EQUILIBAR
PRECISION PRESSURE CONTROL

Released: May 21, 2014

# Alternating Feeds to a Research Reactor: Equilibar Back Pressure Regulator featured in Clean Energy Research

## *Background*

Oak Ridge National Laboratory in Tennessee is a world leader in multiple areas of research including clean energy. Recently, the Fuels, Engines and Emissions Research Center at ORNL has participated in a Department of Energy initiative on low cost emissions control for advanced combustion engines. As part of this research, they have experienced success using the Equilibar back pressure regulator to maintain a continuous and precise flow rate to a catalyst reactor while switching between two separate gas feeds.

## *The Challenge*

In the schematic on page 2, the feed to the reactor must be switched from Stream A to Stream B without a disruption or surge in flow rate. This is especially critical when the switching times are not equal and gas flow rates are low (ORNL employs flow rates as low as 20 standard ml/minute). A 4-way valve is used to make a seamless switch between the gas streams. This valve is designed to select one of the two gas streams to feed to the reactor while exhausting or venting the other; however, because the reactor presents a significant pressure drop, it is necessary to maintain the vent stream at the same pressure as the reactor inlet to avoid disruption in flow to the reactor.

Exact control is critical: If the vent pressure is lower than the reactor pressure when the valve switches, the flow through the reactor will essentially stop until the pressure builds up enough to flow through the reactor bed. If the vent pressure is higher than the reactor pressure, the flow will surge through the reactor. Both of these scenarios are highly undesirable when trying to evaluate and understand the fundamental behavior of a reaction based on a controlled dose of reactants.

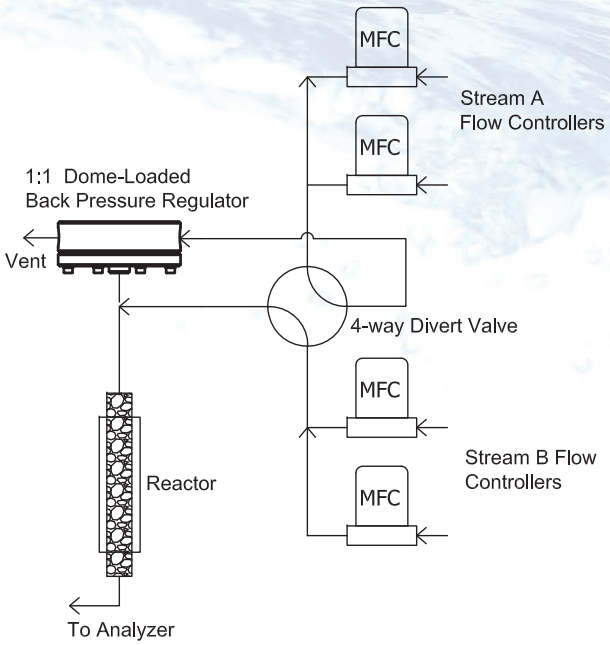
*A photo of the Equilibar® Back Pressure Regulator installed in the stream switching application.*

## *The Solution*

To find an optimal strategy to work with the alternating feeds, scientists and engineers at ORNL worked with Equilibar's application engineers. They determined that it was possible to install an Equilibar® precision back pressure regulator on the vent and use the back pressure at the inlet of the reactor as the dome pressure for the Equilibar.

320 Rutledge Road • Fletcher, North Carolina 28732
(828)650-6590 office • (828)329-4051 mobile • (801)504-4439 fax

www.equilibar.com




*Schematic showing how the 4-way divert valve switches the feed to the reactor. The Equilibar dome-loaded back pressure regulator maintains constant flow rate and pressure during the transition.*

The Equilibar back pressure regulator is a dome-loaded with a 1:1 ratio. Unlike most traditional regulators, the Equilibar can maintain precision below 1 bar, into the millibar range. In this application, the Equilibar restricts the flow just enough to create equal pressures on both the vent and the reactor sides of the 4-way valve and is thus self-regulating.

A key challenge for this application was the combination of low pressure (approximately 0.2 bar gauge) and high temperature (190ºC). Gas flow rates ranged from 20 standard milliliters/minute up to 5 standard liters/minute. To meet this challenge, Equilibar engineers selected a stainless steel Research Series back pressure regulator, model EB1HF2. Although a PTFE/Glass diaphragm was initially selected, a thin polyimide diaphragm was determined to have the best sensitivity for this application.

## *Benefits: Avoiding Unnecessary Complexity*

In this system, the Equilibar plays a key role in automating the reactor under difficult switching conditions. Because the pressure in the reactor increases at high temperatures, the Equilibar is especially useful for temperature ramping/stepping studies. Without such a self-regulated pressure control system, the reactor operator would need to manually adjust a back pressure regulator as the temperature was increased. Alternatively, if traditional electronic back pressure regulators were used for automating this pressure balance, it would require two pressure transducers connected to a control system. Such an approach has been shown to have a limited range of functionality in lab settings and certainly would have increased complexity.

This innovative application at Oak Ridge National Lab demonstrates that an Equilibar back pressure regulator can natively maintain pressure equilibrium on both sides of a diverter valve without set-point knobs or complex control systems. The elegant solution helps ensure precision and ease of use for important research into clean energy.

*Jeff Jennings, P.E., is founder and president of Equilibar, LLC, a provider of high precision pressure control solutions. Prior to Equilibar, he worked as a process development engineer for 23 years. He is a licensed professional engineer in North Carolina and holds several patents. Mr. Jennings can be reached at jeff.jennings@equilibar.com or 828-650-6590.*