MEDIA HANDOUT

The Fit-4-AMandA Project: Fit-4-Automatic Manufacturing and Assembly

New automatic production plant for fuel cell stacks at Proton Motor in Puchheim

Introduction:

Fuel cell technology is regarded as one of the most important basic technologies for the future emission-free transport and renewable energy infrastructure in Europe. Ideally, excess electricity from hydropower, wind power and solar power plants is converted via electrolysers into hydrogen, which is used as fuel in FC vehicles or stored for later use in times of energy shortages. PEM fuel cell systems use – stored – H_2 (hydrogen) and convert it into electrical energy and heat. Although the development of PEMFC components and stacks for transport applications has reached a mature level of operational performance, certain aspects such as manufacturability, production efficiency and production costs have great potential for improvement as they have not yet been the focus.

One of the biggest challenges for the breakthrough of fuel cells in the individual markets is the still very high costs compared to market-established technologies such as gasoline or diesel. This is due not least to the use of non-standardized components and also to the high proportion of manual work in the manufacture of polymer electrolyte membrane fuel cell stacks (PEMFC stacks), which makes them comparatively expensive.

Fit-4-AMandA focuses on several critical production steps in the PEMFC technology chain that are still inefficient in terms of cycle time, cost, yield and reliability. Fit-4-AMandA provides a solution to automate the stack production process to overcome inefficiencies. The knowledge gained in the project thus makes a major contribution to the economical production of fuel cell systems in larger quantities.

Scope of the project:

During the project, new manufacturing technologies will be developed especially for the PEMFC stack production processes that go beyond the state of the art. Established best practices of the automotive industry with regard to production and quality will be analysed and transferred to the production of PEMFC components and stacks. New QA strategies relevant to the transport sector (compatible with ISO/TS 16949) will be proposed and evaluated. The production readiness achieved at the end of the project is MRL7 (ability to produce systems, subsystems or components in a production representative environment).

This project will test the fuel cell system using the components produced by the automated manufacturing process under real operating conditions of a light commercial vehicle, but these products can also be used in other mobile applications such as heavy duty buses, trucks, forklifts, auxiliary engines, etc. as well as in maritime and stationary applications such as main power and uninterruptible power supply.

Facts and figures:

Complete Name: Future European Fuel Cell Technology: Fit for automated manufacturing and assembly

Acronym: Fit-4-AMandA

Start date: 1 March 2017

Project duration: 36 months

Total budget: € 2.9 million.

Project partners: Proton Motor, IRD, Aumann, UPS, Fraunhofer IWU, TUC/ALF, UPS, Uniresearch

Consortium:

The international project team consists of Proton Motor Fuel Cell GmbH as stack manufacturer, IRD Fuel Cells A/S as component manufacturer, Aumann Limbach-Oberfrohna GmbH as manufacturer of automated assembly systems, UPS Europe SA as potential user as well as the Fraunhofer Institute for Machine Tools and Forming Technology IWU and the Chemnitz University of Technology / Department of Advanced Powertrains (ALF). Uniresearch B.V. is responsible for project management.

Fig. 2: Economical production puts fuel cell technology on the road.

As an experienced PEMFC stack manufacturer, **Proton Motor Fuel Cell GmbH** is primarily responsible for optimizing the fuel cell stack design and its components. Due to the different framework conditions of automated production in contrast to conventional manual stacking, there is a certain need for optimization of the individual components, which could also be used to improve performance at the same time. A further project objective is to significantly reduce material costs by redesigning several stack components. During the new development, all essential components and concepts of the fuel cell stack such as the so-called bipolar plate, the electrochemically active membrane with catalyst layer, gas diffusion layer GDL and also the end plate / tensioning unit were put to the test.

IRD Fuel Cells A/S as supplier of the newly developing stack components is responsible for the redesign of the process and tool technology for the production of the key component bipolar plates BPP and the membrane electrode assembly MEA. The requirement criteria are the achievable performance, compliance with dimensional tolerances and process optimization, with the aim of direct integration into the automated assembly line.

