EQUILIBAR
PRECISION PRESSURE CONTROL

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Hydrogen Fuel Cell Testing: Equilibar Back Pressure Regulator provides precise control to optimize process conditions in green energy research

Summary

Researchers at Charles University in Prague, Czech Republic, have successfully used an Equilibar® Back Pressure Regulator combined with a Proportion-Air electronic pressure regulator to provide precise control of fuel cell anode and cathode pressure across a wide range of test conditions. The research is part of vital international efforts to develop improved environmental catalysts for automotive fuel cells.

Background

Fuel cells play a key role in green energy research by converting hydrogen and other clean energy sources into electricity through a catalyzed reaction. Fuel cells require a steady supply of both fuel and oxygen to maintain the production of electricity throughout the reaction.

At Charles University, fuel cell research is working to develop improved catalysts with the goal of lowering noble metal content, which would directly lower the cost of the power supply while also using more environmentally friendly materials.

The Challenge

A fuel cell's performance is extremely sensitive to its process operating conditions, which must reflect real-world conditions and also be tightly controlled. To change the stoichiometry from one case to another, researchers vary the cathode and anode flow rate in relation to the current supplied by the fuel cell.

A further restriction for automotive fuel cell applications is that the reactants are supplied at higher than atmospheric pressure in order to increase performance. This elevated pressure demands an extremely high performance back-pressure regulator for any research or testing program.

To achieve the required stability, Charles University researchers specified that the regulator meet a demanding range of requirements.

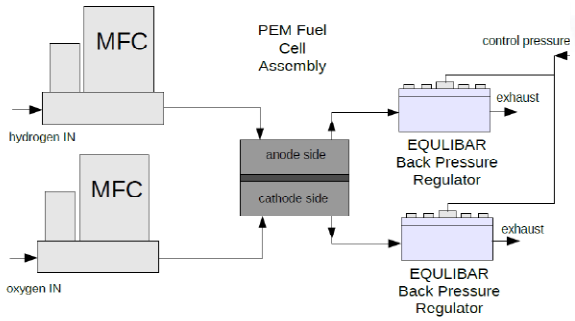

Figure 1: Simplified schematic of typical connection of fuel cell with back pressure regulators for operation at elevated pressure

- It must exhibit high stability and operate over a wide range of flows in the range of tens to thousands of sccm (standard cubic centimeters per minute).
- It must be resistant to humidity at elevated temperatures (typically almost 100% relative humidity at 80 degrees of Celsius).
- It must be able to handle mixed phase operation as liquid condensation occurs in the pipes. Many units on the market are unable to deal with bi-phasic applications, which are further complicated by liquid slugs entering the regulator causing a sudden spike in required flow coefficient (Cv) of the unit.
- It must maintain stable pressure on the fuel cell in test conditions when the reactant flow is zero during leak checking of the fuel cell assembly.
- It must enable researchers to electronically control the back pressure regulator using an analog computer signal.

The Solution

Faced with this daunting combination of challenges, researchers at Charles University turned to Equilibar, a manufacturer of high precision pressure control. Together, the researchers and Equilibar engineers selected the EB1LF1 back pressure regulator made out of SS316 with a PTFE/

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Glass diaphragm. This regulator is part of Equilibar's Research Series and provides the following unique advantages:

- Chemical Compatibility to the process gases, including pure hydrogen and pure oxygen
- Resistance to humidity
- Ability to operate at elevated temperature
- Stable performance with mixed phase operation
- No deviation from required pressure set point over a wide range of flows.

The dome pressure to the EB1LF1 can be delivered by a manual pressure reducing regulator or electronic pressure regulator controlled by a computer. Charles University researchers chose to use a Proportion Air electronic pressure regulator (model QPV1) provided by Equilibar. The QPV1 unit was calibrated 0-10 Volts = 0-2 Bar (gauge).

Both back pressure regulators were piloted by the same electronic pressure regulator, providing the researchers assurance that both lines were acting on the same pressure signal. This allowed for simplification and automation of the Fuel Cell testing procedure.

The solution was implemented during the fall of 2013 and has been in service since. Two additional units were purchased by researchers in February of 2014.

Figure1 shows a schematic for the test set-up. Two mass flow controllers were used to control the delivery flow to both the anode (hydrogen) and cathode (oxygen) side of the fuel cell test piece. The exhaust from both the anode and cathode was controlled via an Equilibar unit. Both back pressure regulators share a common pilot pressure from the electronic pressure regulator.

Figure 2 is a picture of the Equilibar Research Series EB1LF1 units installed with the single Proportion Air pilot controller on the users' test rig.

Figure 2: Hydrogen Fuel Cell Experimental Rig (Two Equilibar Back Pressure Regulators piloted by single Proportion Air QPV)

Customer Feedback: Advantages of Equilibar Back Pressure Regulators

- Simple & robust design
- Ability to set pressures in two or more independent process lines
- Excellent control over wide range of flows
- Easy control with QPV electronic pressure regulator
- Repeatable results with electro-pneumatic combination compared to using mechanical regulators.

Contact Equilibar

Equilibar is a provider for unique and innovative pressure control solutions based in Fletcher, North Carolina. The patented back pressure technology is used in a wide array of processes including catalyst, petrochemical, supercritical and other industrial applications. For more information please contact an Equilibar applications specialist at www.equilibar.com or 828.650.6590.

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