Equilibar Flow Control

Precision Control Valves for Research and Industry
How It Works

The Equilibar® control valve works in a completely different way than traditional regulators and valves.

Instead of a single valve seat the Equilibar valve uses multiple orifices sealed by a flexible diaphragm. The Equilibar valve is dome-loaded by a pressure on top of the diaphragm that controls the process fluid flow proportional to that “pilot pressure” on the diaphragm. As flow requirements change, the diaphragm moves a few millimeters to open and close over some or all of the orifices, providing instantaneous and frictionless control.

The Equilibar valve was conceived as a precision back pressure regulator but is easily configured to control flow rate in a flow control PID loop with an electronic pilot controller. Over the years, Equilibar customers have discovered the significant benefits of the Equilibar control valve in demanding flow control applications where the supply pressure is largely stable.

HOW IT WORKS IN FLOW CONTROL

In a flow control configuration, the Equilibar® fluid control valve (FCV) uses an electronic pilot pressure controller and a flow meter in a control loop. See Fig. 1. A proportional-integral-derivative (PID) controller monitors input from a flow transmitter (FT) and adjusts the pilot pressure to control flow. An electronic pressure controller translates the electronic signal from the PID into a pressure signal for the pilot pressure. Flow is decreased by raising the pilot pressure and increased by lowering the pilot pressure. See Fig. 2.

Pressure and flow have an inverse relationship, so the control scheme will be set up differently. When using an Equilibar FCV in flow-control operations, the PID loop must be used in direct mode instead of the more common inverse mode used by traditional control valves because pressure must be increased in response to an increase in flow. Opposite flow responses of a traditional globe control valve (red) and an Equilibar control valve (blue) in response to actuation pressure are represented in Fig. 2.

WHEN TO USE EQUILIBAR VALVES FOR FLOW CONTROL

In many chemical process flow control applications, a traditional globe or needle-style control valve will be the most economical and convenient solution, but there are advantages to using an Equilibar fluid control valve for demanding application requirements including:

- Wide range of required flow Cv
- Highly corrosive gases and liquids (using exotic alloy bodies and diaphragms with FFKM)
- High temperature (seals available up to 500ºC)
- Sanitary and biopharmaceutical applications (available with USP Class VI diaphragms)
- Extremely low flow rates (controls Cv down to 1E-9)
- Mixed phase fluid flow control
CONTROLS ACROSS WIDE RANGE OF FLOW
One characteristic of traditional flow control valves is that of limited flow range (or the max/min ratio of effective Cv). Most control valves operating in research and process industries are limited to between a 10:1 and 15:1 ratio. An Equilibar® valve can easily operate in a Cv range greater than 100:1 and have been used in applications requiring 250:1 Cv range. They can operate at extremely low flow rates with Cv down to 1E-9.

CONTROLS MULTI-PHASE FLUIDS
The unique design of the Equilibar valve enables it to handle two-phase or mixed-phase flow streams while maintaining high precision. This can include gas/liquid processes, water/oil flow streams, or supercritical fluids.

Traditional valves use a single annular valve seat, sometimes very small, so that when slugs of liquid flood the valve throat, volumetric flow rate drops suddenly as the denser fluid is accelerated through orifice. This momentary reduction in volumetric flow disrupts the stability of the upstream process pressure.

The unique Equilibar technology uses a direct-sealing diaphragm over multiple orifices to control the pressure drop. The supple diaphragm can vary its proximity to the orifices nearly instantaneously to adjust to the varying valve coefficient (Cv) requirements of the various fluid phases.

ISOLATES FROM DOWNSTREAM PRESSURE
An Equilibar valve provides a buffer against changes in downstream pressure. Because it is a back pressure regulator, the Equilibar valve will automatically adjust to keep its inlet pressure at setpoint regardless of changes at the outlet port. When using a traditional flow control valve (FCV), any change in downstream pressure will require a PID control adjustment to remain stable.

WITHSTANDS CORROSIVE FLUIDS
Equilibar valves can be constructed of exotic metal alloys and polymers including Hastelloy, Titanium, Zirconium, PTFE and PVDF. Combined with a selection of diaphragm and O-ring materials compatible with highly corrosive gases and liquids, Equilibar valves can be used in applications with corrosive fluids.

