Hydrogen from Regenerative Energy Power Sources: pressurised alkaline electrolyser with high efficiency and wide operating range

The EU-Project „RESelyser“

R. Reissner¹, G. Schiller¹, E. Guelzow¹, Y. Alvarez Gallego², W. Doyen², A. Funke³, H. de Bie³, J.R. Bowen ⁴

The RESelyser Project is supported by the European Union's Seventh Framework Programme (FP7/2007-2013) for the Fuel Cells and Hydrogen Joint Technology Initiative under grant agreement n° [278732]
Alkaline water electrolysis – advantages and problems

- Well established technique up to large scale systems
- Cheap materials
- Gas purity problems at low load and high pressure
- Electrode stability when electrolyser off
- System adaptation to use with RES
New approaches to solve the problems

- double layer diaphragm with internal KOH supply ("E-bypass membrane") and adapted cell concept
New approaches to solve the problems

- double layer diaphragm with internal KOH supply ("E-bypass membrane") and adapted cell concept
New approaches to solve the problems

- Coated nickel electrodes for low overpotentials and long-term stability with RES load profile. Coating by plasma spraying.
New approaches to solve the problems

- System design adapted to RES power profile

Example solar and wind power profile on a cloudy May day in Southern Germany

Data source: DLR Stetter, Brinner
First results

**Diaphragm:** double side coated PP spacer-fabric.

First version:

- total thickness ca. 2.4 mm.
- Zirfon® (ZrO2/polymer composite) dual layer, individual layer thickness ca. 0.5 mm.
- interposed free electrolyte channel, 1.4 mm.
**First results**

**Cathodes** coated with NiAlMo (Raney-Nickel with Mo) for reduced overpotentials and increased stability

![Graph showing overpotential vs. current density for Nickel-punched hole sheet and NiAlMo alloy coated cathodes.](image-url)
Cathodes coated with NiAlMo (Raney-Nickel with Mo) for reduced overpotentials and increased stability

First results

XPS-spectra
a) newly coated
b) activated
c) after long operation
First results

Cathodes coated with NiAlMo (Raney-Nickel with Mo) for reduced overpotentials and increased stability.

Pore size analysis of VPS-coated and activated NiAlMo electrode.

3D SEM measurements planned to see evolution of the pore size distribution.
First results

- **Anodes** coated with NiAl (Raney-Nickel) and various Perowkites and Spinell structure oxides.
- NiAl for electrical conductivity and high surface, oxides for increased oxygen production activity
- Preparation by plasma spraying, activation by leaching out the Al
Summary

- DLR, VITO, Hydrogenics and DTU join their know how and forces to overcome the problems of gas purity and variable load operation of high pressure, low cost liquid alkaline water electrolysers
- The project RESelyser will run until October 2014
- First steps towards improved diaphragms and electrodes could be demonstrated