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EWAS – ANODENSUBSYTEM FÜR PEM-BZ

Project Overview

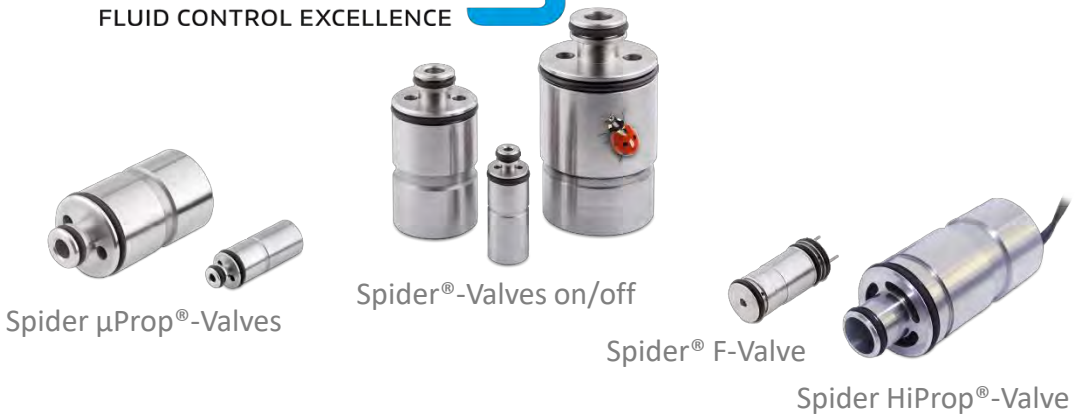
EWAS - **E**rhöhung der **W**ettbewerbsfähigkeit von PEM-Brennstoffzellen durch Optimierung des **A**noden-**S**ubsystems und dessen Komponenten Druckregelventil und Anoden-Ventile

- Duration: 1 September 2018 – 28 February 2021
- Total Cost: 1.086 k€
  - Financial contribution: 633 k€
- Project Organisation:
  - Bundesministerium für Verkehr und digitale Infrastruktur (BMVI)
  - Projektträger Jülich (PTJ, Energietechnologien/ERG5)
- Project Partners: Staiger GmbH and ElringKlinger AG

Company Profiles

Leading development and production partner for

- Fuel cell components
- Fuel cell stacks
- Fuel cell modules



Spider µProp®-Valves

Spider®-Valves on/off

Spider® F-Valve

Spider HiProp®-Valve

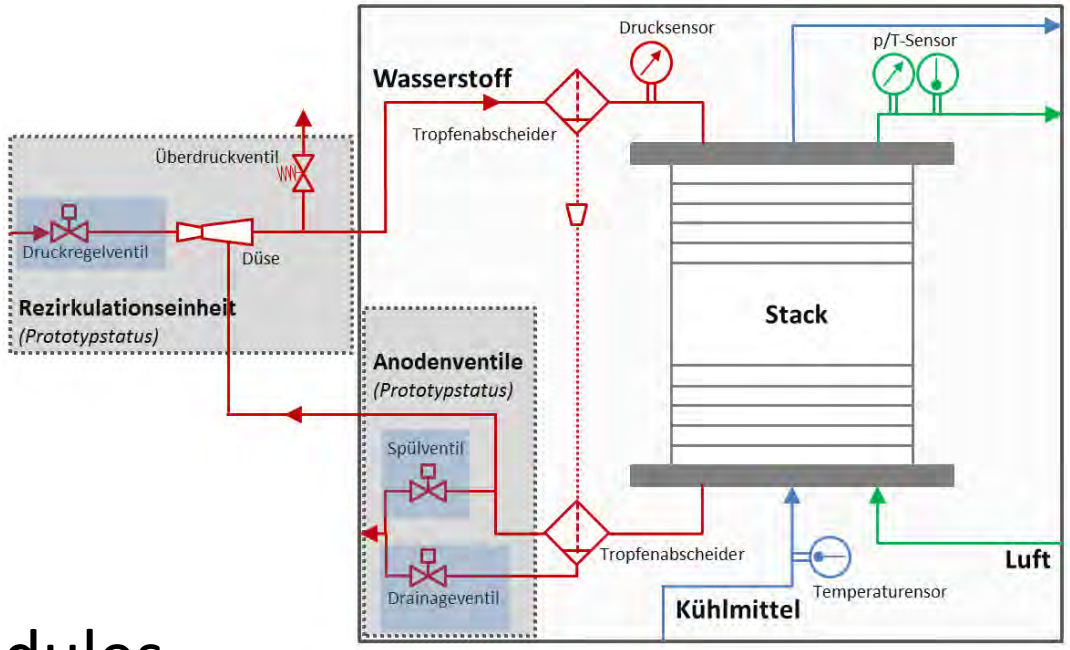
Leading development and production partner for customer-specific solenoid valves and manifolds in

