EQUILIBAR
PRECISION PRESSURE CONTROL

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Colorado School of Mines uses Equilibar® Back Pressure Regulator to improve catalyst research in ammonia production

Background

Ammonia production accounts for 2% of the world's energy consumption. It uses the Haber-Bosch process, which has remained relatively unchanged for more than 100 years. Recently, because of its superior gravimetric density (17.7 wt%), ammonia has been investigated as a hydrogen storage material for the purpose of renewable energy; However, renewable and distributed ammonia production remains a significant challenge.

Professor Colin A. Wolden of the Colorado School of Mines Department of Chemical and Biological Engineering conducts research focused on the synthesis of nanostructured materials and their application in solving challenges in the areas of renewable energy and sustainability.

As part of a multifaceted project at the Colorado School of Mines, Dr. Wolden is investigating novel catalyst materials and methods for distributed ammonia production. For the ammonia catalyst apparatus, three variables are critical: gas flow rates, reactor temperature, and reactor pressure. Thermodynamics and downstream separation favor high pressure operation. Therefore, the ability to precisely control pressure for extended duration is critical to analyzing catalyst stability at relevant conditions.

Challenge

Previous stability tests at elevated pressure were challenging due to the use of manual, spring loaded, back pressure regulators. The pressure in the system would drift, and careful monitoring and adjustment were required. Wolden was looking for improved control of reactor pressure.

Solution

Professor Wolden worked with Equilibar engineers to find a pressure control solution for the ammonia catalyst apparatus. They chose a stainless steel Equilibar® LF2 Precision Back Pressure Regulator (BPR) with EPDM O-Rings and PTFE Glass Laminate diaphragm. The application at the Colorado School of Mines requires an operating pressure up to 1000 psi and temperature of 100 °C.

The LF2 is part of Equilibar's Research Series back pressure regulators, which are designed for a variety of gas, liquid and mixed phase applications where precision performance is critical. The LF2 model is used where low flow rates are desired.

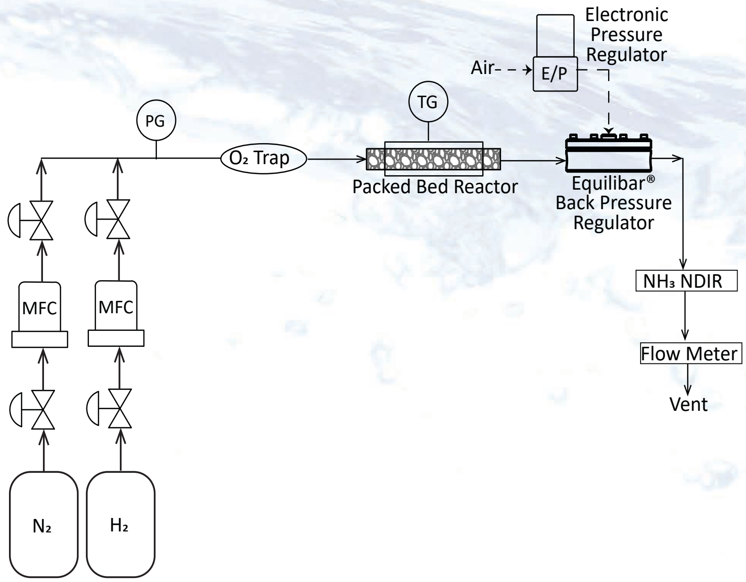
Equilibar Research Series BPRs are used in applications that involve low flow rates, extremely high pressures and other challenging laboratory scenarios. By using unique combinations of diaphragm and O-ring materials, Equilibar regulators are able to perform with high accuracy even in the harshest environments, including those with high temperatures and aggressive chemicals.

Figure 1. Equilibar LF2

Equilibar BPRs are controlled by a pilot regulator that provides the process setpoint to the Equilibar BPR. This setpoint regulator can be manual or electronic. Professor Wolden required electronic pressure control, so Equilibar application engineers suggested a QB1 Precision Electronic Regulator for his process.

Application Specifics

The schematic of the ammonia catalyst apparatus is shown on the following page with an Equilibar LF2 BPR at the exit of the reactor keeping precise pressure for the reaction.

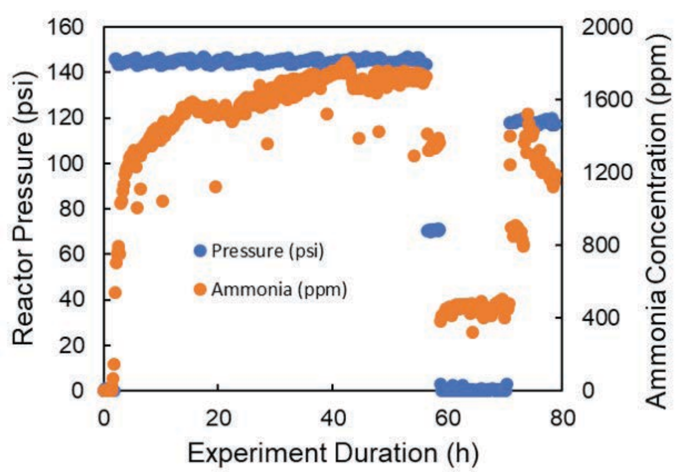


> *"The ability to have electronic control of reactor pressure independent of feed flow rates was critical. The Equilibar BPR performs this task exceptionally well and its integration into our process control and data acquisition framework was straightforward."*
>
> *- Professor Colin Wolden*

Figure 2. Schematic of Wolden's ammonia catalyst apparatus

Figure 3. Photograph of Wolden's ammonia catalyst apparatus

As indicated earlier, the ability to precisely control pressure for extended duration is critical to analyzing catalyst stability at relevant conditions. Below is a graph from these experiments showing the stable reactor pressure for the duration of a 6o hour catalyst stability test.



Note that in this experiment at t ~ 60h the pressure setpoint was intentionally changed to 0 and then reset to a new pressure at t ~ 70h. The Equilibar BPR adapted to these step changes rapidly and with high fidelity.

About the Department

Colorado School of Mines, Department of Chemical and Biological Engineering focuses on education and basic and applied research aimed at problems of national interest. https://chemeng.mines.edu

Contact Equilibar

Equilibar is a provider of unique and innovative pressure control solutions based near Asheville, North Carolina. Equilibar's patented pressure regulator technology is used in a wide array of processes including catalyst, petrochemical, sanitary, supercritical and other industrial applications. For more information please contact an Equilibar applications engineer at inquiry@equilibar.com or 828-650-6590.

Professor Colin A. Wolden's research interests are focused on the synthesis of nanostructured materials and their application for solving challenges in the areas of renewable energy and sustainability. Synthesis techniques include both vapor deposition (sputtering, CVD) and solution processing (reactive precipitation, electrodeposition, etc.). A central theme is developing novel processing techniques that impart nanoscale control while retaining high rate for the efficient synthesis of mesoscale structures (5 – 500 nm). The materials synthesized serve as integral components in thin film photovoltaics, solid state batteries, and membrane reactors. Investigation of these processes is guided by detailed reactive flow modeling and experimental measures of both homogeneous and heterogeneous kinetics. In-situ process diagnostics and ex-situ materials characterization are used to gain a fundamental understanding of the process–structure–performance relationships in these systems.

Diane Jacober is a Technical Marketing Specialist at Equilibar, LLC, provider of high precision pressure control solutions. She has B.S and M.S degrees in engineering and has worked as a process engineer, project engineer and technical marketing specialist in several industries. Diane can be reached at info@equilibar.com *or 828-650-6590.*