LJUBLJANA, 31.01.2023 2 $\rm H_{_2}$ + $\rm O_{_2}~\rightarrow~2~H_{_2}O$ (fl.) + 572 kJ S. KANIYAMPARAMBIL, J. CLABEN, S. STERLEPPER CHAIR OF THERMODYNAMICS OF MOBILE ENERGY H_2 + 436 kJ / mol \Rightarrow 2 H· **CONVERSION SYSTEMS & CENTER FOR SUSTAINABLE** HYDROGEN SYSTEMS $H \cdot + O_2 \rightarrow HO \cdot + O$ PREPARED FOR **SLOVENIAN – GERMAN** $O + H_2 \rightarrow HO + H \cdot$ **HYDROGEN DAY** $OH \cdot + H_{2} \rightarrow H_{2}O + H \cdot$ $3 H_{p} + O_{p} \rightarrow 2 H_{p}O + 2 H \cdot + 48 \text{ kJ}$ Slovenian – German **Hydrogen Day** 31 January 2023 Gospodarska zbornica Slovenije Elektrolyseur peiche zbornica **CLUSTERS4FUTURE – HYDROGEN**





INSIGHTS

With the concentrated power of over 50 Professorships the Center for Sustainable Hydrogen systems strives to build a sustainable future





With the concentrated power of over 50 Professorships the Center for Sustainable Hydrogen systems strives to build a sustainable future





 H_2

The cluster approach: meeting challenges through thematic (horizontal) and H_2 technological (vertical) networking

TECHNOLOGY READINESS LEVEL (TRL)



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H_2

The cluster approach: meeting challenges through thematic (horizontal) and technological (vertical) networking

TECHNOLOGY READINESS LEVEL (TRL)



The Clusters4Future - Hydrogen addresses the entire hydrogen economy and connects research, industry and society





Coordinator RNTHAACHEN UNIVERSITY



Funded by

Bundesministerium für Bildung und Forschung

Conception phase





Our approach: Objectives and efficacy of the projects are based on technological, economical and social networking



 H_2

Our approach: Objectives and efficacy of the projects are based on technological, economical and social networking



Advantages / Disadvantages of reversible Solid-Oxide Cells (rSOC) determine their field of application Disadvantages Advantages \sim **High Efficiency High operation Temperatures Reversible Operation** Start-up / Shut-down times **Fuel Flexibility Dynamic Operability**



Advantages / Disadvantages of reversible Solid-Oxide Cells (rSOC) determine their field of application





efficiencies, up to 60%

can be a challenge for materials and components.









Advantages / Disadvantages of reversible Solid-Oxide Cells (rSOC) determine their field of application



Advantages (

080 2011

High Efficiency

SOFCs have the potential to achieve high conversion efficiencies, up to 60%



Reversible Operation

Solid Oxide Cells can be operated in Fuel-Cell mode (SOFC) or Electrolysis mode (SOEC)

Fuel Flexibility

Disadvantages

High operation Temperatures

SOFCs operate at high temperatures (800-1000 °C), which can be a challenge for materials and components.



Start-up / Shut-down times

Start-up and Shut-down times of SOFCs are considerable longer to avoid to thermal gradients







Advantages / Disadvantages of reversible Solid-Oxide Cells (rSOC) determine their field of application



Disadvantages





High Efficiency

SOFCs have the potential to achieve high conversion efficiencies, up to 60%

Advantages



Reversible Operation

Solid Oxide Cells can be operated in Fuel-Cell mode (SOFC) or Electrolysis mode (SOEC)



Fuel Flexibility

SOFCs can operate on a variety of fuels, including natural gas (L/CNG), hydrogen (H_2) and Ammonia (NH_3).

High operation Temperatures

SOFCs operate at high temperatures (800-1000 °C), which can be a challenge for materials and components.



Start-up / Shut-down times

Start-up and Shut-down times of SOFCs are considerable longer to avoid to thermal gradients

Dynamic Operability

SOFCs can respond to load changes much slower than comparable systems such as PEM Fuel–Cells



Utilization of rSOC only sensible for stationary or quasi-stationary applications such as Building Energy supply & Aviation / Maritime applications





Cluster4Future P6: Solid Oxide Fuel Cell (SOFC) for flexible Fuel use to meet Building Energy requirements

HT FUEL CELLS WITH FLEXIBLE FUEL UTILIZATION FOR SELF-SUFFICIENT ENERGY SUPPLY



Source.: Sunfire Fuel Cells GmbH, ICE: Internal Combustion Engine, Flaticon





Center for Sustainable

Hydrogen

What's the role of rSOC in decarbonized shipping? The answer to this question is sought to be researched in 4 levels



Source: IMO, Flaticon

14 | Slovenian-German Hydrogen Day, 31.01.23

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KEY MESSAGE



- RWTH Aachen University and the Center for Sustainable Hydrogen Systems have established themselves as a focal point for hydrogen research in Germany
- The Clusters4Future Hydrogen dives deep into fundamental questions regarding a sustainable hydrogen economy and connects research, industry and society

Building a sustainable Hydrogen Economy requires strong interdisciplinary & international collaborations, we have started to pave the road – will you join us?



Any Questions?





"The best way to predict the future is to create it"

-Alan Kay



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