FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

Project PRETZEL
Risk Assessment Approach

Workshop on Safety of Electrolysis

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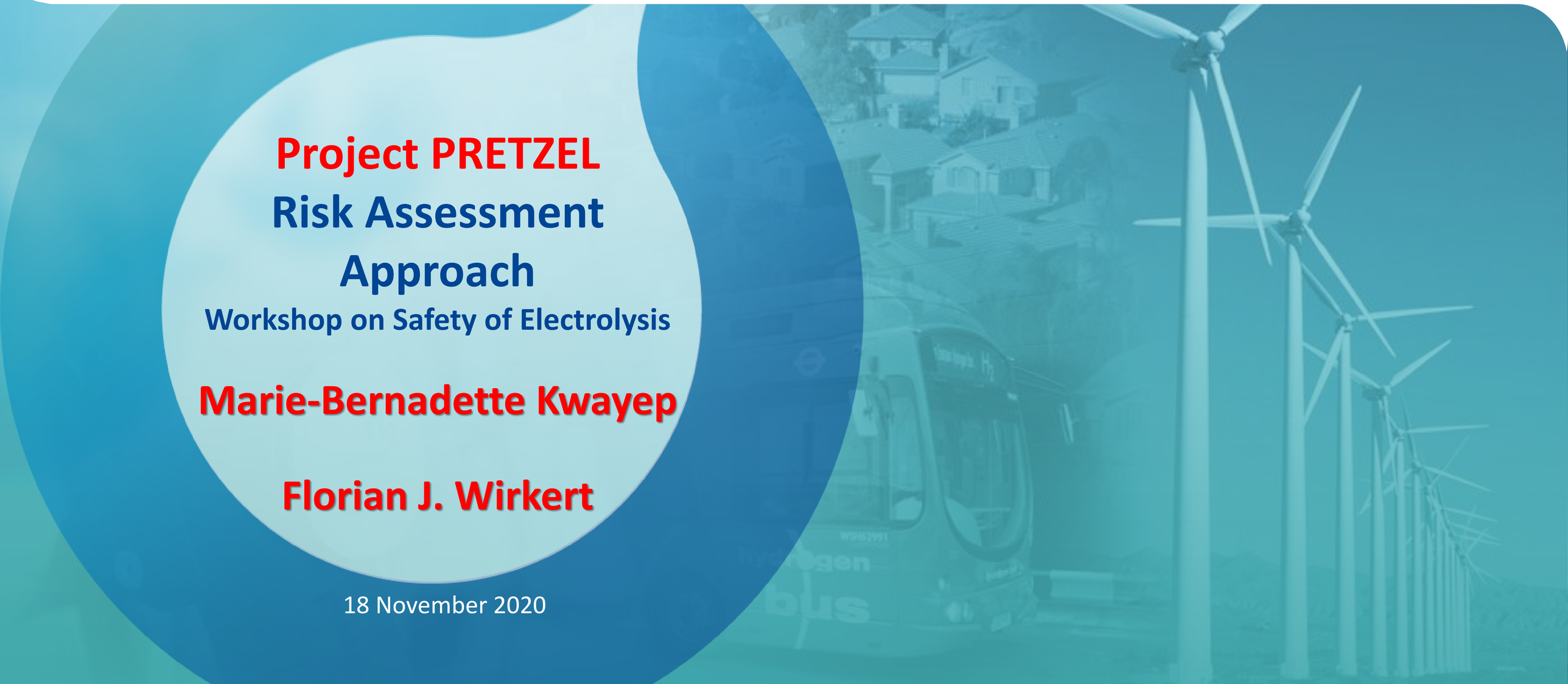
18 November 2020