INCLUDES OPTIONS FOR SANITARY PROCESSES
Equilibar has a family of valves designed with ASME BPE specifications specifically for use in sanitary processes. These FD Sanitary Valves range in size from 1/2” ports to 3” ports and can be used in flow control for operations such as precision dosing and CIP.
Application Spotlight

INJECTION AND INLINE BLENDING FLOW CONTROL

Traditional flow control valves have difficulty in injection and metering applications where the downstream pressure is widely varying. Changes in required flow rate are compounded with changes in available differential pressure, creating a very wide range requirement for valve Flow Coefficient (Cv). It is difficult for a single flow control valve to be sized to handle such wide Cv range. The traditional solution has been to use two or three parallel control valves of different sizes to handle these widely varying conditions.

The Equilibar® fluid control valve (FCV) with its multiple orifices and supple diaphragm, however, can consistently function across flow rate variations of 100:1, regardless of wide changes in downstream pressure. This valve uses an air or nitrogen pilot signal and a sensitive diaphragm to control flow rate. Very small changes in the pilot pressure produce correspondingly small changes in the flow rate. Because the flow control valve is based on the design of a back pressure regulator, fluctuations or even wide variations in pressure downstream of the valve do not have a significant effect.

Some example applications where this is important are inline blending of dyes and perfumes in consumer products, inline dilution of buffers in biopharmaceutical processing and deep well injection operations.

Fig. 3: Deep well injection application requiring wide range of Cv operation.

DEEP WELL INJECTION EXAMPLE

Deep well injection applications involve the injection of a fluid into the bottom of the oil well to improve conditions of the well. These are a challenge for flow control valves because the downstream pressure of the wellhead can vary greatly with conditions and flow rate inside the well. In addition, the required injection flow rate can vary as well.

For example:
- Maximum Fluid Supply Pressure = 300 psig
- Range of injection pressure to wellhead = 0 to 270 psig
- Range of Flow Required = 0.25 GPM to 5 GPM
- Fluid density = water-like

The maximum Flow Coefficient required for injection is based on the maximum flow of 5 GPM with an available differential pressure of only 30 psid (300-270 psig). This results in a Cv (max) = 0.91.

The minimum Flow Coefficient is based on the minimum flow of 0.25 GPM and an available differential pressure of 300 psig. This result is Cv (min) = 0.014.

In this example, the Max/Min ratio is 63 which is greater than the typical control valve range of 20:1 or 15:1.

CUSTOMER CASE STUDY: Cv OPERATING RANGE OF 230:1

A customer case study published in the June 2020 edition of Flow Control Magazine describes how Equilibar fluid control valves were used in a well injection application where a Cv range of 230:1 was required.
Flow Control Valve Specifications

Equilibar® fluid control valves are available in a wide range of sizes, materials and port options. They are also available in sanitary design for consumer products, biopharmaceutical or food and beverage applications. Below is a chart of several popular sizes with dimensions shown for stainless steel. Other models are unlisted but available to suit specific application requirements.

Please contact an Equilibar application engineer to discuss your application to determine the best valve for your process.

An Equilibar fluid control valve is controlled by an electronic pilot pressure controller. Equilibar sells models listed on the next page with a range of signal outputs to communicate with the end-user’s choice of PID controller. For best performance, we recommend using a responsive flow meter and PID controller with guidance from the end-user’s onsite controls engineer.

