NEMESIS

New Method for Superior Integrated Hydrogen Generation System

(contract # 019827)

Antje Wörner
DLR – German Aerospace Center
Project Achievements

Project and Partnership Description

Definition phase – system specifications

System Modeling / Thermal Management

FPM
- Pre-reformer
- Desulphurization

HGM
- Reformer
- WGS
- Off-gas burner

HCM
- Membrane Separation
- PSA
- Metal Hydrides

Proof-of-principle fuel processor prototype

Economic evaluation and scale-up strategy
Project Achievements

Project Starting Point and Goal

Fuel Processor Technology for NG

Hyger

Fuel Processor Technology for NG

Diesel

NG

H₂
10kg/day

NG

HGM

HCM

FPM
Project Achievements

Approach for R&D

System Modeling / Thermal Management

FPM
- Pre-reformer
- Desulphurization

HGM
- Reformer
- WGS
- Off-gas burner

HCM
- Membrane Separation
- PSA
- Metal Hydrides

- prereformer catalyst testing
- test setup for adsorbents for desulphurization
- CFD simulation of burner and reformer
- reformer testing
- investigation of metal hydrides
- membrane development
- testing of advanced PSA

system specification

system simulation

NEMESIS
Project Achievements

Progress towards overall project goal

Project targets and goals

Functional requirements
- Process concepts

System simulation
- Decision for lead concept

Layout of prototype unit

Manufacturing of prototype unit
- Testing

L- and G-Desulphurisation
- Prereforming
- CFD-Simulation
- Reformer Testing
- Single Bed PSA
- Membrane Separation
- Metal Hydrides

NEMESIS

System simulation
- Decision for lead concept

Operating Conditions
- Adsorbents
- Catalysts
- Membranes
- Material & Design

05/06 11/06 08/07 06/08 11/08
Project Achievements

Technical Achievements

- fuel processor based on steam reforming
  - improvement in efficiency

- liquid and gaseous fuel
  - multi-fuel aspect
  - desulphurization

- based on existing technology upgraded by innovative materials and components
  - marketability
Alignment to IP
Correlation with IDAs

IDA 1: Hydrogen and Refueling Stations

- develop and install distribution chains for hydrogen vehicles
- Phase I 2010: demonstration at 13 sites with 9 refueling stations → onsite H₂ production
- R&D: refuelling technologies
  - reduce cost of technology
  - improve system reliability
  - regulation and safety issues
- strengthen SMEs → smaller production values and early markets
Alignment to IP

Project activities vs. IP document targets

- Phase I 2010: demonstration with 9 refueling stations
  - 2008: proof-of-principle prototype 10kg H₂/day
    → upscaling by a factor of 10 to 50 for fueling 20 to 100 vehicles/day
  - 2020: cost of hydrogen at pump <2.5€/kg (centralized and decentralized, excl. taxes)
    cost target can be reached with NEMESIS technology
- strengthening of the position of SMEs
- HyGear as manufacturer of small fuel processors
Results from FURIM have been considered as input for NEMESIS

Co-operation contract of Air Products with HyGear on the sales and marketing of steam reforming technology into various application areas including refueling stations
Project future perspectives

**Proposed future research approach**

- end of the project: proof-of-principle prototype unit with 10kg H$_2$/day, concept for upscaling and integration into the existing infrastructure

- starting point for next steps towards demonstration and commercial product

**NEMESIS II project**

- optimization of innovative materials
- testing of critical operating conditions
- expansion of fuel range (e.g. DME, biodiesel)
- system integration of fuel processor
- integration into refueling station
- upscaling to 100 to 500kg H$_2$/day
cooperation on EU level

WP7 Economic Evaluation
- input from CUTE and HYWAYS (experiences and cost figures from technical side)
- input from HyApproval (codes and standards)

contribution to future JTI Work Programme

demonstration of the technology developed within NEMESIS at refueling stations
Thank you for your attention!

Antje Wörner
DLR – German Aerospace Center