- Automotive
- Analytical & Medical
- Machinery industry
- Aerospace & Space
- Energy and many others…

Project goals

Modular and scalable hydrogen supply unit with passive gas recirculation unit including valves for PEM fuel cell modules

- Development of pressure control valve
- Cost reduction of purge and drain valves
- Development of passive anode gas recirculation unit (“H_2R”) for the entire power range (partial loads)
- Ex-situ and In-situ testing on fuel cell modules



Result : Pressure Control Valve

- excellent control behaviour with small hysteresis (< 10%)
- robust performance for a wide range of ejector diameter/counter pressure
- valve can be adapted to individual inlet pressure ranges* up to 21 bar(g)

dimensions:	Ø21 mm x 49 mm
mass:	55 g
port size:	2.0 mm**
nominal power:	5 W
operation cycles:	> 50 million

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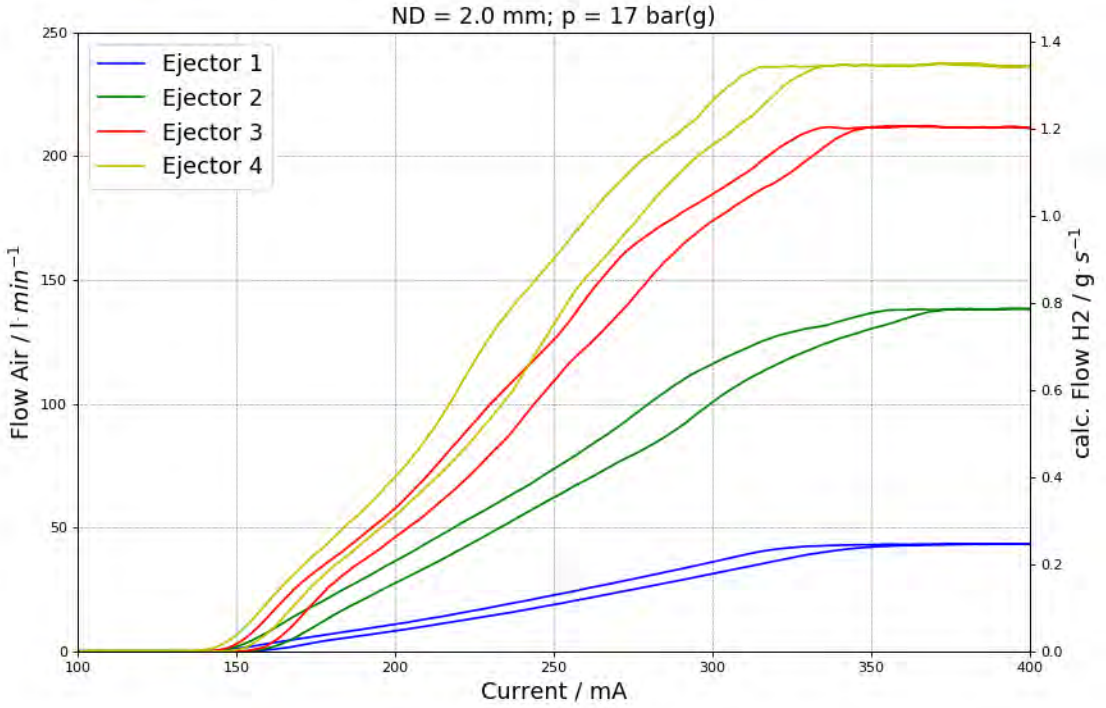
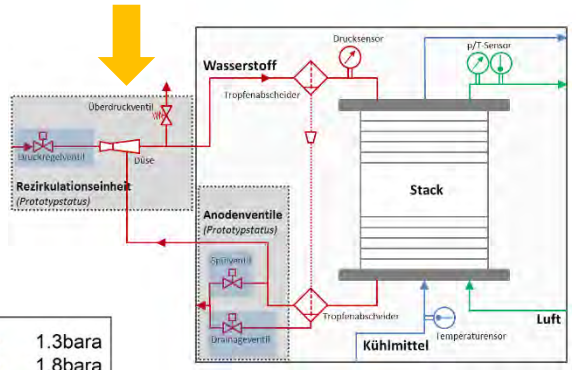
Patent granted



