

Pressurised high temperature co-electrolysis as effective source for Power-to-X applications

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Solid oxide cells (SOC) are commonly used in high temperature electrolyzers for hydrogen production. The advantage in electrical efficiency compared to water electrolysis can be achieved in case excess steam or surplus heat for water evaporation is available. In addition to this point, another advantage is that also carbon containing fluids like CO₂ can be used as feed gas in the SOC electrolyzers. This option is used so far mainly in the reverse operation, the fuel cell mode (SOFC) where CO can be used as fuel gas besides hydrogen.

The process of producing hydrogen and CO in one process is called co-electrolysis. This can be useful in a range of applications, where a synthesis gas (syngas) is required. As example for such processes, Power-to-Gas and Power-to-Liquids (both referred to as PtX) can be mentioned. A specific application for PtG is methanation. In times of discussing possibilities for energy storage, producing methane with renewable energy and simply feed it into the existing natural gas grid is an option that becomes into the focus more and more. The reason seems obvious, as the storage capacity itself is already existing and does not require further investments. For that purpose, the coupling of a high temperature electrolysis with a methanation reactor is investigated in the ongoing European funding project “HELMETH” (www.helmeth.eu) by the FCH JU (Fuel Cells and Hydrogen Joint Undertaking).

As for PtX processes usually high pressures are required, the overall process efficiency can be further increased if steps of compression and expansion of the involved gases can be reduced or avoided. Therefore, it is of high interest to run the high temperature co-electrolysis at high pressures as well.

This publication contains results from sunfire for high temperature co-electrolysis for different operation point, showing that the outlet gas composition of the syngas can be well tuned by changing the inlet gas parameters. In addition, the influence of reverse water gas shift reaction (RWGS) on the results will be shown.

Furthermore, preliminary results of a pressurised electrolysis up to 10 bar will be presented. Up to now, the focus was mainly on the control of the total pressure and on the differential pressure between the anode and cathode gas volume. In ongoing experiments, transient operation points (OCV, part load, full load, changing gas conversion and composition) are becoming more important.

Finally, the thermal integration of the pressurised high temperature electrolysis with a methanation unit to demonstrate high efficiencies will be discussed.