PEM Stack Module for Range-Extender Bus application

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Full-Size Stack Modules

ElringKlinger, as the responsible partner for the stack, developed and provided full-size stack modules for laboratory experiments and for the integration into the fuel cell range-extender bus system. In particular, development of suitable mechanical, fluidic and electrical system interfaces are some of the main project achievements.
The required gross power of the fuel cell stacks calculated by system simulations on the basis of VDL bus drive cycles was set to 80 kW. The NM5 stack platform, which is used in this project and shown in figure 1, offers the possibility of realizing a highly efficient system due to the low pressure loss on the cathode side. Patented structures within the metallic bipolar plate ensure a very homogeneous gas distribution and therefore operational stability even in partial load at lower gas flow rates.
The high power density of the fuel cell stack is achieved by a newly developed cell configuration in combination with a bipolar plate design that allows a very compact sealing concept with optimal utilization of the surface area. Basis for the realization of such a design is ElringKlinger's internal know-how of high-precision manufacturing processes that have been transferred from existing ICE-powertrain components.

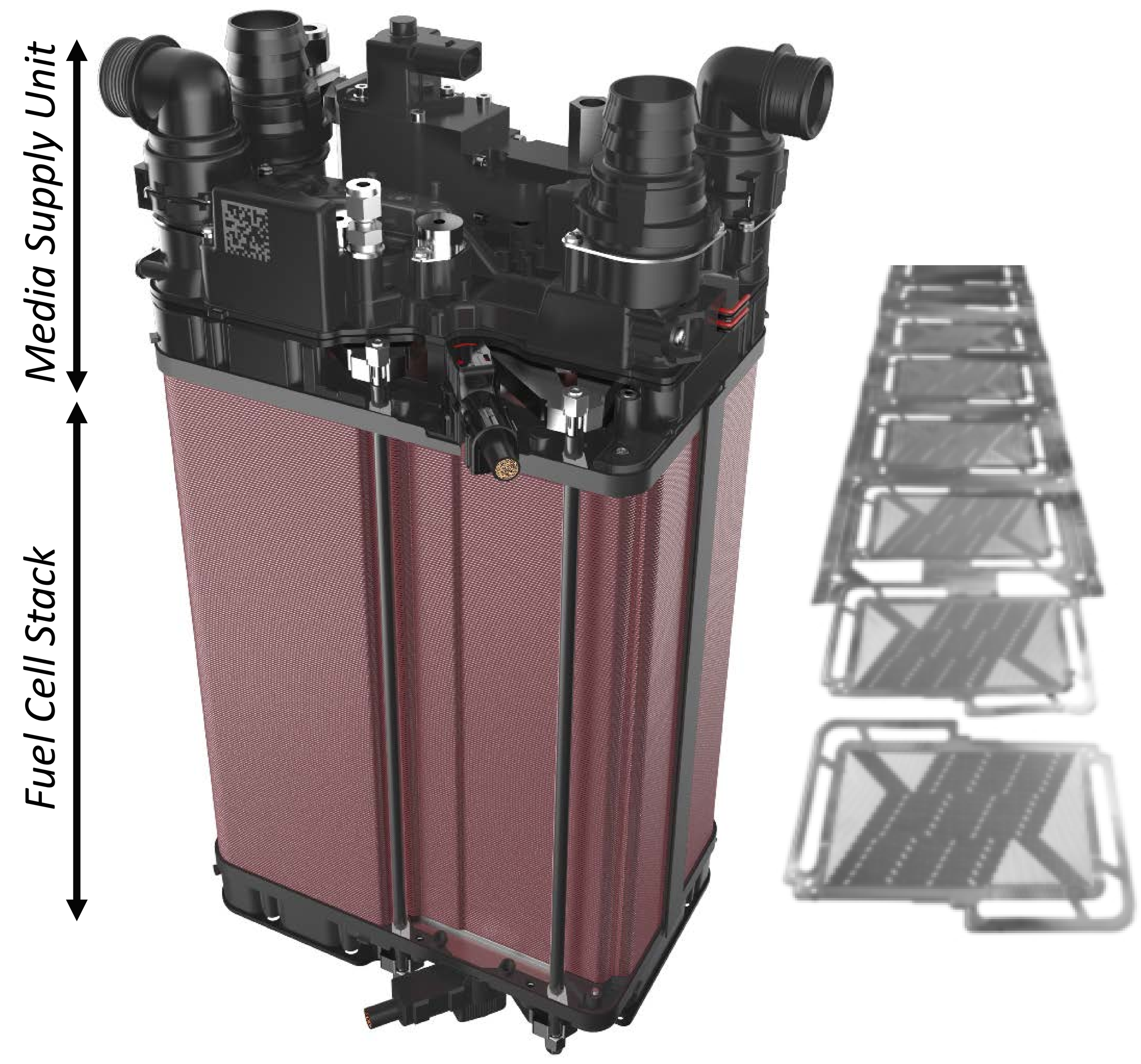

Figure 1: ElringKlinger NM5 40 kW Stack Module based on metallic bipolar plates suitable for series production