* port size = 2.5mm in development

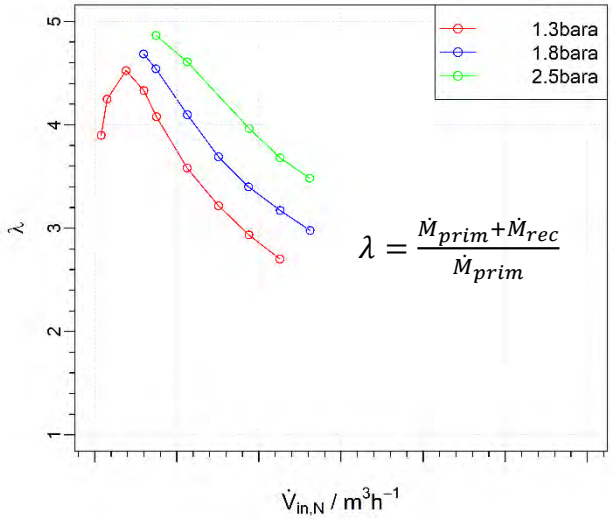
** NanoMQS-connector as multijet model

Result : Testing on subsystem basis



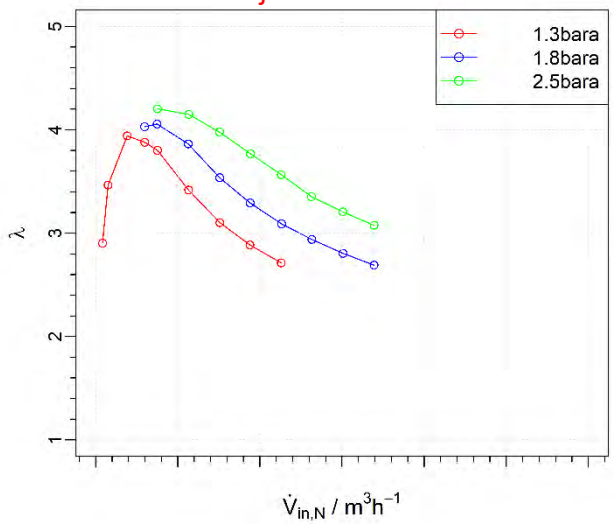
- Ex-situ: Ejector characteristics with H_2