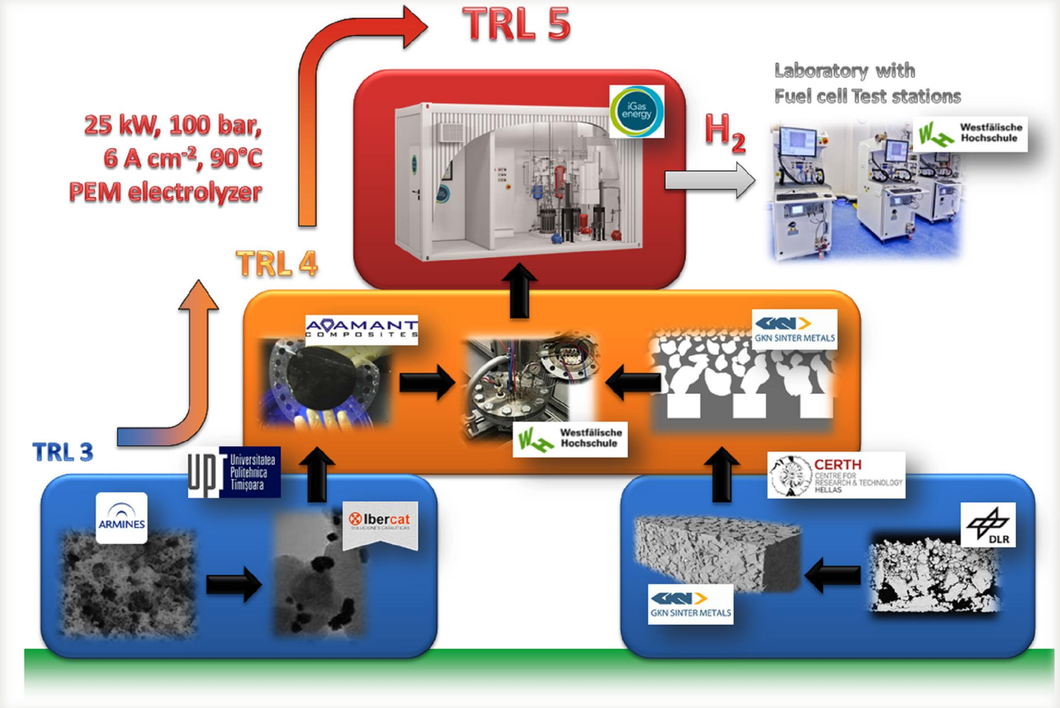
Project PRETZEL

Workshop on Safety of Electrolysis

Project Brief

PRETZEL

Novel modular stack design for high **PRE**ssure PEM water elec**T**roly**Z**er t**E**chno**L**ogy with wide operation range and reduced cost



Regulations, Codes and Standards

- Technische Regeln für Betriebssicherheit, especially TRBS 2152, Teil 1- 4
- Technische Regeln für Gefahrstoffe, especially TRBS 407, 510, 725, 727
- AD2000-Merkblätter
- DIN EN ISO 12100
- DIN EN ISO 13849
- BGI 518, DIN EN 60079-29-2
- DGUV Regel 113 – 001; EX-RL

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Risk Assessments

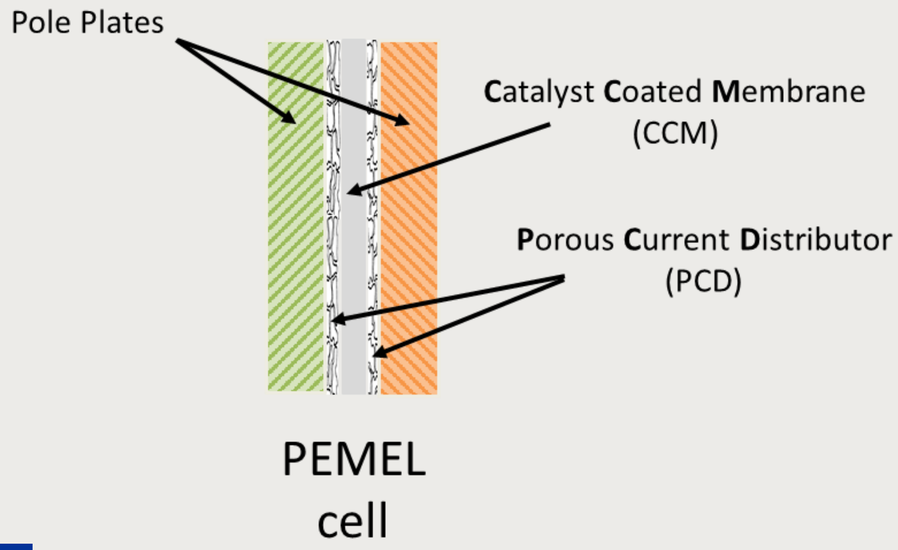
- High hydrogen pressure of up to 100 bar
- High oxygen pressure of up to 100 bar
- High operation temperature of up to 90 °C
- High current densities of up to 6 A/cm^2
- Usage of experimental components
  (Pole plates, Current distributors, MEAs)

