Why Fuel Cells?

Fuel cells have shown great promise for residential micro-Combined Heat and Power (mCHP) generation due to their high electrical efficiency and ability to run on conventional heating fuels, but high capital costs remain a key challenge to the advancement of this sector and mass market introduction in Europe.

About HEATSTACK

This 36-month project, funded through the FCH Joint Undertaking and Horizon 2020, focuses on reducing the cost of the 2 most expensive components within the fuel cell system – the fuel cell stack and heat exchanger – which together represent the majority of total system CAPEX. The project has partners in 5 EU countries.

Senior Flexonics UK, based in Crumlin (Wales), provide expertise in the design, development and manufacturing of heat exchange solutions for the energy generation market and for the diesel engine market. The manufacturing facility in Olomouc (Czech Republic) covers 3630m² and is equipped to for the production of Turbo Oil Drain and Turbo Oil Feed tubes for passenger car engine manufacturers, and volume production of Cathode Air Pre-heaters (CAPH) working at up to 950°C and a 1000°C peak.

The Centre for Hydrogen & Fuel Cell Research, part of the University of Birmingham's School of Chemical Engineering, is internationally recognised for its dynamism and expertise in Fuel Cell Technologies. It focuses on R&D, applications and demonstrations of Hydrogen and Fuel Cell systems; it has numerous publications and patents in Fuel Cell Technologies, as well as state of the art facilities.

ICI Caldaie is a leading company of the CHP sector thanks to the continuous R&D of highly reliable heating generators keeping up with the technological evolution, which has allowed the firm to transfer the know-how acquired in the planning and realization of industrial steam generators, a sector in which the firm occupies a leading position.

Vaillant is one of the market leaders and technological pace-setters within the heating, ventilation and air-conditioning industry. Their product portfolio encompasses highly-efficient CHP appliances based on gas engines for the use in single- or multi-family homes that represent today's most efficient gas technology.

Sunfire develops and produces high-temperature fuel cell (SOFC) and electrolyser (SOEC) systems, which address a multitude of problems in energy systems. Sunfire's SOC technology has been perfected to achieve the optimal balance between high reliability, low manufacturing costs, high electrical efficiencies and reversible operation.

The PNO Group is a pan-European innovation consultancy active across 12 European countries. Working across all principle industry sectors, PNO has developed extensive expertise in establishing, managing and contributing to complex international technology transfer consortia, communities, processes and projects.

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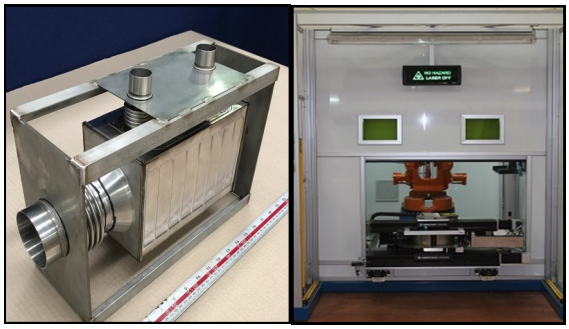
Year 1 Project achievements

- Senior Flexonics has a production-ready CAPH using AluChrom that gives robustness, cost effectiveness and industry leading low levels of Chromium leakage.
- Significant investment has been made in equipment and tooling to achieve process efficiency.
- Simulation has allowed the development of a design that can be used in different applications, which functions at different temperatures, pressures and flow rates, within the boundary condition range of ICI Caldaie's specifications.



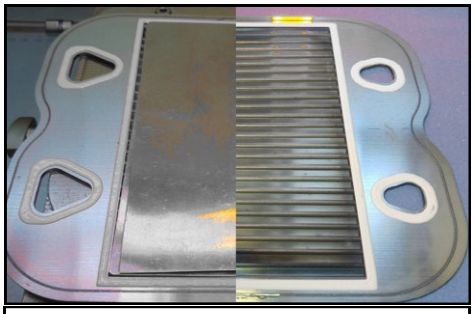


Image: thin layer (left wet, right dry)

- Printing of glasses was chosen by Sunfire out of 6 alternatives as the method with the best value for industrial stack production.
- Devices needed for printing have been designed and built.
- 2 printing slurries have been developed during the project.
- The first printing tests showed good results for thin layers.

- A denuder technique was employed by the University of Birmingham to quantitatively analyse the chromium vaporisation from Inconel 625 & AluChrom 318.
- The Cr evaporation rate for the AluChrom 318 is approximate one order of magnitude lower than that for the Inconel 625.
- The formation of a dense and continuous alumina scale on alloy surface could effectively reduce the high temperature Cr leakage in the long term.
- The low cost, low Cr evaporation, and excellent high temperature corrosion resistance offered by AluChrom 318 make it highly suitable for CAPH application.

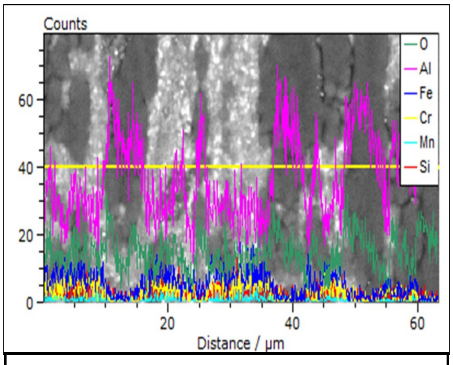


Figure: EDX line scan from steel through the oxide scale of AluChrom 318 after 1000 hours exposure at 850 °C in air containing 3% H_2O (6.0 L/min).

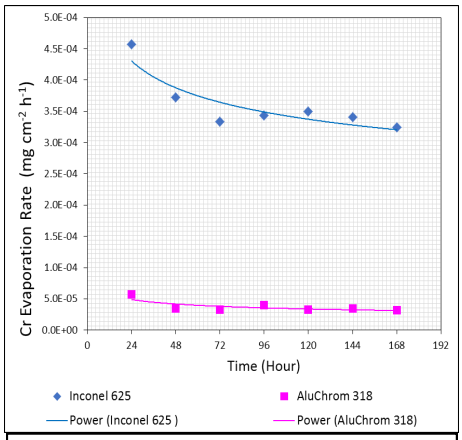


Figure: Rate of Cr evaporation as a function of time for Inconel 625 and AluChrom 318 at 850 °C in air containing 3% H_2O (6.0 L/min).

- The results for operating hours from Vaillant's field testing are positive for HEATSTACK.
- This field testing (from 2013 to April 2017) totals over 3.4 million operating hours.
- The maximum single CAPH operating time with Inconel so far is 28,600 hours.
- The maximum single CAPH operating time with Aluchrome so far is 19,700 hours.