Ejector 1

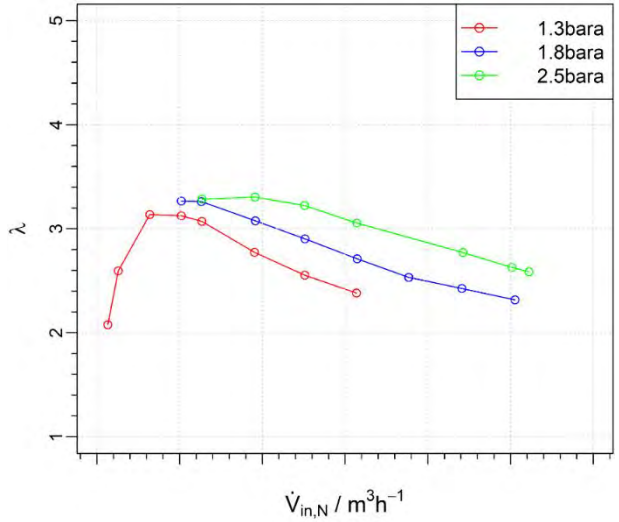


$$\lambda = \frac{\dot{M}_{prim} + \dot{M}_{rec}}{\dot{M}_{prim}}$$

Ejector 2

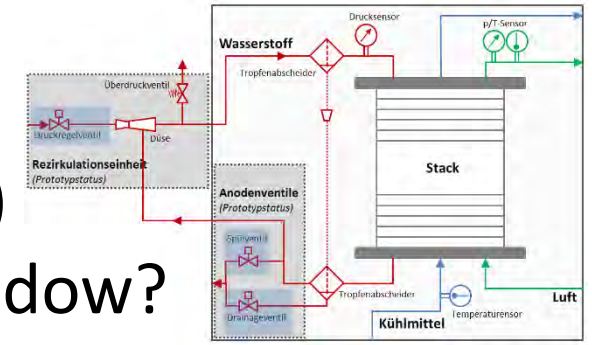


Ejector 3



- Combination of pressure control valve and different ejector sizes can meet mass flow requirements for EK's NM5 stack platform ✓
- H_2R units show high recirculation rates over a wide operating range ✓