→

- Increased possibility of unforeseeable failures
- Necessity for preventing known failure mechanisms
- Necessity for permanent survailance and process control

Prevention and mitigation – Stack level

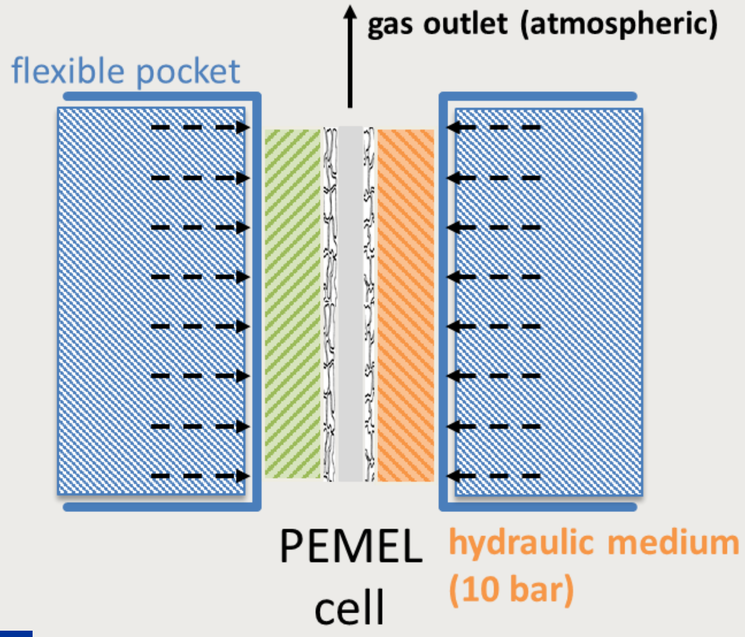
- Hydraulic single cell compression



M. Brodmann et al., METHOD AND SYSTEM FOR OPERATING AN ELECTROLYSER, 2014, published under patent number WO2014040746A1

Prevention and mitigation – Stack level

- Hydraulic single cell compression
- Homogeneous pressure distribution



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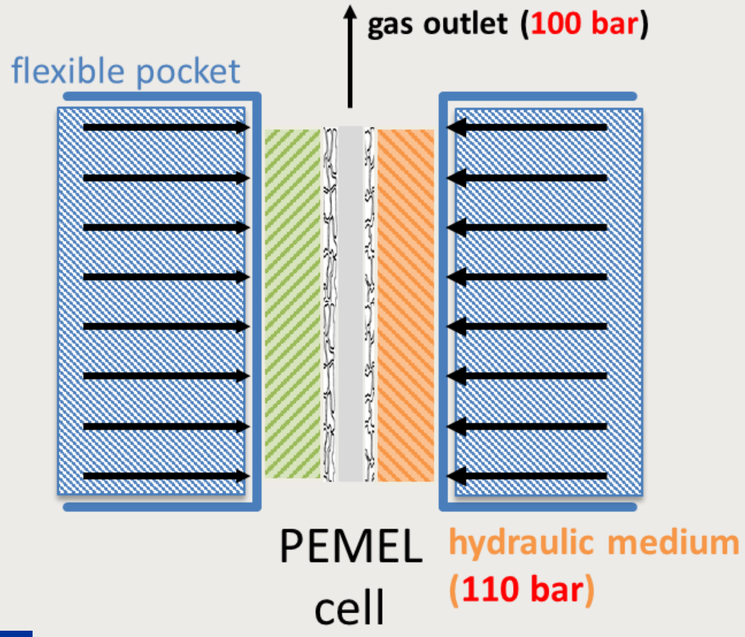
Prevention and mitigation – Stack level

- Hydraulic single cell compression
- Homogeneous pressure distribution
  constant at any gas output pressure



