Fluid Management component improvement for Back up fuel cell systems

FLUMABACK

(GA 301782)

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FLUMABACK OVERVIEW

- **Call topic**: SP1-JTI-FCH.2011.3.3: Component Improvement for stationary power applications
- **Application Area**: Stationary
- **Start and end date**: 1 July 2012 - 30 June 2015 - project completed
- **Budget**: 3.999.005 €, **FCH JU contribution**: 2.482.969 €
- **Consortium:** 10 partners from Italy, Slovenia, Spain, The Netherlands
- New design and improvement of selected balance of plant (BoP) components: air and hydrogen blowers, humidifier and heat exchanger for back-up systems with 10,000 hours (10 year) lifetime without maintenance

electro power systems

DOMEL We create motion

Nedstack PEM FUEL CELLS To be sure.

ENVIRONMENT PARK

FOUNDATION FOR THE DEVELOPMENT OF NEW HYDROGEN TECHNOLOGIES IN ARAGON

Institut "Jožef Stefan", Ljubljana, Slovenija

TUBIFLEX Flexibility!

ONDA Advanced Heat Transfer Solutions

FLUMABACK TARGETS AND ACHIEVEMENTS

Programme objective/target	Project objective/target	Project achievements to-date/ Final achievements
MAIP		
2015 target: Cost backup system €/kW - 1,500 €/kW	214 €/kW total cost of BoP components to be developed	The target total cost/kW of the BOP components developed has been achieved for the 6 kW fuel cell system (150 €/kW) for production of 100 pieces; for the 3 kW fuel cell system (180 €/kW) for production of 800 pieces.
2015 target: Durability / Reliability backup system- 10,000 h	Lifetime of BoP components: 10,000 hours	Ageing tests on air blower successful. No ageing tests on the hydrogen blower because of development issues. Wet and dry cycles on the material have been performed and no degradation has been observed.

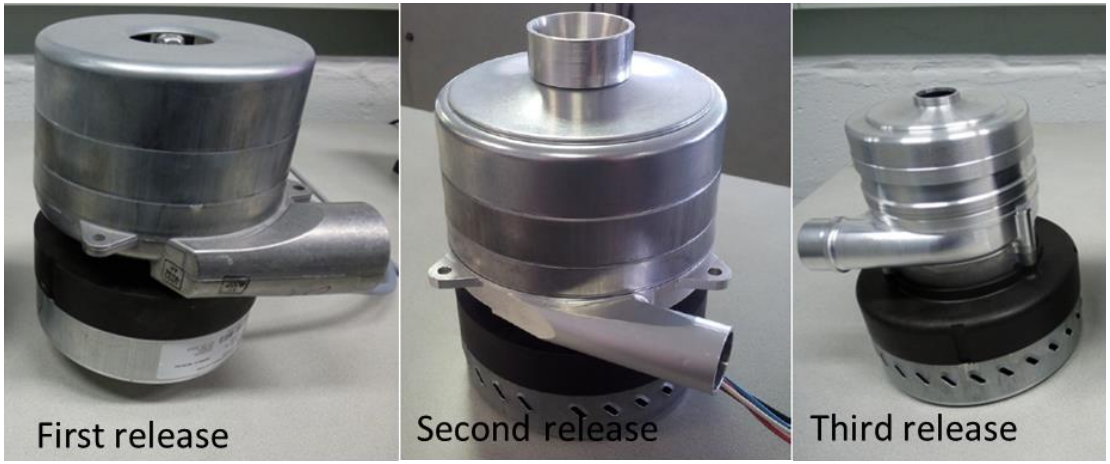
FLUMABACK TARGETS AND ACHIEVEMENTS

Programme objective/target	Project objective/target	Project achievements to-date/ Final achievements
	AIP	
Components lifetime and maintenance cycle consistent with system lifetime up to 10 years for small scale applications	Lifetime of BoP components: 10,000 hours, consistent no maintenance in 10 year lifetime of back-up system	Ageing tests on air blower successful. No ageing tests on the hydrogen blower because of development issues. Wet and dry cycles on the material have been performed and no degradation has been observed.
BOP Electrical efficiency > 90% for system < 10 kWe	BOP Power consumption relative to 6 kW fuel cell system output power: 8.3%	Power consumption of last iteration of developed BOP component is 8.6% of the net 6 kW system output .