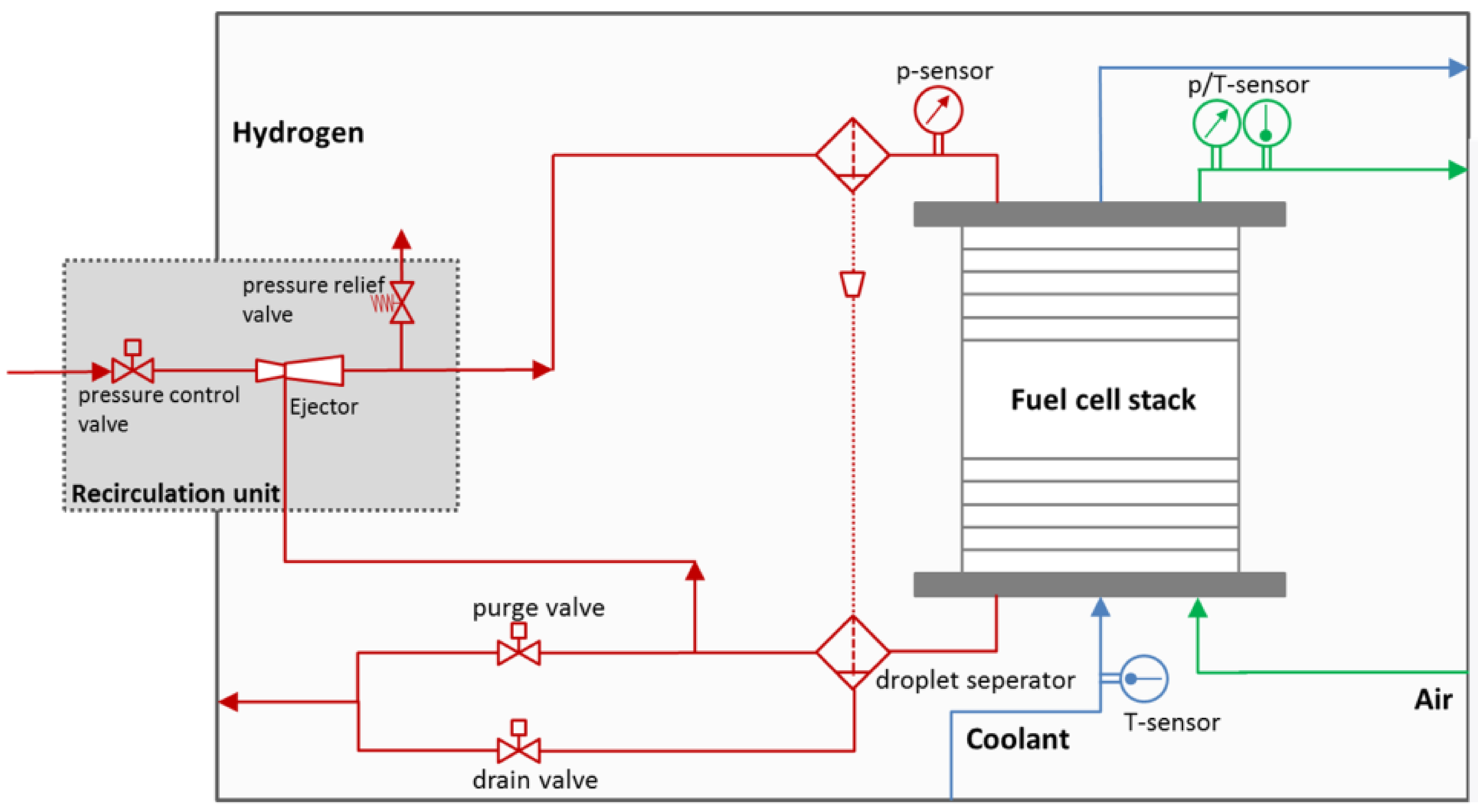

Figure 2: P&ID of GIANTLEAP Stack Module configuration with integrated sensors, valves and the hydrogen recirculation loop

System Interfaces

The interfaces and the resulting scope of delivery is shown in the piping and instrumentation diagram (P&ID) in figure 2. Besides sensors, valves, droplet separators and bypass structures, the P&ID shows that the passive hydrogen recirculation unit, as a major part of the anode sub-system, is already integrated into the stack module. Hydrogen gas recirculation in general is necessary to maintain optimal gas distribution as well as humidification of the dry hydrogen supplied by the tank system of the trailer. High recirculation rates based on performant ejectors in combination with low pressure drop media compartments enable effective liquid water discharge and prevent fuel starvation. With regard to the lifetime requirements of the bus application, the development and optimization of the hydrogen recirculation unit was a major focus for ElringKlinger within the project.

