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Improved electrolysis for distributed hydrogen production

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High Performance PEM Electrolyser for Cost-effective Grid Balancing Applications

HPEM2GAS - Deliverable report

D6.2 Building, safety and compliance testing and factory acceptance test of the electrolyser unit

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Summary

The final objective of the HPEM2GAS project is to demonstrate an innovative PEM electrolyser at the Emden Council in Germany to assess the stack's and system's robustness to cope with dynamic situations under real-life conditions and to validate achievement of TRL6 for the developed system in a field test campaign.
The generated hydrogen is fed into the gas feed station via an underground pipeline. The hydrogen has to pass through a regulator section in which the pressure is reduced from 20 bar to 9 bar. A reduction of the pressure is necessary because SWE's gas network is operated at 8.5 bar. The hydrogen then enters a mixer to mix the feeding volume with the natural gas.

The unit has completed the build phase and has undergone FAT testing as detailed in this report. Following on from the successful completion of this acceptance testing the unit has been transported to Germany where it has been integrated into the whole system (plant), commissioned and tested and is undergoing TUV approval prior handover to SWE for the commencement of the field trial.

Contents

1 Introduction

After the completion of a system build there are several stages a unit must go through to ensure it has been built correctly, is leak tight and will respond in the correct way when in operation.

This work is split into various sections as shown in the table below. This report concentrates on the work carried out in the first 2 steps

FAT 1	Inspection of build, cleaning and testing of all systems PRIOR to hydrogen generation.
FAT 2	Hydrogen generation and testing of automated running of system
DECOMISSION	Disconnecting system from services (water, power etc.) securing of internal components for transportation.
TRANSPORTATION	
SAT 1	Rebuild system and connect to services and any other onsite equipment (e.g. storage), leak test to ensure no damage was done in transportation
SAT 2	Automated running of system, customer training and system handover

2 FAT 1

2.1 Basic

- Confirm system matches PID
- Complete Equipment, Instrument and Valve lists noting serial numbers and checking valve orientations.

2.2 Electrical

- Confirm system is wired to a suitable power source
- Confirm all internal breakers are the correct size and are in the correct position for initial powering of the system
- Power up system and confirm PLC boots up correctly
- Confirm all E-Stops work correctly (shut down the plant)
- Confirm DI water system powers up correctly

2.3 Valve, Instrument and Equipment

- Ensure that all valves can be operated from the HMI
- Ensure all sensors show values on the HMI and complete the calibration sheets
- Ensure all equipment can be operated from the HMI – NOTE DO NOT OPERATE THE PUMP DRY
- Ensure correct phase rotation for all pumps and fans

2.4 Water Setup

- Confirm system is connected to the mains water and the connection is leak free
- Confirm DI unit is operational and is generating water
- Confirm DI water quality is suitable
- Fill O_2 separator to high level and inspect the system for leaks.
- Confirm main process pump is operational (checking phase rotation) and the correct flow value is displayed on the HMI (FT001)

2.5 Piston Pressure

- Check pneumatic system for leaks
- Perform leak test on system manifold
- Set pressure of PVC201 –record value on equipment list

2.6 Hydraulic System

- Fill hydraulic system and bleed air from J001
- Leak check hydraulic system at
    - Low pressure (60 bar)
    - High pressure (650 bar)
- Using hydraulic hand pump set PRV101 and PCV101

2.7 Pressure Test

- Ensure all hydrogen pressure system valves are operating correctly prior to any pressure testing
- Remove all PRVs and hydrostatically pressure test system to 1.43 x PRV set point.
- Fully dry hydrogen system (using nitrogen)
- Refit PRVs and carry out helium leak test at operating pressure

2.8 Control System Checks

- Confirm that alarms and warnings checklist is available and up to date
- Note control system revision and ensure it is correct
- Confirm shutdown procedures are executed correctly
- Complete alarms and warnings checklist

2.9 Electrolyser Stack Checks

- Complete differential pressure test on stack
- Complete common pressure test on stack
- Switch hydraulic system to automatic and confirm pressure
- Enable piston pressure and record gauge reading
- Circulate water through stack and note quality reading after 1 hour FAT 2

3 FAT 2

3.1 Basic

- Power up system and engage breakers for operation
- Confirm that the plant has completed a SD#1 – use HMI to confirm

3.2 Vent 1

- Confirm vent lines are connected and well supported
- Ensure output line is connected to vent

3.3 Control

- Confirm alarms and warning has been updated from FAT 1
- Confirm latest LFD is available as hard copy for annotation during testing
- Using automatic mode on the control system operate the plant to confirm the actions noted down in the logic flow are correct - make notes on logic flow diagram where actions differ from those shown
- Perform automatic operation and change HMI-settable values where necessary to perform any outstanding tests required in the Alarms and Warnings checklist
- Confirm with ECI that ALL code tests are complete

