SDO Single Use Precision Back Pressure Regulator

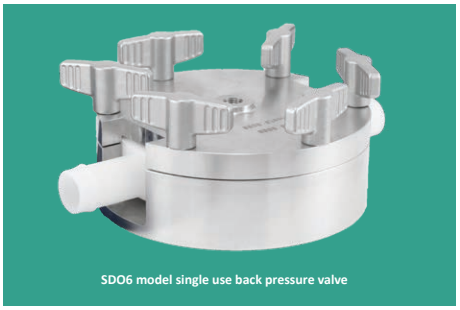
REGULATOR USE AND STARTUP

WARNING:

Make sure that you have read and understand these directions before using, installing, or maintaining the Equilibar pressure regulator. Take steps to ensure this instruction manual reaches the operator of this regulator and stays with the regulator throughout its lifetime. Use, installation, operation, and maintenance of all pressurized products including this regulator must be performed by personnel who are properly trained and qualified through experience or specific training.

Failure to properly observe the instructions contained in this document may result in, but is not limited to:

- Serious personal injury or death
- Unconstrained release of the pressurized media
- Permanent damage to the pressure regulator and/or permanent damage to connected equipment



BACKGROUND

The Equilibar® SDO Single Use regulators are precision back pressure regulators (BPRs). The USP Class VI polymer body and diaphragms are disposable and are inserted into a reusable stainless steel cradle assembly with wing nut closure for quick and easy assembly.

This BPR controls the fluid pressure at its inlet port. The Equilibar SDO controls the pressure by allowing excess flow to vent from the system through the outlet port. The flow direction is from inlet to outlet.

The Equilibar SDO is pilot operated. The pressure setpoint is determined by the pilot pressure that is applied to the Reference (also known as pilot or dome) port. The BPR will control the pressure on its inlet port in a precise 1 to 1 relationship with the pressure applied to the pilot port. The pilot pressure may be applied with a mechanical knob adjusted regulator or with an electronic pressure regulator (see **Fig. 1)**.

The Equilibar BPR uses a flexible membrane diaphragm to both sense the pressure and to provide a direct seal against the orifices in the regulator body. The pilot pressure is applied to one side of the diaphragm. The Inlet "I" port pressure is sensed on the other side of the diaphragm. When the pilot pressure is higher than the Inlet pressure the diaphragm is pushed firmly against the orifices to form a seal and the regulator is effectively closed. When the inlet pressure builds and just equals the pilot pressure, the closing forces are removed from the diaphragm and media can begin to pass from the Inlet to the Outlet port. When sufficient media has passed through the regulator, the Inlet pressure will be reduced slightly, and the diaphragm is allowed to seal against the orifices again. In normal practice equilibrium is achieved and the diaphragm modulates into a position where just enough flow is allowed out of the regulator in order to maintain a steady pressure on the inlet port (see **Fig. 2**).

Typical Circuits:

An SDO back pressure regulator can be used to control the pressure across a membrane filter. In the example circuit shown in **Fig. 3**, Equilibar SDO valves are installed in both the retentate and permeate lines of the tangential flow filtration (TFF) process. Using electronic pilot regulators, setpoints are established to the domes of the SDO valves to deliver the desired TFF transmembrane pressure differential. The SDO valves are able to adjust quickly to changes in upstream pressure or flow in order to maintain stable target dP for effective TFF process control.

The SDO regulator may also be used in other downstream ultrafiltration processes where precise pressure regulation improves process performance.

Equilibar has trained engineers who can work with you to suggest a regulator design for your specific application. These suggestions are recommendations only and are dependent on complete and accurate information from the end user about the application.

It is the ultimate responsibility of the user to determine the compatibility of the media with the materials of construction of the back pressure regulator and with the pilot gas in use.