<table>
<thead>
<tr>
<th>BASE PART #</th>
<th>FLOW COEFF. (CV)</th>
<th>MAX PRESSURE PSIG (BAR(G))</th>
<th>INLET / OUTLET PORT SIZE</th>
<th>REFERENCE PORT SIZE</th>
<th>PORT THREAD OPTIONS</th>
<th>DIM A</th>
<th>DIM B</th>
</tr>
</thead>
<tbody>
<tr>
<td>LF1</td>
<td>1E-08</td>
<td>0.07</td>
<td>1000 (68)</td>
<td>1/8&quot;</td>
<td>1/8&quot;</td>
<td>1/8&quot;</td>
<td>2.5 (64)</td>
</tr>
<tr>
<td>LF2</td>
<td>1E-08</td>
<td>0.07</td>
<td>1000 (68)</td>
<td>1/4&quot;</td>
<td>1/8&quot;</td>
<td>1/8&quot;</td>
<td>2.5 (64)</td>
</tr>
<tr>
<td>HF1</td>
<td>1E-05</td>
<td>0.41</td>
<td>1000 (68)</td>
<td>1/8&quot;</td>
<td>NPT; BSPP; Custom</td>
<td>2.5 (64)</td>
<td>1.5 (39)</td>
</tr>
<tr>
<td>HF2</td>
<td>0.41</td>
<td>1000 (68)</td>
<td>1/4&quot;</td>
<td>NPT; BSPP; Custom</td>
<td>2.5 (64)</td>
<td>1.5 (39)</td>
<td></td>
</tr>
<tr>
<td>GSD2</td>
<td>1E-05</td>
<td>1.20</td>
<td>750 (51)</td>
<td>1/4&quot;</td>
<td>NPT; BSPP Flange; Custom</td>
<td>3.00 (76)</td>
<td>1.34 (34)</td>
</tr>
<tr>
<td>GSD3</td>
<td>1.80</td>
<td>400 (28)</td>
<td>3/8&quot;</td>
<td>NPT; BSPP Flange; Custom</td>
<td>3.50 (89)</td>
<td>1.40 (36)</td>
<td></td>
</tr>
<tr>
<td>GSD4</td>
<td>3.20</td>
<td>350 (24)</td>
<td>1/2&quot;</td>
<td>NPT; BSPP Flange; Custom</td>
<td>4.50 (114)</td>
<td>31.73 (44)</td>
<td></td>
</tr>
<tr>
<td>GSD6</td>
<td>1E-04</td>
<td>5.50</td>
<td>300 (21)</td>
<td>3/4&quot;</td>
<td>NPT; BSPP Flange; Custom</td>
<td>6.00 (152)</td>
<td>2.01 (51)</td>
</tr>
<tr>
<td>GSD8</td>
<td>8.50</td>
<td>150 (10)</td>
<td>1&quot;</td>
<td>NPT; BSPP Flange; Custom</td>
<td>7.80 (198)</td>
<td>3.33 (85)</td>
<td></td>
</tr>
</tbody>
</table>

Sanitary Options

| FDO4        | 1E-7             | 1.0                         | 150 (10 bar)            | 1/2"                | 1/8" NPT Tri-Clamp Custom | 3.4 (86) | 1.4 (36) |
| FDO6        | 1E-4             | 4.0                         | 150 (10 bar)            | 3/4"                | 1/8" NPT Tri-Clamp Custom | 5.9 (151) | 2.0 (51) |
| FDO8        | 1E-4             | 8.0                         | 150 (10 bar)            | 1"                  | 1/8" NPT Tri-Clamp Custom | 8.1 (204) | 2.4 (61) |
| FDO12       | 1E-3             | 12                          | 150 (10 bar)            | 1.5"                | 1/8" NPT Custom          | 9.1 (230) | 2.7 (69) |
| FDO16       | 1E-3             | 19                          | 150 (10 bar)            | 2"                  | 1/8" NPT Custom          | 11.1 (280) | 3.6 (91) |
| FDO24       | 1E-3             | 36                          | 150 (10 bar)            | 3"                  | 1/8" NPT Custom          | 14.8 (375) | 5.1 (129) |

Fig. 6: DIM A and DIM B for LF, HF & GSD models

Fig. 7: DIM A and DIM B for FDO models
Equilibar® fluid control valves (FCV) are pilot operated with a setpoint pressure called ‘reference’ or ‘pilot’ pressure applied to the top port. When combined with a high resolution electronic pilot regulator, the Equilibar FCV provides precision flow control with instantaneous response to changes in setpoint and process fluctuations. Below are some options for electronic pilot control for Equilibar FCV.