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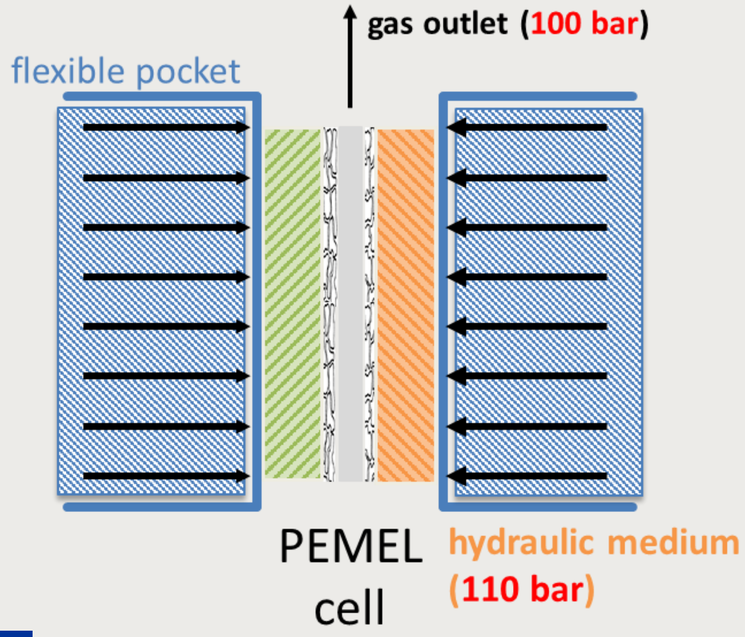
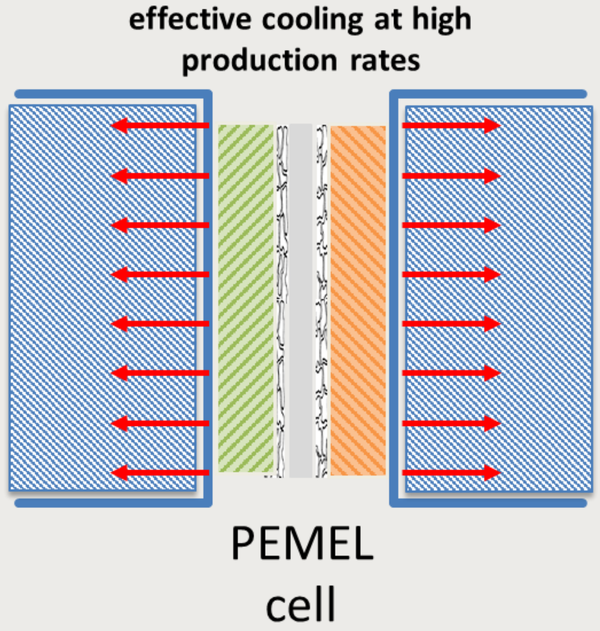


- Homogeneous cell cooling
- Effective cooling at high power densities



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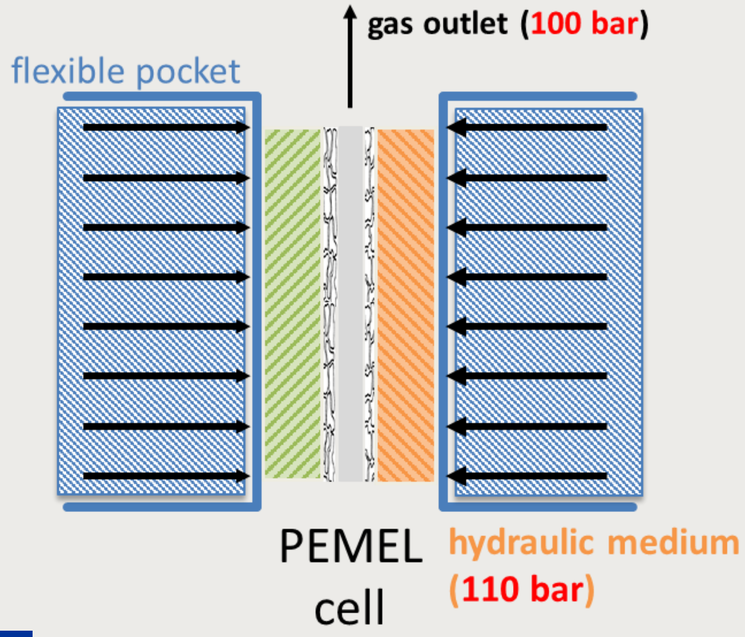

