Electrolyse à Haute Température – Une technologie à haut rendement pour la transition énergétique

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GENVIA

- Established 1 March 2021, based on 40 patents and 15 years of R&D
- Today more than 100 employees
- Maturing, industrialising and developing industry solutions with Solid Oxide Technology
Contextual Situation of Electrolysis

Hydrogen Production by Water / Steam Electrolysis

Function of temperature

- Liquid water: Low temperature electrolysis
  - Alkaline Electrolysis (AEL)
  - PEM Water electrolysis (PEMWE)
- Steam: High temperature electrolysis
  - High temperature steam electrolysis (SOEL)

Produce H2 with low carbon footprint if electricity is decarbonized or renewable
Interest of High Temperature Electrolysis

Why High temperature Steam Electrolysis (HTSE - SOEL)?

HIGH EFFICIENCY TECHNOLOGY

H₂O (g) → H₂ (g) + ½ O₂ (g)

ΔH Working in gas/liquid mode saves 15% in Energy

ΔG : Rising in T saves 15% additional electricity

30% gain for high temperature steam electrolysis

When coupled to a heat source (~ 150°C) to produce steam

SOEL operating range = 700-850°C

EFFICIENCIES

Source: Strategic Research and Innovation Agenda, Clean H₂ partnership, Feb 2022

30% gain in high temperature water vapor electrolysis
High temperature steam electrolysis - SOEL

The key components of the different technologies

Technology with no expensive noble catalysts

Modular technology

- **Electrolysis cell** composed of:
  - 2 electrodes (anode and cathode)
  - One electrolyte
  - Need of electricity (and heat)

- **Stacking** of several electrolysis cells to increase the power

- **Integration of stacks into a module** including 1st level Balance of Plant components Can/will include several stacks into a module

- **Integration of modules into an electrolysis system/plant** including all Balance of Plant components = electrolyser Can/will include several modules into the electrolysis system/plant

Metallic interconnect
Scientific and Technologic Developments

Cell optimization to reach the best combination of performance/durability

- New active materials compositions
- New cell architecture
- New Processes

A complex multi-layer architecture combining specific mixed oxides:
- Conductivity Ionic & Electronic
- Microstructure control Porous vs. Dense
- High Temperature 700-800°C
Scientific and Technologic Developments

Stack Development

**Performance:** Optimize pressure drops and electrical contact layers

**Stacking:** Increase number of SRU to increase power/stack

**Manufacturability and Integration in module:** Design devices to handle and transport the stack

**Sealing:** No leakages

**Lifetime & Performance:** Improve cell performance and durability

Cost

→ Co-Current Engineering and Model-Based Design
Scientific and Technologic Developments

System Development

Performance: Overall Efficiency

Lifetime: Same behaviour for all the modules/stack

Manufacturability: Automated process of assembly

Cost: Toward Giga factory in 2030
TWO STREAMS FOR OUR PRODUCT DEVELOPMENT

Building benchmark and experience with the SOEL200 EXP in 2023

Delivering performance with a new design, the H-Pod Design frozen in 2026
GENVIA FIRST STEPS

Genvia founded Q1 2021

Electrolyser workshop delivered Q3 2021

First Stack produced Q4 2021

Genvia Beziérs Team Q1 2022

Genvia with main CO2 emissions industries at Elysée Q4 2022

Genvia (and a Stack) represents France 2030 technologies at Elysée Q3 2023
GENVIA KEY ACHIEVEMENTS AND NEXT STEPS

Stack prototyping
→ 7000+ hours of test
→ Successful performance tests

Next step:
Improve stack longevity and reliability

System Engineering
→ Detail application engineering for prototype completed
→ Launch production of prototype

Next step:
Scale to designing applications for all demonstrator use cases

Stack manufacturing
→ Pilot line completed

Next step:
Increase throughput, improve quality and design automation for gigafactory
Example of SOEL applications
Industrial Coupling: Steel Industry

 Cooling Unit

 Annealing Furnace

 HRU: Heat recovery unit

 HPU: H2 Processing Unit
Industrial Coupling: CCUS (SOEC vs. Co-SOEC)

Theoretical covers 105% of the heat needed for steam production.
Industrial Coupling: Haber-Bosch

**Chemical Reaction:****

\[
N_2 + 3H_2 \rightarrow 2NH_3 \quad \Delta H = -107,800 \text{kJ/mol}
\]

Theoretical: covers 187% of the heat needed for steam production.
Nuclear Coupling

Present nuclear Reactors:
• Electrical coupling + thermal network

New EPR nuclear Reactors:
• Low temperature coupling (<150°C)

Small Modular Reactors
• Low, Medium to high temperature coupling (from 150°C, to 550°C and 800°C)