Testing and Characterisation

For the use in a range-extender bus application, ElringKlinger evaluated a new cell configuration. For an optimal technical and economical design of the fuel cell system, it was important to determine fundamental characteristics of the chosen cell configuration during several tests and provide them as an input for further system development to BEG.
*As shown in figure 3, the full-size stack modules were tested mainly at two different pressure levels. At the nominal load point which is defined as 0.6 V average cell voltage, the cell configuration delivers 240 A in atmospheric operation. With pressurized media systems at 1.8 bara, the current reaches up 330 A which leads to a power density of 4 kW/l *.*

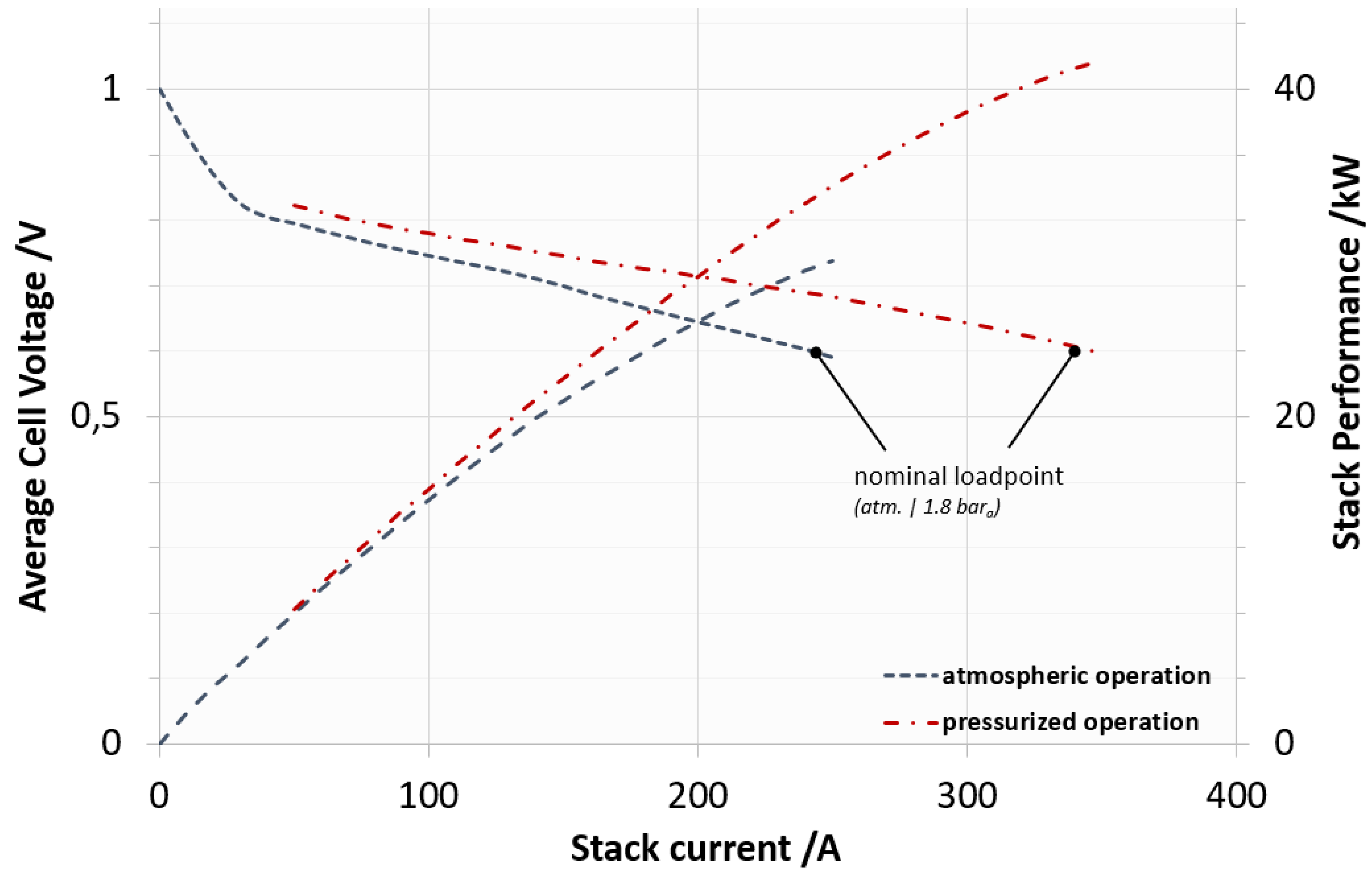

Figure 3: Test results at diffent pressure levels

**full-size stack without media supply unit*

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