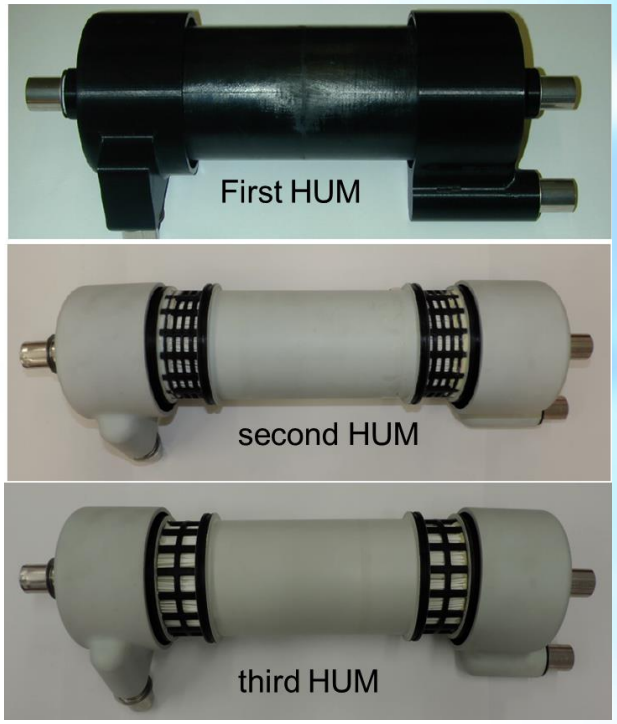
FLUMABACK TARGETS AND ACHIEVEMENTS

- **Three successive releases of air blower, hydrogen blower and humidifier and one heat exchanger has been developed and delivered**
  - The air blower developed in the project shows significant improvements respect to SoA in terms of cost (50€/kW for 100 pieces), efficiency (29%), lifetime (10,000 hours). It is ready to be used in commercial fuel cell system products.
  - The hydrogen recirculation blower is a completely novel design. It has proper flow capacity and presents lower consumption than SoA, but further development is necessary to improve lifetime.
  - The humidifier developed in the project has been proved to be very promising in terms of material alternative to Nafion, performance, design and manufacturing costs (<100€/kW). Further development activities are required in the manufacturing process to improve lifetime.
  - The H2/air heat exchanger development has been interrupted as no benefits were observed, while several disadvantages exist (increase in costs and system space and reduction of efficiency).

