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Testing of a Pilot-Plant for the Characterization and Validation of Novel Alkaline Water Electrolysis Stacks

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State-of-the-Art Electrolyzers

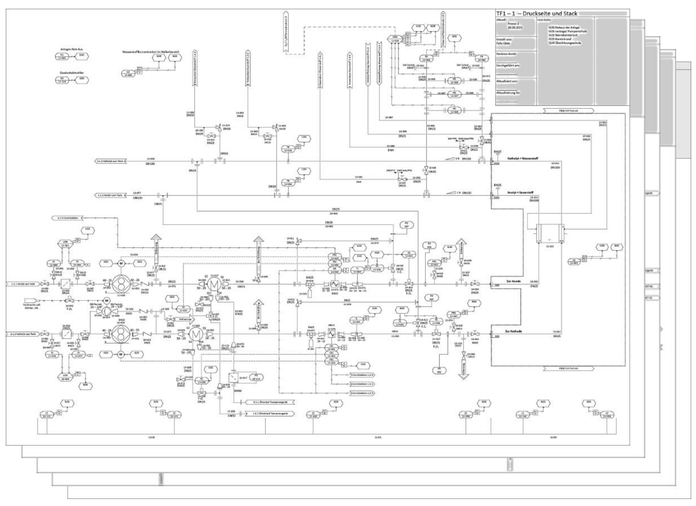
- Producing hydrogen from water using electricity is an old technology that is experiencing a revival today. [1]
- Hydrogen is mostly produced from methane, which is not in line with the idea of a circular economy.
- Water electrolysis is an alternative that enables renewable energy to be stored over long periods of time and also reduces carbon emissions from the chemical industry.

➡ But the technology is not fully developed in terms of cost and resource efficiency.

Engineering and Operation

Pilot-plant for testing short-stacks:

- Built-up in one year
- First operation in June 2022
- Operated in fully automated test protocols for characterization and operating strategy development.
- Characterization of cells with industrial-scale electrode size



Main focus on operation and research:

- Investigation of dependencies on load changes, e.g. dynamic behavior
- Lifetime and reliability of components and characterization of efficiency
- Optimization of process control routines. e.g. balancing strategies

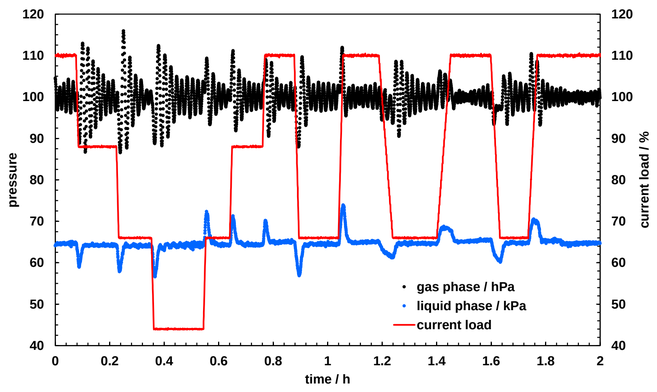


Fig. 1: Measured pressures in gas phase and liquid phase during short-stack operation. Current loads are changed and pressures destabilize; plant is correcting pressure.

Balancing Strategy

By continous operation:

- Migration and electrosmotic mass flow from anode to cathode which increase catholyte level in tanks and concentration during electrolysis.
- Balancing possible by mixing anolyte and catholyte with the disadvantage of fluctuating gas purity quality and high efforts in operation requirements. [2]
- New approach of adjustments in the stack and in the operational conditions to mitigate these effects.