Fig. 1 HOW EQUILIBAR TECHNOLOGY WORKS

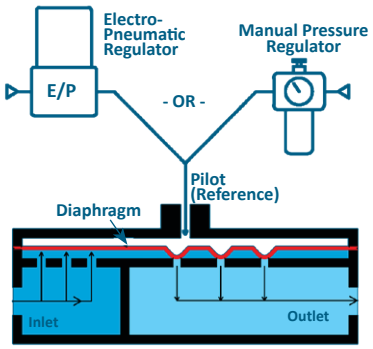


Fig. 2 PRESSURE BALANCE DIAGRAM

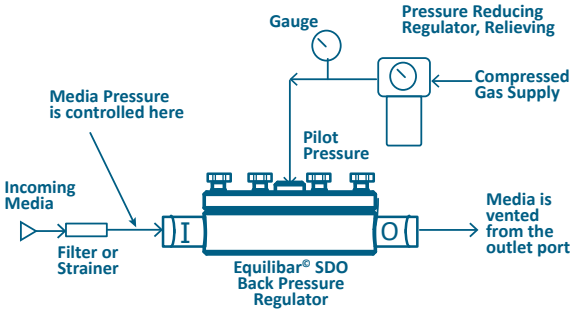
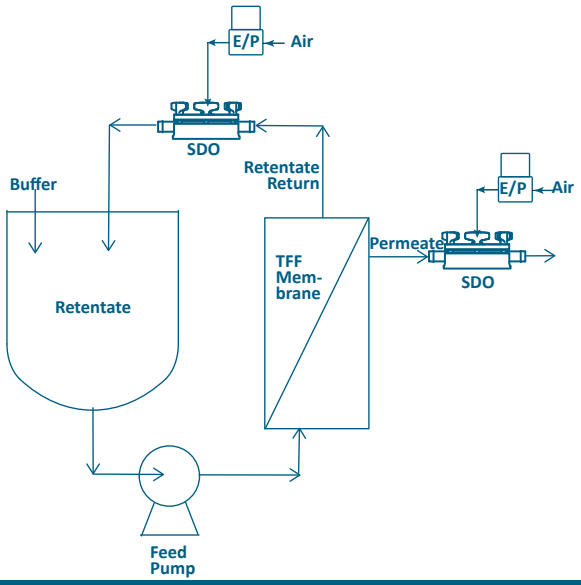


Fig. 3 TANGENTIAL FLOW FILTRATION



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PREPARING FOR INSTALLATION

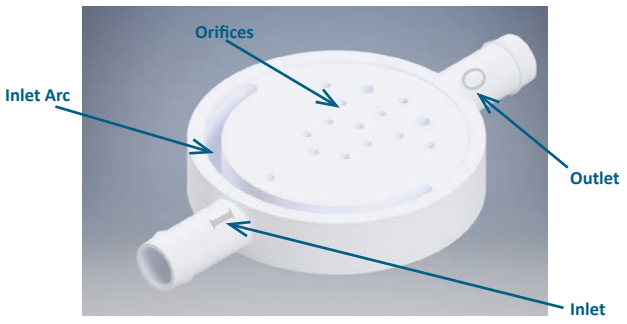
Inspect the Equilibar back pressure regulator (BPR) for any damage. Contact Equilibar before proceeding if you find any damage.

- Verify that the part number on the Equilibar BPR product label matches what you had requested
- Call or email Equilibar if you have any questions, concerns, or need a new copy of these instructions. +1(828)-650-6590; inquiry@equilibar.com
- Take precautions to prevent injury to personnel in the event of a diaphragm failure or external leak. Sensitive fluid controls can experience internal or external leaks. See standard terms and conditions for important limitations of liability notes.
- The Equilibar BPR is not a "Safety Accessory" as defined by the Pressure Equipment Directive 2014/68/EU. Be sure to install appropriate overpressure protection devices such as safety relief valves or rupture discs to protect the system and the BPR from exceeding the maximum allowable working pressures. These safety devices must meet applicable law, codes, regulations, and standards for your jurisdiction.
- Equilibar SDO disposable polymer bodies are prepared and packaged in a class 7 clean room and shipped in hermetically sealed plastic bags ready for sterilization. End users, please follow additional recommendations provided with the tube set.
- Inlet and Outlet ports are labeled with a pronounced "I" and "O" molded into the hose barbs. Ensure that flow goes from the inlet "I" port to the outlet "O" port.
- The inlet port will be connected to the point in the system where it is desirable to maintain or control the pressure of the media. The best pressure control will be seen if the plumbing to the BPR inlet port is as short and as large as practical to minimize the amount of pressure drop in the plumbing.
- System media will be vented out the BPR outlet port. Be sure that the media is vented to a safe environment, away from employees, and in accordance with applicable laws in your jurisdiction.
- Any bolt, screw, or connector that is threaded into a stainless steel cradle assembly should have some small amount of lubricant to prevent thread galling. Thread galling is usually permanent and causes the regulator to be scrapped. The Equilibar factory applies USP Class VI certified DuPont Krytox to bolt thread connections that are not wetted by the process fluid.
- The pilot pressure supply should be an inert compressible gas. Incompressible media such as liquids do not make effective pilot pressures because they do not allow the BPR diaphragm to adjust quickly. Make sure the pilot media is compatible with the media flowing through the BPR.
- The controlled pressure is a near exact 1:1 relationship to the pilot pressure. Installing a pressure gauge in the pilot port may offer advantages over installing a gauge in the Inlet "I" port. The inert pilot media can be read with a less expensive gauge and the pilot pressure may be set even when there is no system media actively flowing.
- The BPR is designed to have maximum pilot pressure applied even when there is no pressurized media at the inlet port. No damage will result.