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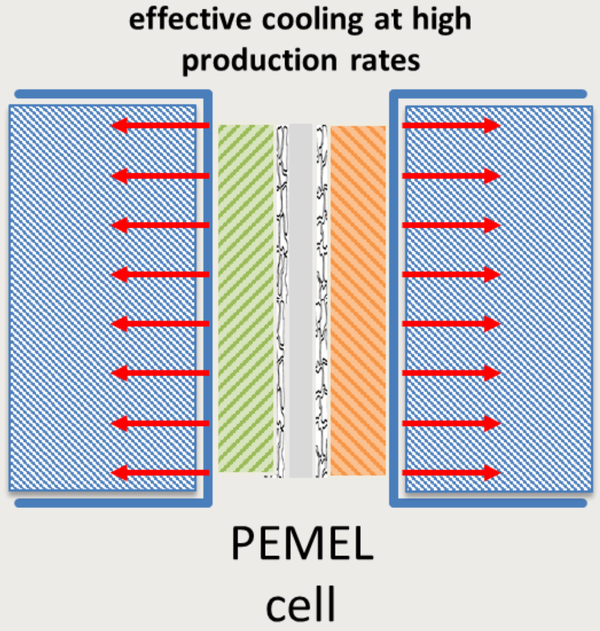

- Constant conditions at every operationg point
- Minimized (mechanical) stress for crucial parts

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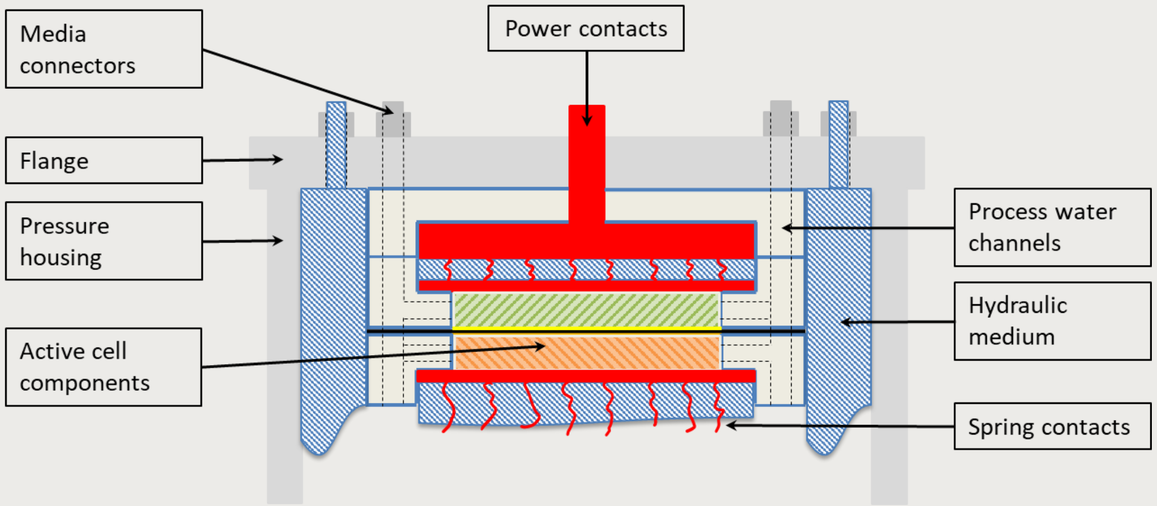
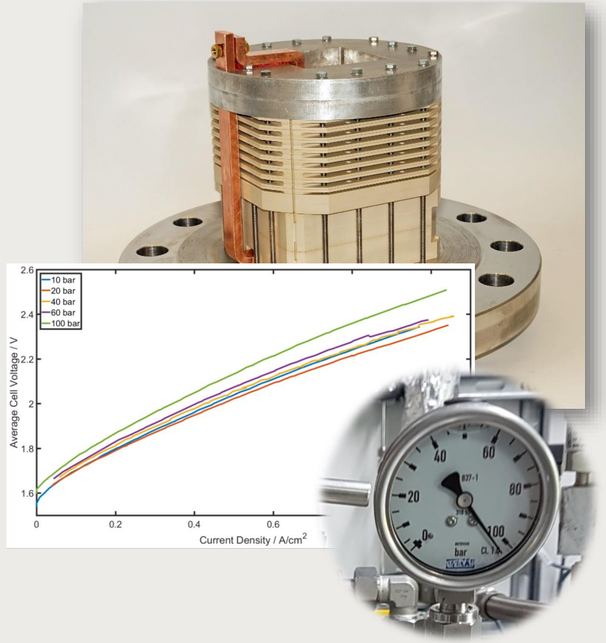
Prevention and mitigation – Stack level