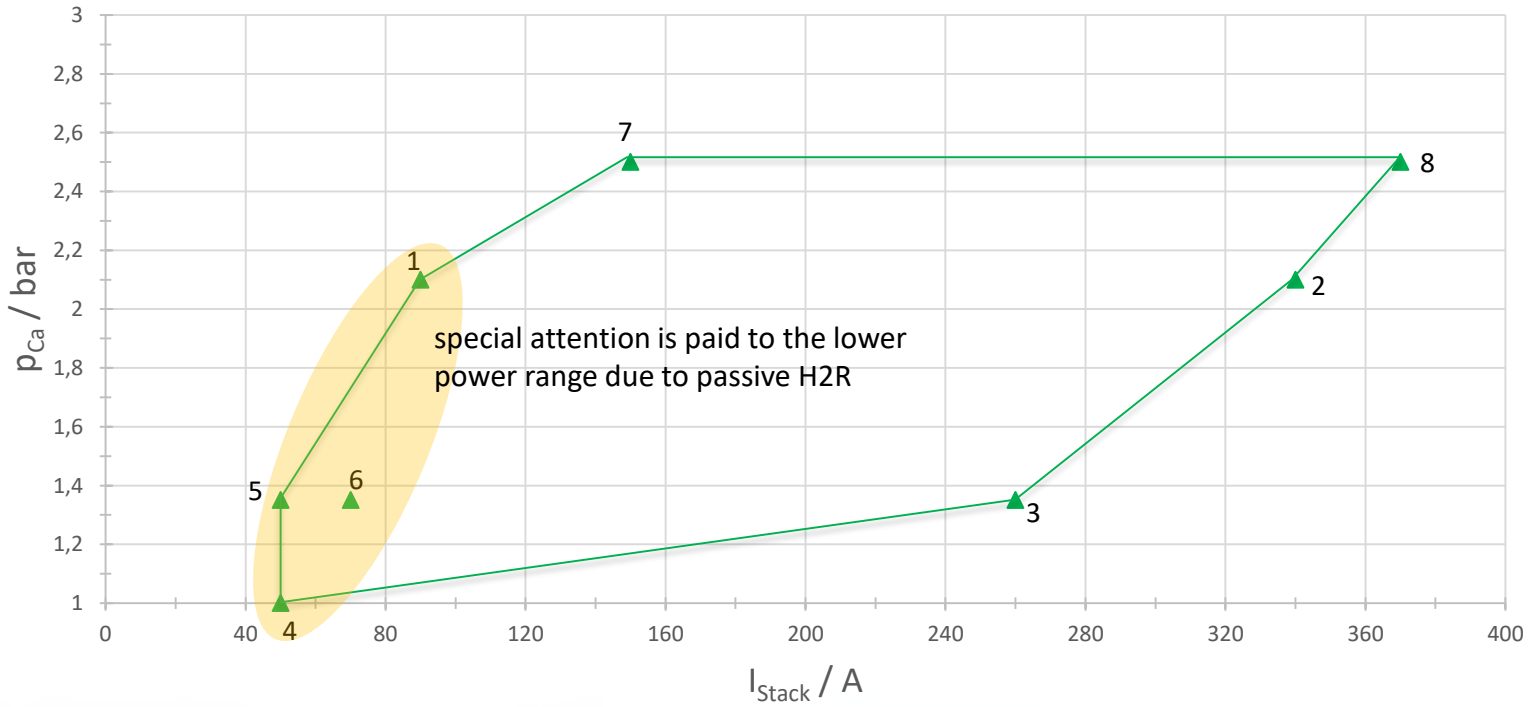
In-situ testing on fuel cell modules



Stack performance test of an EK-NM5 stack (here 300 cells)

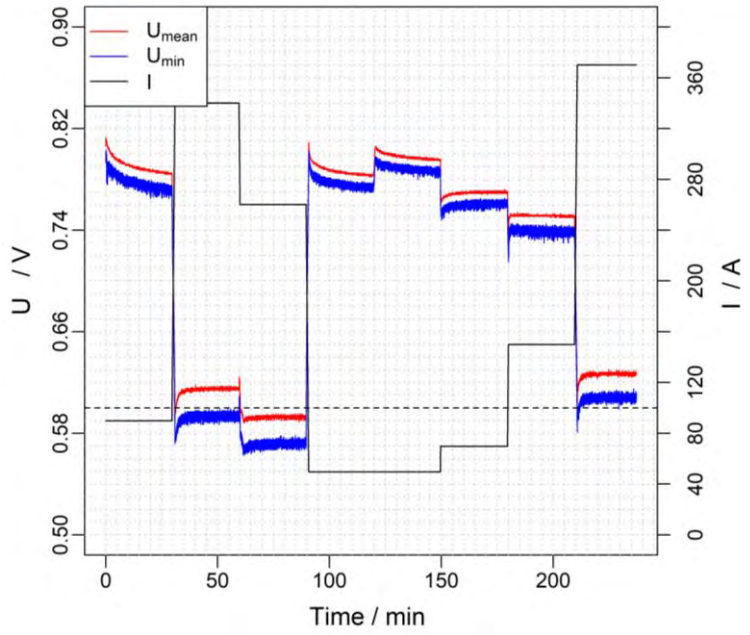
Challenge : can the stack be operated stable within the window?

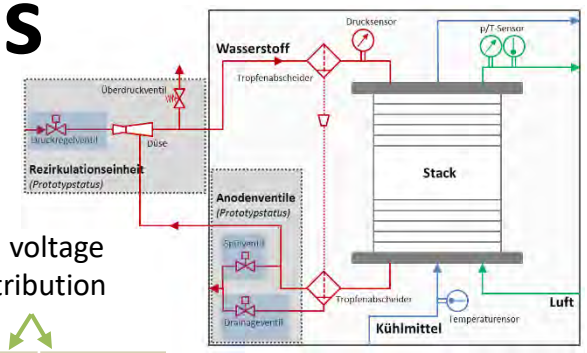
8 stationary operation points have been defined:



Result : In-situ testing on fuel cell modules

Stack performance test of an EK-NM5 stack (here 300 cells)