Aumann Limbach-Oberfrohna GmbH was responsible for the development, design and construction of the automated production plant for PEMFC stacks. Based on the experience gained in recent years in the field of fuel cell stack assembly, a scalable and highly flexible system was developed. This includes the possibility of processing metallic or graphitic bipolar plates, seal-on MEAs or prefabricated multi-layer MEAs and also the design for different stack variants, stack dimensions and heights. This includes all process steps from the automated feeding of the components to the MEA assembly, the stacking of the components to the bracing and fixing of the stack by tie rods.

An essential aspect of the project is the integration of the fuel cells produced in this way into a real end application. As an application example, a PEMFC stack produced on the developed assembly line should be installed in a delivery vehicle of the logistics company UPS Europe SA. The project partner is pursuing the approach of retrofitting the diesel drive train of a conventional delivery vehicle with an electric drive with Li-ion battery and fuel cell system. The fuel cell enables a significantly increased range and flexibility of the vehicle with (at least) locally emission-free operation. Depending on the source of the hydrogen used and the charging current for the battery, completely emission-free operation is also possible. A feasibility study on the integration of the fuel cell system and other components into the UPS vehicle as well as the implementation of the newly developed stack with the associated system environment is an essential part of the project.

The scientific monitoring of this project is carried out by the research institutions **Fraunhofer Institute for Machine Tools and Forming Technology IWU** and the Department of Advanced Powertrains, **ALF of Chemnitz University of Technology**: The theoretical analysis and improvement of the current stack components and the evaluation of manufacturing processes, especially for metallic BPPs and the derivation of current case studies considering the advantages resulting from the serial production of PEMFC stacks was carried out by Fraunhofer IWU. The analysis, evaluation and above all the selection of the test and diagnostic methods for quality assurance in the automated production of components and stack assembly was carried out by the Chemnitz University of Technology team. This task, which is essential for the success of the machine and thus of the entire project, involves above all the identification and elimination of the limitations (both in terms of time and the resolution of the required quality level) of the selected test methods in the manufacturing process. The TUC is also responsible for the implementation of the developed in-line testing into the production line and subsequent verification to ensure a significant reduction in the number of faulty PEMFC stacks.

Finally, project control and coordination is carried out by the Dutch company **Uniresearch BV**. Its expertise in obtaining and supporting European funding projects was already of decisive importance during the preparation and application of the project and its professionalism ensures a smooth and concentrated course of the project.

Automated stack production plant at Proton Motor in Puchheim:

The plant for the automated production of fuel cell stacks, which was developed and set up during the course of the project, was delivered to the project partner Proton Motor Fuel Cell GmbH in Puchheim near Munich in June 2019.

Proton Motor Fuel Cell GmbH has the following advantages in stack production:

- Increase of the annual production capacity to 5,000 to 10,000 PEMFC stacks (depending on stack size).
- Reduction of stack assembly time by approx. 95 percent.
- Cost reduction for the assembly process of approx. 50 percent.

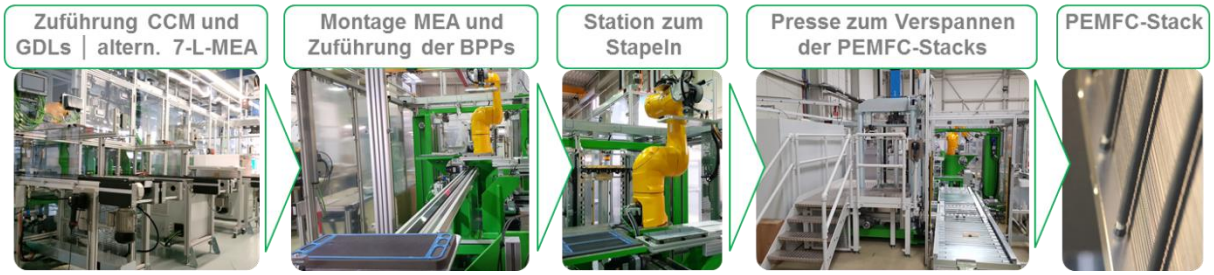

Fig. 2: Fuel cell stack assembly functional units.

For the targeted cost reduction of at least 50 percent, not only the actual production costs but also the number of units play an important role. It is only through this production machine that Proton Motor is able to produce the quantities relevant for mobile target markets in the first place. The sales generated in this way can bring economies of scale to bear, which play a significant role in reducing the costs of key components and thus of the stack.

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