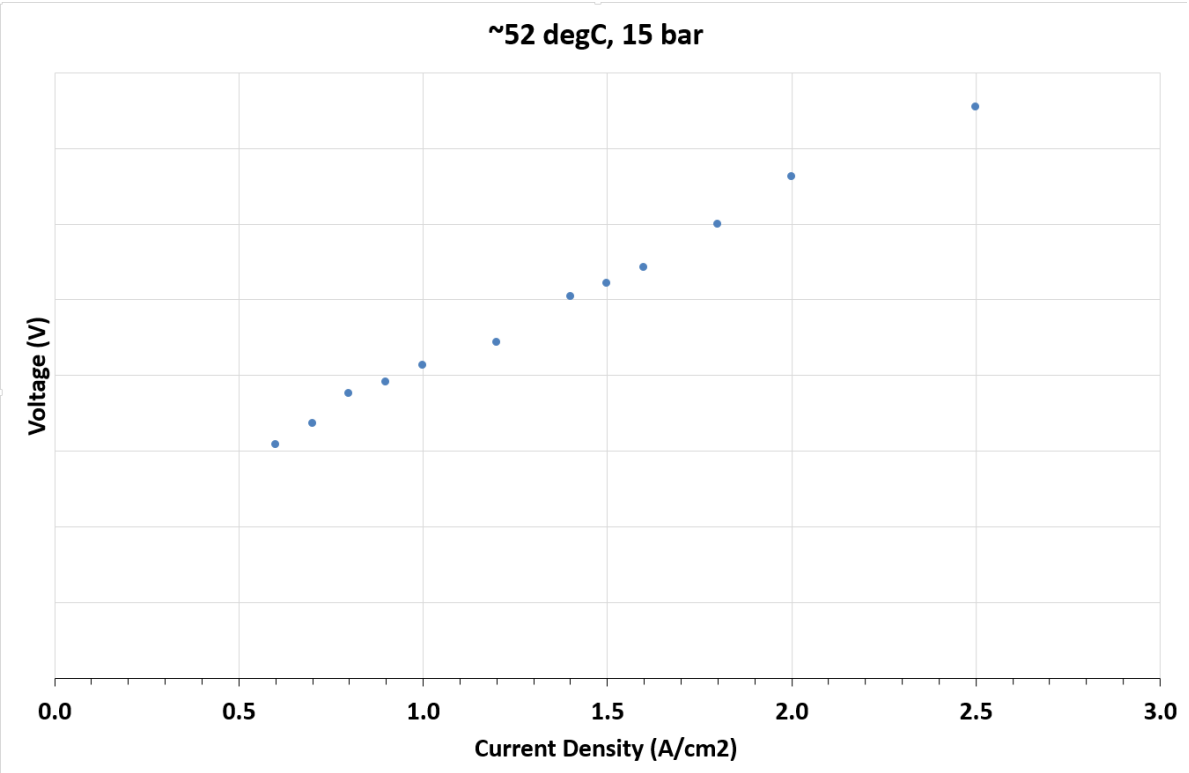
3.4 I-V

- Using manual operation mode setup the system to run at normal pressures
- Run the system at normal pressure until the process water temperatures are roughly stable at operating levels
- Starting at 100% capacity reduce the power into the stacks in 10% increments recording the current, and H_2 pressure of the system and the individual stack voltages, piston pressures, and hydraulic pressures
- Record the above data in an excel spreadsheet and report to Stack production manager for OK to proceed with testing

3.5 Operation

- Use automatic operation to run plant for >1 hour at full capacity noting operating temperatures and chiller activity - check for any system SDs
- Use automatic operation to run plant for > 6 hours at full capacity noting operating temperatures and chiller activity - check for any system SDs
- If system is capable of sub 100% operation then operate the plant in automatic mode and proceed to change the operating % and confirm that he changes create no shutdowns:
- 100% --> 10% (or lowest level when operating)
- Use automatic operation to run plant for 24 hours at normal working gas generation levels

4 FAT I-V curve



System I – V curve showing plant operation during FAT. Due to the public nature of this report the Voltage figures have been removed for confidentiality reasons.

5 CONCLUSIONS

A specific objective of the HPEM2GAS project is to demonstrate an advanced 180 kW (nominal) polymer electrolyte membrane (PEM) water electrolyser in power to gas process by injecting the produced hydrogen in the gas grid.

The PEM electrolyser unit has completed the build phase at ITM in Sheffield and has undergone a factory acceptance test testing. After the successful completion of the FAT, the unit has been transported to Emden where it has been integrated into the whole plant for power to gas assessment. The unit has been commissioned, tested and is undergoing TUV approval prior handover to SWE and the commencement of the field trial.