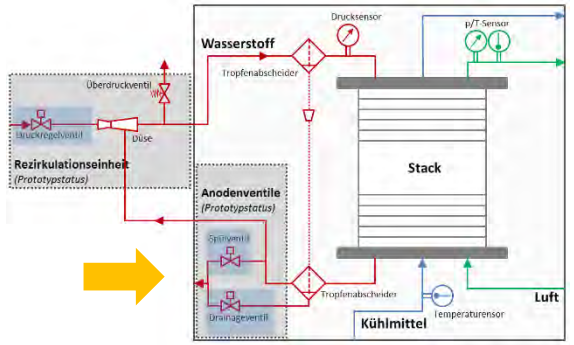
average cell voltage (U_m) | cell voltage distribution

Setpoint	I_{stack} / A	p_{ca} / bar	$U_{mean,pass}$-$U_{mean,act}$ / mV	$U_{mean,pass}$ / V	ΔU_{pass} / mV	ΔU_{act} / mV
1	90	2,1	12	0,785	13	14
2	340	2,1	13	0,615	21	24
3	260	1,35	14	0,592	20	21
4	50	1	7	0,783	9	8
5	50	1,35	7	0,795	9	9
6	70	1,35	1	0,769	9	9
7	150	2,5	4	0,751	12	13
8	370	2,5	10	0,627	19	20

- Operation with passive H_2R is stable in all stationary points ✓
- shows the same U_m as with active recirculation ✓
- shows a very homogeneous cell voltage distribution ✓

Result : Purge / Drain Valves

- small and fast switching flat armature valve
- low energy consumption
- 13% cost optimization through a new solenoid concept
- optional: integrated heating element for accelerated frost start* (4x)



dimensions:	Ø21 mm x 47 mm
mass:	72 g
flow coefficient:	2,2 l/min
switch-on time:	5 ms
nominal power:	< 4 W
heating power:	20 W

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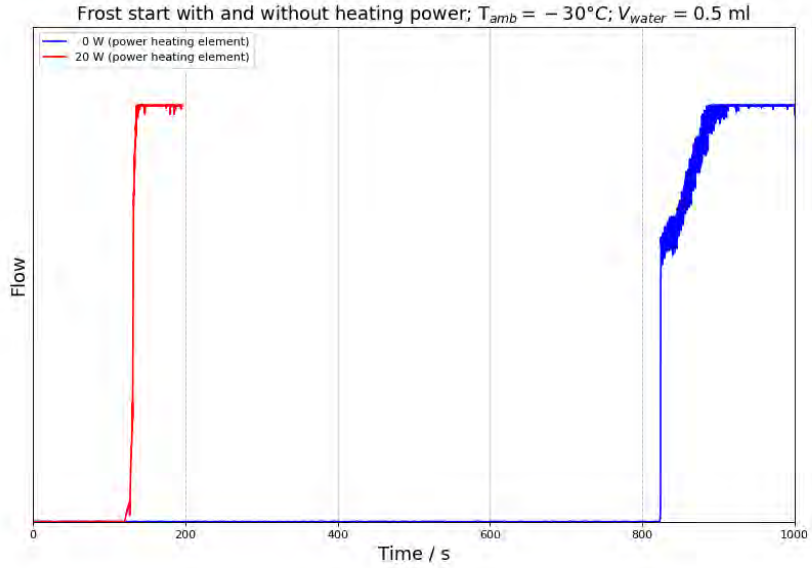

* Patent application filed

** NanoMQS-connector as multijet model

Summary

- New pressure control valve with excellent behaviour
- Recirculation unit enables stable stack operation over a wide range
- EK stacks show very good performance with passive recirculation
- Cost-effective solenoid concept with integrated heater element for purge / drain valves

We thank the *Bundesministerium für Verkehr und digitale Infrastruktur* and *Projektträger Jülich* for funding and supporting the project.

Thank you for your attention!

www.elringklinger.de www.staiger.de