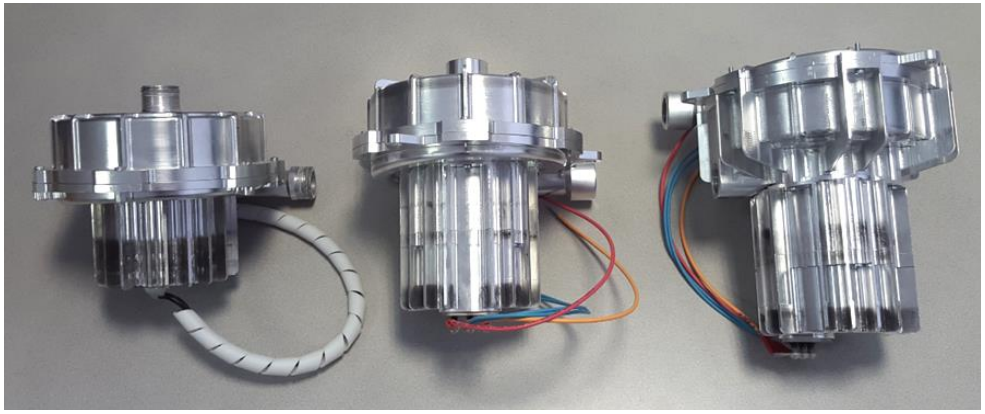
FLUMABACK TARGETS AND ACHIEVEMENTS



Air blower



Humidifier



Hydrogen recirculation blower

Heat exchanger

FLUMABACK TARGETS AND ACHIEVEMENTS

- A computer model has been developed in Simulink/Matlab environment for fuel cell stack, air blower, humidifier, H2 blower. The validation process resulted in a good matching between the experimental values and those obtained in the simulation. A dynamic approach has been followed to perform an efficiency assessment in a complete set of scenarios.
- Specific activities related to market preparation and environmental sustainability assessment have been performed:
  - RCS report analysis with the full range of regulations, codes and standards that apply stationary fuel cell systems;
  - LCA report analysis: material composition, production processes, supply of fuel including evaluation of tie-up time of material resources and system overall energetic efficiency for each component of fuel cell system;
  - End-of-Life (EoL) assessment for main components of Flumaback fuel cell system, taking into account reverse logistics process and legislation;
  - A market analysis for each BOP components and fuel cell systems including potential business cases for Flumaback fuel cell systems in North Africa and North Europe in the telecommunication sector.

RISKS AND MITIGATION

- Hydrogen recirculation blower (instead of hydrogen recirculation pump) development issues:
  - Compatibility problems of bearing grease with humid hydrogen;
  - Third iteration development with relocation of electric motor to prevent damage of bearings due to the water;
  - 10,000 hours target not considered
- Humidifier development issues:
  - Increased pressure drop
  - Manufacturing process: problem with fixing tubes with resins;
  - Third iteration development with reduced number of tubes and improved manufacturing
  - 10,000 hours target not considered but degradation of selected material evaluated

SYNERGIES WITH OTHER PROJECTS AND INITIATIVES

- Flumaback has NOT been co-funded by any other agency or under a national programme.

- Interactions with FCH JU/EU projects:
  - FITUP: reference for test protocol of fuel cell systems
  - FC-HyGUide: reference for LCA report

- Interactions with any international-level projects or initiatives:
  - Manunet 2010 – HyFCAir: basis for development of air blower

HORIZONTAL ACTIVITIES

- Training and education:
  - 4 April 2014, Lange Nacht der Forschung, Klagenfurt, Austria (http://www.langenachtderforschung.at/)
  - 15 November 2013: Development and economic challenges of hydrogen technologies breakthrough into practice, Chemical Institute, Ljubljana

- Project work in safety, regulations, codes, standards:
  - RCS report analysis with the full range of regulations, codes and standards that apply stationary fuel cell systems;

- General public awareness:
  - Electronic press releases have been sent to the media: Nov ‘13, Dec ‘13, Apr ‘14, Aug ‘14, Dec’14, Aug ‘15
  - Promotional material for all events and meetings: note pads, Pes, USB keys, Flyers etc.

DISSEMINATION ACTIVITIES

- Presentation of Flumaback project at several conferences (total of 8) in Italy, Slovenia, Belgium and Korea.
- Publications:
  - University of Ljubljana, Faculty of Mechanical Engineering: Year Book 2014
  - Applied Energy: **Environmental Impacts of Fuel Cell Backup Power Supply System Operation**, in preparation
  - Journal of Fluid Power, Automatization and Mechatronics: Slovenian knowledge in EU research project FluMaBack, June 2015
  - EU Research: Improving the operation of Balance of Plant components, december 2014
  - A. Debenjak, P. Boškoski, B. Musizza, J. Petrovčič and Đ. Juričić: Fast measurement of PEM fuel cell impedance based on PRBS perturbation signals and Continuous Wavelet Transform, Journal of Power Sources, 254 (2014) 112 – 118

EXPLOITATION PLAN/EXPECTED IMPACT

- Improved air blower (better than SoA in terms of performance, efficiency and cost) ready for use in commercial 3-6 kW fuel cell systems.
- Material alternative to Nafion identified and proven humidifier design ready for mass manufacturing at very competitive cost.
- Novel and proven design for hydrogen recirculation blower.
- 3-6 kW fuel cell systems more efficient and less expensive to be used in back-up applications worldwide.