ORIENTATION FOR INSTALLATION

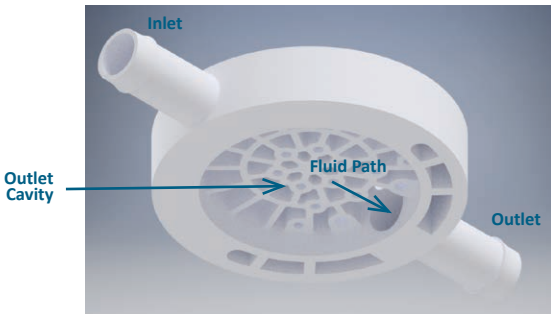
Top:

The top if the regulator can be identified by its field of orifices on a flat surface and its inlet arc. See isometric view below.



Bottom:

The bottom of the regulator can be identified by its domed outlet cavity. See isometric view below.



PATENT INFORMATION

This regulator is subject to one or more of these patents: US6,886,591; US7,080,660; US7,673,650; US8,215,336; DE60322443D1; GB1639282; FR1639282; Other patents pending. https://www.equilibar.com/support/patents/

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INSTALLATION INSTRUCTIONS

- The permanent stainless steel SDO cradle assembly, when initially installed into the system, should be located so that the reference cap is easily accessible. The reference cap will need to be removed each time the single use valve body is replaced.
- The single use valve body may arrive as a single unit in a sealed package or attached in a tube set form designed for your process.
- Before changing the SDO valve body, be sure the system is shut down and no fluid is running through the system.

1. To install the disposable polymer valve body, loosen the wing screws of the permanent cradle and remove the reference cap.
2. Remove and dispose of the old single use valve body and attached diaphragms per your disposal instructions and local regulations.
3. Look carefully at the new SDO to determine the inlet and the outlet ports. Inlet and Outlet ports are labeled with a pronounced “I” and “O” molded into the hose barbs. Ensure that flow goes from the inlet “I” port to the outlet “O” port.
4. The top and bottom diaphragms are welded in place, but they are translucent so you can see the valve construction underneath the diaphragm when identifying the top and bottom of the SDO. Use the images on the previous page to identify top and bottom.
5. Place the SDO into the stainless steel cradle assembly with bottom side down and such that the inlet port is positioned at the inlet of the process.
6. Place the stainless steel reference cap on top of the bottom cap, aligning the holes in the reference cap with those in the bottom cap.
7. Install all wing screws, twisting until they are just flush with the reference cap and begin to tighten.
8. Hand tighten each wing screw starting with one and continuing to tighten in a star-like pattern as shown in Figure B. While tightening, the upper and lower gaskets will compress. Keep tightening until it feels like the gasket deformation has stopped. ***Hand tighten*** as tightly as possible without tools. *Note that fluid may leak if wing nuts are not completely tightened and overtightening with tools may lead to valve failure.*