## Pilot Control Options

### QPV Series

**High Precision Low Pressure Regulator**
- Controls up to 150 psi (10 bar)
- Aluminum IP65 enclosure
- Optional digital display
- 4-20 mA or 0-10 VDC

**Key Features**
- Min range: 0-0.3 psig, vacuum
- Max range: 0-150 psig
- Available in gauge, absolute, vacuum and vacuum-positive ranges
- Superior proportional valve action
- Accuracy: 0.1% - 0.5% FS
- Resolution: 0.005% - 0.2% FS
- Tuned ready for setpoint pilot service
- Optional DeviceNet / Serial communication
- Factory set for your pressure

### EPR Series

- Models control to 150 psig; 500 psig; 1000 psig; 3000 psig
- Available in gauge, absolute
- Proportional inlet & outlet valves for maximum stability
- No gas wasted at steady state
- Accuracy: +/- .25% F.S
- Repeatability: +/- .08% F.S
- Factory set for your pressure
- Digital or analog communications
- Direct control from the keypad

**The EPR controls pressure accurately and with high resolution within a closed volume or in a system with low flow rates. The dual valve technology controls pressure with minimal loss of expensive gases. Several control ranges available.**

<table>
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<tr>
<th>REGULATOR</th>
<th>DESCRIPTION</th>
<th>KEY FEATURES</th>
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<tbody>
<tr>
<td>QPV Series</td>
<td>High Precision Low Pressure Regulator Controls up to 150 psi (10 bar) Aluminum IP65 enclosure Optional digital display 4-20 mA or 0-10 VDC</td>
<td>- Min range: 0-0.3 psig, vacuum - Max range: 0-150 psig - Available in gauge, absolute, vacuum and vacuum-positive ranges - Superior proportional valve action - Accuracy: 0.1% - 0.5% FS - Resolution: 0.005% - 0.2% FS - Tuned ready for setpoint pilot service - Optional DeviceNet / Serial communication - Factory set for your pressure</td>
</tr>
<tr>
<td>EPR Series</td>
<td>The EPR controls pressure accurately and with high resolution within a closed volume or in a system with low flow rates. The dual valve technology controls pressure with minimal loss of expensive gases Several control ranges available Aluminum IP40 enclosure 4-20mA or 0-5VDC Analog RS232 &amp; RS485 Digital</td>
<td>- Models control to 150 psig; 500 psig; 1000 psig; 3000 psig - Available in gauge, absolute - Proportional inlet &amp; outlet valves for maximum stability - No gas wasted at steady state - Accuracy: +/- .25% F.S - Repeatability: +/- .08% F.S - Factory set for your pressure - Digital or analog communications - Direct control from the keypad</td>
</tr>
</tbody>
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**Fig. 5:** Equilibar GSD8 with QPV pilot controller

**Fig. 6:** Equilibar FDO4 control valve in a flow control loop with an Equilibar EPR electronic pilot regulator and a high resolution flow meter. PID controller not shown.

1flow meter is supplied by end-user; it is not for sale through Equilibar

Contact an Equilibar application engineer to discuss your flow control application.
About Equilibar

Equilibar provides innovative and robust fluid control technology for researchers and engineers worldwide. We are proud to design, manufacture and test our patented back pressure regulators in our factory overlooking the Blue Ridge Mountains near Asheville, NC, and we are equally proud to work with clients around the world each and every day.

APPLICATION ENGINEERING – WHAT SETS US APART

Unlike mass-market valve distributors, we focus on working with you, the scientist or engineer with a complex fluid control scenario.

Our application engineers work collaboratively with clients to identify the optimal model, trim, and diaphragm for each application’s unique challenges. No matter where you are on the globe, you can stay in close contact with your engineer by email, telephone, videoconferencing or fax.

After installation, your application engineer will support you with start-up information and fine-tuning as needed.

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Each application is reviewed by our engineering team to ensure quality performance of our products.

Our engineers offer custom designed solutions for the most difficult fluid control challenges. Feel free to contact us to discuss your situation.

Equilibar’s quality system is ISO 9001:2015 certified.