- Hydraulic single cell compression
- Realized in a compact cell design
- Scalable modular design approach
- Small-scale prototypic device





F.J. Wirkert et al., A modular design approach for PEM electrolyser systems with homogeneous operation conditions and highly efficient heat management, Int. J. of Hydrogen Energy, 45, 2 (2020) 1226-1235, DOI: 10.1016/j.ijhydene.2019.03.185

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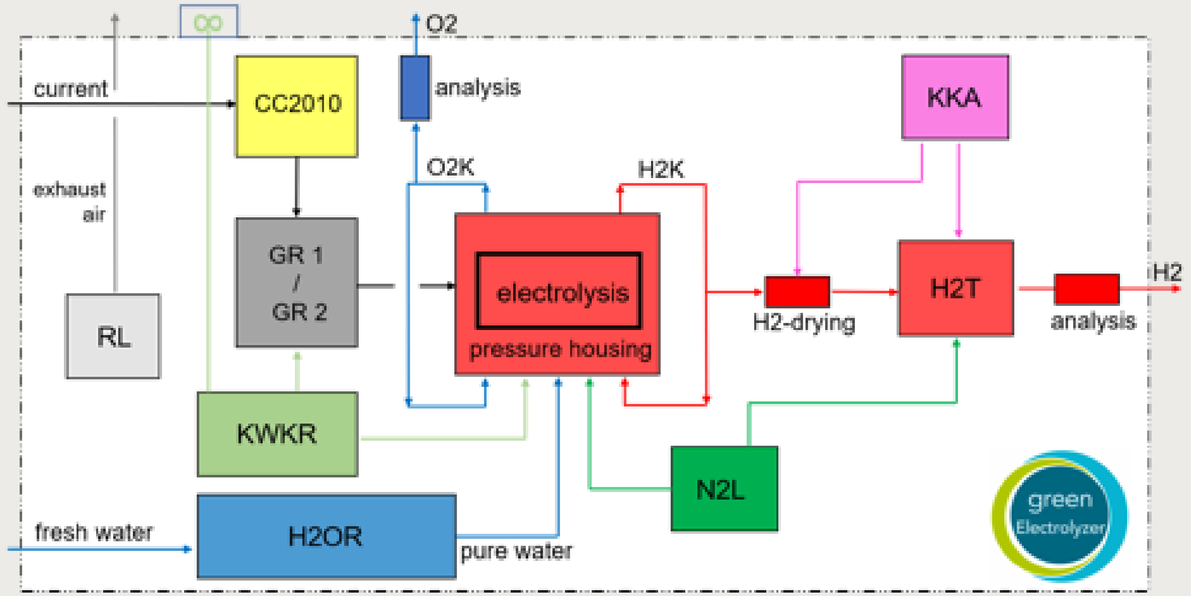
Prevention and mitigation – System level

- PEM electrolyser system built in a container solution
- Container divided in two rooms

- Several separate circuits are included in the system



Prevention and mitigation – System level

Safety measures for operating the system:

- All detachable connections are designed in such a way that the system is “permanently technically sealed”
- Mechanical safety valves are installed in anode circuit and cathode circuit, respectively, with a set pressure of 120 bar
- Installed gas detector in Balance of plant room
- Installed respective O2 and H2 exhaust pipe
- No connection between O2 and H2 circuits
- Permanent aeration of the system
- Permanent measurement of output pressure and pressure drop at both sides (H2 and O2)
- Permanent analysis of O2 in H2 as well as analysis of H2 in O2
- All sensors are connected to the operation control system
- Emergency stop outside of the container as well as nearby the rectifier unit

Operational concepts, education and training

- Only experienced workers are allowed to operate the system
- Number of persons, who have access, is limited
- Data is recorded permanently and stored at separate devices
- Work at the system is logged manually by the person in charge

Safety issues observed so far

- First system of this kind with high-pressure operation
- Due to strict safety measures, no issues arised so far
- Necessity of reliable pressure and temperature control was confirmed in first test runs
- Careful operation and observation of the whole process is necessary in the future to recognize safety issures prior to possible accidents

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