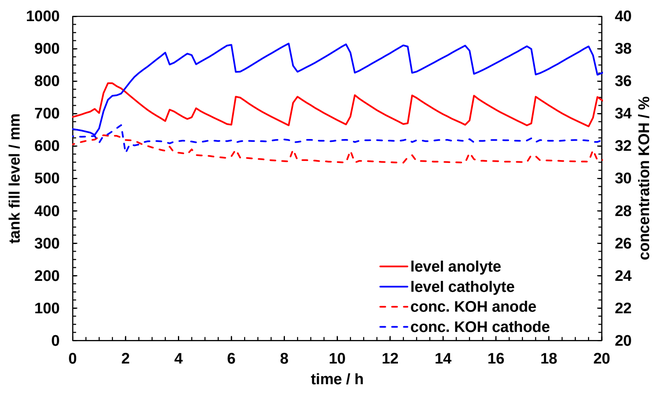


Fig. 2: Tank fill levels and electrolyte concentrations over time. Changes from migration of both are noticeable as well as the drastic effects of balance activities by mixing electrolytes.

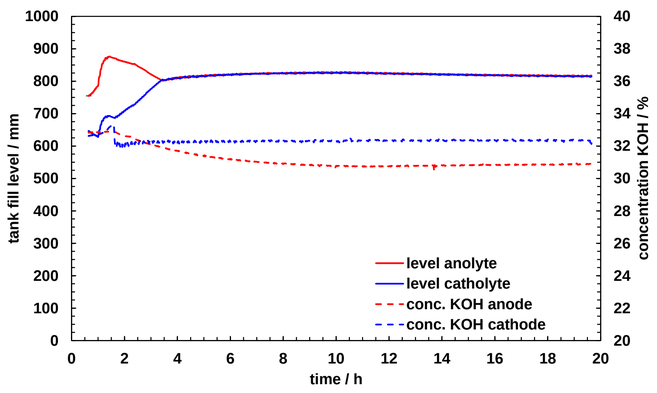
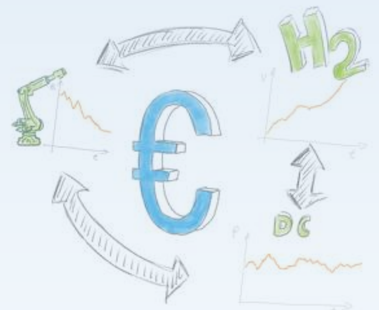


Fig. 3: Achieved implementation of new adjustment in the stack. The fill levels and concentrations remain constant after an initial equilibration time.

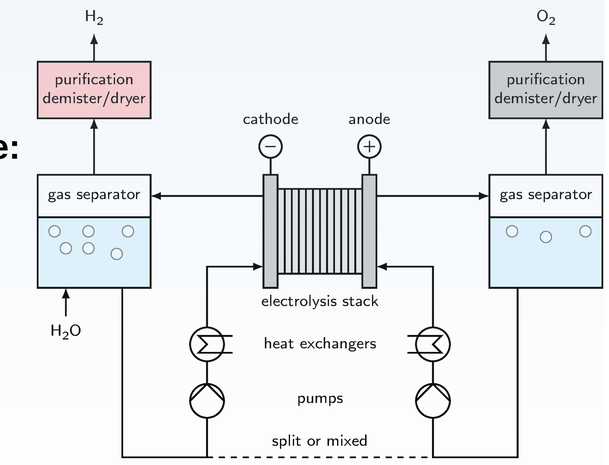
Stack Revolution "StaR"

- BMBF funded project, part of **H_2Giga**, to establish hydrogen technology industry in Germany.
- "StaR" is meant to rethink design of water electrolyzers in all parts of cost-drivers:
  - ❖ cost-efficient materials
  - ❖ automated production
  - ❖ high process stability



Plant Specification

- **Pressure:** < 500 mbar
- **Temperature:** < 90 °C
- **Current:** < 4000 A
- **Production:** < 3 kg H_2 h^{-1}



Next Steps

- Operation of new generations of short-stacks developed and build by **WEW**
  - Long-term tests for characterization
  - Further optimization of automation control system and rebalancing strategies
- Focus on dynamic operation to simulate fluctuations in renewable energies

References

[1] Bockelmann, M. et al. Erzeugung von Wasserstoff durch Elektrolyse. *Chem. Unserer Zeit* **2023**. DOI: 10.1002/ciuz.202300024

[2] Brauns, J.; Turek, T. Alkaline Water Electrolysis Powered by Renewable Energy: A Review. *Processes* **2020**, *8*, 248. DOI: 10.3390/pr8020248

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