Flagship Project
H_2Mare

e-XPlore: A High-Pressure Solid Oxide Cell Electrolyser in a Sea Container for Offshore Power-to-X Applications

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High temperature electrolysis

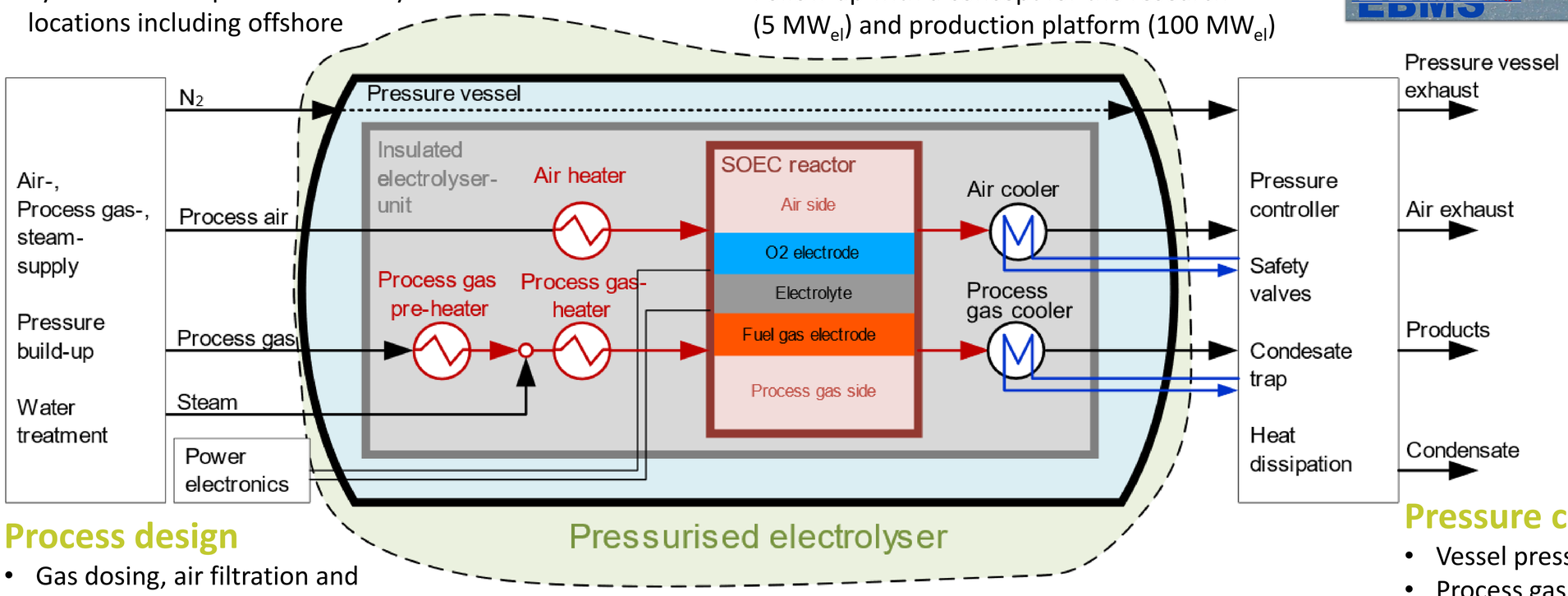
- Chemical storage of electrical energy
- Carbon neutral synthesis gas production, when green energy is used
- Electrolysis is thermodynamically favorable at high temperature
- High temperature electrolysis can use CO_2 and H_2O (steam) as educts to produce synthesis gas
- Hydrogen production under pressure is advantageous for further processing e.g. Fischer-Tropsch-Synthesis benefits from elevated pressure to start with.

e-XPlore: The SOEC-System

- Customized 40 feet sea container
- Suitable for offshore operation
- 10 kW_{el} power input for electrolyser
- 8 to 25 bar operation pressure
- PLC for 24/7 operation without supervision
- Fresh air, water and cooling water supply is included in the system
- Container is moveable via crane and truck
- System will be operated on many different locations including offshore

H_2Mare PtX-Wind

- Experimental platform for proof of concept
- Challenging offshore environment
- DLR analyses synthesis gas production for Fischer-Tropsch (FT)
- FT will produce synthetic fuels for industry
- Production location is advantageous for ship transport → Lower investment costs than a pipeline
- Follow up with a concept for the research (5 MW_{el}) and production platform (100 MW_{el})

