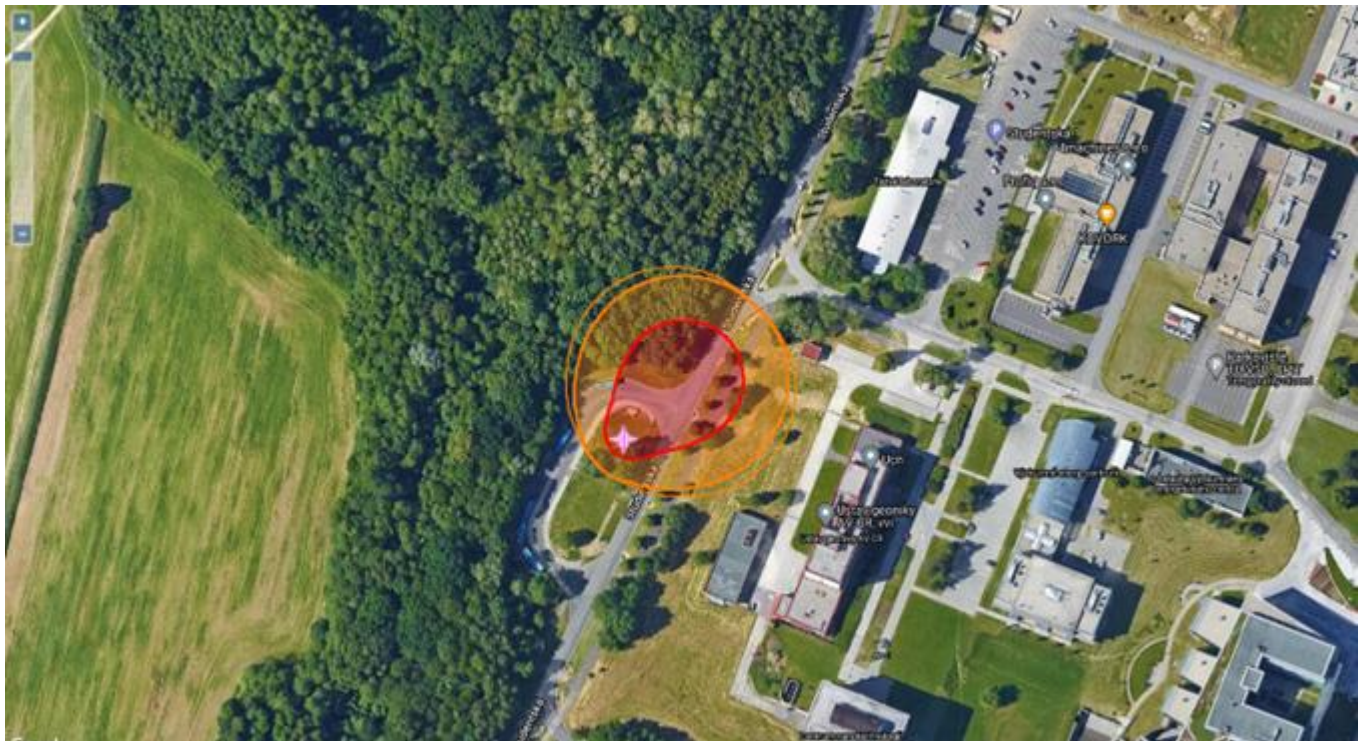
Systematic identification of causes and initiation event

Identification of representative scenario – cause description

- High-pressure storage – app. 300 kg of hydrogen
  - Hydrogen release / leakage - loss of tightness of storage or pipelines
  - Scenario – rupture in average 1 cm (Purple Book)

ALOHA results

Scenario	Substance	Rupture [cm]	Amount [kg]	Max. of releasing amount [kg/min]	Leakage time [min]	Threat level	Accident range [m]
Fire	Hydrogen	1	260	122	23	10 kW/m^2	14
Explosion	Hydrogen	1	260	95	23	55 kPa	62



Overall evaluation of the object risk

Based on the risk analysis the precautions are sufficient

Effectively separate amount of the hazardous substances in technologies

- Smaller parts, remote control valves (low / high pressure systems)

Hazardous substances leakage detection

- Hydrogen leakage detection, automatically close of valves, total stop

Systematically increasing employee knowledge level

- source of the risk, emergency scenario training

HYdrogen SAfety COncept - HySaCo

Open call in safety research for 2023-2029

Safety Concept of Hydrogen Technologies for Smart Cities and Regions

- Project leader: prof. Dr. Ing. Aleš Bernatík (FBI)
- Project manager: Ing. Vojtěch Jankůj, Ph.D. (FBI)
- Project partner: Ing. Adam Giurg, Ph.D. (UniCRE)
- Project period: 1.1.2023 – 31.12.2026

The aim of the Project

- Risk management in the hydrogen life cycle with focusing on the so-called hydrogen valleys or hydrogen cities
- Theoretical background of hydrogen technologies and their use
- Practical obtained and evaluated data which will be used for scenarios

Conclusion

Thank you for your attention

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