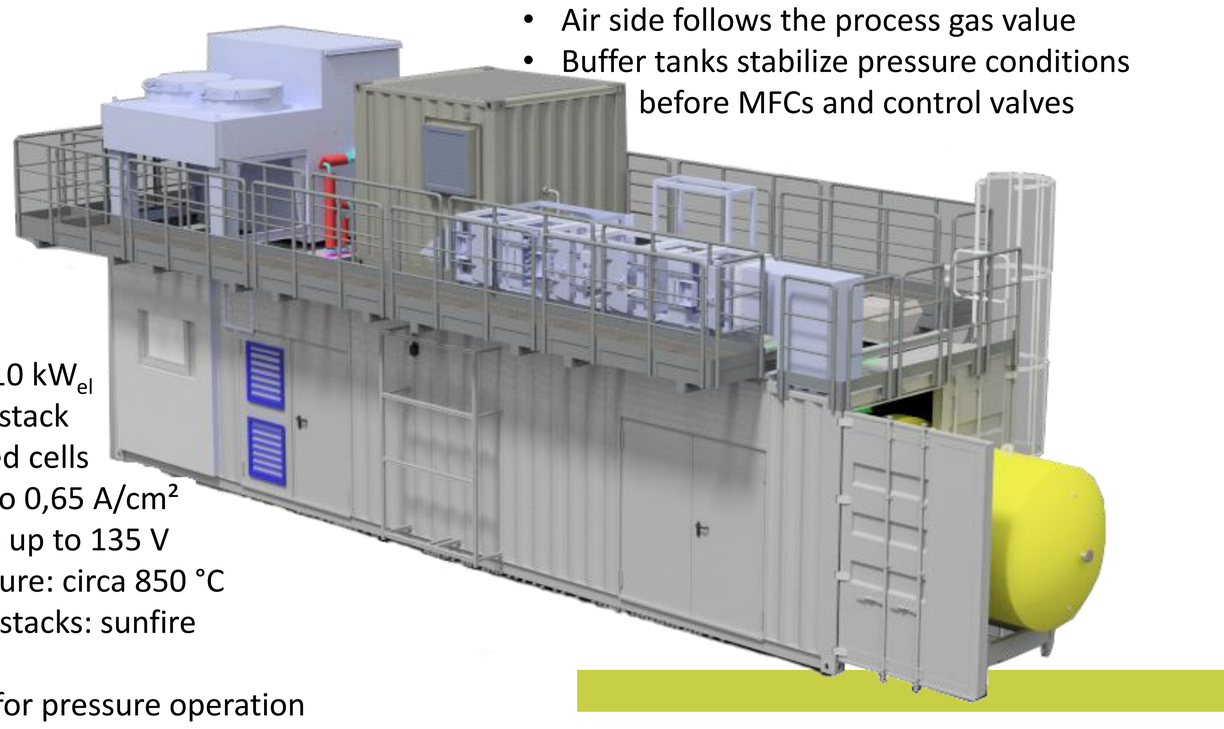


Process design

- Gas dosing, air filtration and pressurisation happens at room temperature
- Water treatment purifies tap water for evaporator and supplies the system with steam up to 300 °C
- Pressurised operation of SOEC makes pressure vessel necessary, because SOEC cannot withstand the pressure difference of 25 bar to the ambient
- Pressure controlling and water pumps leads to a operation pressure of 8 to 25 bar
- Components in the vessel do not need to be designed to bear 25 bar pressure, which lowers production costs
- Every component designed for more than 800 °C is in the pressure vessel and insulated within a thermal insulation unit to minimize heat losses
- With the gases and air heat up and cooldown within the pressure vessel the maximum feed through temperature is around 300 °C
- The exhaust air gets expanded to 0 bar and the product gases to 0 bar or from 8 to 15 bar for the Fischer-Tropsch supply at 300 °C
- N2 flow through vessel gets check for hydrogen and carbon monoxide to detect leakages of the SOEC

Pressure control

- Vessel pressure is the reference
- Process gas side follows its lead
- Air side follows the process gas value
- Buffer tanks stabilize pressure conditions before MFCs and control valves



SOEC module

Specifications:

- Electrolysis power: 10 kW_{el}
- 90 cells with 30 per stack
- Electrolyte supported cells
- Current density up to 0,65 A/cm²
- SOC module voltage up to 135 V
- Operation temperature: circa 850 °C
- Manufacture of the stacks: sunfire

Modifications:

- Optimized air flow for pressure operation
  - Each cell gets the same amount of air (+- 2 %)
- Gas tight cover around stack tower prepared for pressure differences up to 100 mbar
  - For high pressure gradients due to operation failures or safety maneuver

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