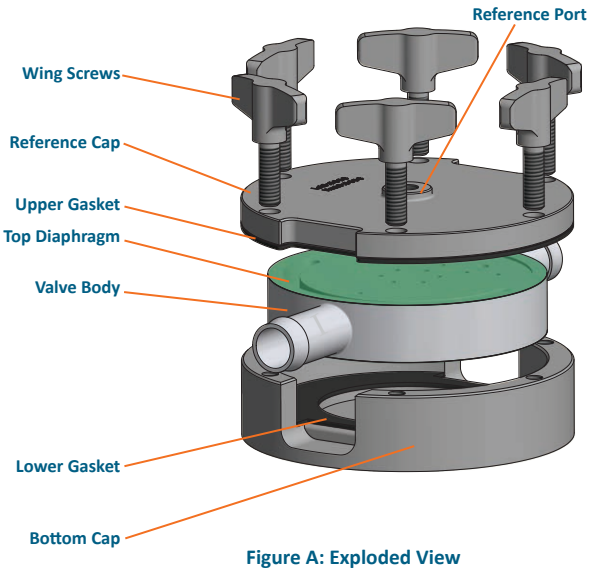

Figure A: Exploded View

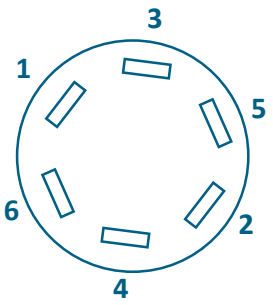

Figure B: Torque Pattern

9. Attach the line from the pilot regulator into the reference port on the reference cap.
10. Equilibar recommends an “initial setting” of the diaphragms up to 1.5X of the application operating pressure. This is achieved by applying pressure to the reference port. This “setting” of the diaphragm can help improve the diaphragm performance at lower flow rates. The unit is designed to withstand full differential pressure of rated pressure from reference/pilot to process pressure.
11. Set the pressure on the pilot regulator for the required system setpoit. Valve is ready to use. *Equilibar recommends that reference pressure be applied before pressurizing the process (inlet and outlet) ports.*
12. Start the flow of process fluid after the diaphragm has been set and the pilot pressure has been applied.
13. Exercise caution when reducing the pilot pressure. The BPR will attempt to reduce the inlet pressure at the same rate that the pilot pressure is being reduced. This can result in extremely rapid release of media through the outlet port of the regulator. Reduce the pilot pressure as slowly as practical.

SDO assembly demonstration video available at https://youtu.be/jH3zsaloVdw

RATED PRESSURE NOTE

Equilibar regulator bodies have a *shell pressure rating* based on the body and bolt strength using principles of the ASME BPVC and B31.3 and are confirmed using hydrostatic testing. These shell pressure ratings are the maximum possible rating for each regulator design as listed in the technical brochures. For example, SDO6 is listed with a maximum pressure rating of 60 psig / 4bar(g). Specific operating conditions may cause pressure derating, therefore the MAWP printed on an Equilibar BPR label reflects that of the selected application conditions and will not exceed the maximum shell pressure rating of the body design.

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TROUBLESHOOTING

PROBLEM	POSSIBLE SOLUTIONS
Maximum flow is reduced	Replace valve
External leak around diaphragm	Check for loose bolts or punctured diaphragm
Chatter on the downstream tubing	Contact Equilibar for additional assistance
Air in process	Check for ruptured diaphragm
Fluid out of the reference port	Check for ruptured diaphragm

SYSTEM HAZARD ANALYSIS

Both normal operation as well as possible failure modes and foreseeable misuse must be accounted for in the design of the system which interacts with and connects to the Equilibar back pressure regulator (BPR). It is the responsibility of the end user to account for these hazards. **Please read all of the following safety and hazard precautions before installing or operating any equipment.**

a. The BPR is not certified as or marketed as a pressure vessel safety relief valve. The BPR is a precision control valve. Guarding against overpressure must be achieved with devices designed and marketed as such.

b. Sensitive diaphragms and external seals can leak. It is the responsibility of the end user to use this product in a way that prevents injury to personnel should leakage occur. See Standard Terms and Conditions for important Limitation of Liability notes.

c. Diaphragms may fail in the open or closed position. Proper safety precautions should be taken for either failure mode.

d. If the internal diaphragm ruptures or leaks, the pilot fluid can be introduced into the process fluid or vice versa. Make sure that the fluids are compatible and not hazardous when mixed.

e. Most auxiliary pressure regulators used to provide pilot pressure to the BPR are of the self-relieving design. Guard against the process fluid relieving out the pilot regulator if the BPR diaphragm fails.

   i. One method to accomplish this is to set the pilot pressure into a static volume chamber that is sealed with an ON/OFF valve after the pressure is set to the desired value.

   ii. Another method is to feed the pilot pressure from the pilot regulator through a check valve to the BPR. In order to reduce the pilot pressure, a bleed from the pilot port to a safe location must be employed. In many cases this bleed can be made to the output of the BPR.

f. If an electronic pressure regulator is used for a pilot regulator, then special consideration must be made. In addition to reviewing the prospect of having the process media coming in contact with and venting out of the electronic pressure regulator, the possibility of ignition of the media by the electronic pressure regulator must be examined. It is the user's responsibility to determine if a hazardous area classification exists and to make sure that the electronic pressure regulator employed meets or exceeds the requirements of intrinsic safety for that area.

g. If the internal diaphragm ruptures or leaks, the result is often that the BPR will fail into a closed position. This results in a blocked pipe with no path for the fluid to escape through the BPR. Over pressurization of the upstream can occur. Steps must be taken to ensure that the upstream piping is made sufficiently strong to withstand this or is guarded by an overpressure relief device.

h. Make sure the process pressure to be controlled is connected to the BPR Inlet port. Process fluid flow is from the Inlet to the Outlet. If the BPR is connected in reverse, it will still operate but it will give poor control and can result in excess pressures. See orientation instructions on page 2.

i. Observe the maximum temperature and pressure ratings on the BPR label. Take steps to ensure these values cannot be exceeded. Where necessary to protect equipment, a suitable type of safety overpressure relief valve must be connected in parallel to the BPR. The overpressure relief valve must be rated to prevent the pressure or temperature from exceeding the BPR maximums as listed on the BPR label. In some installations a rupture disc may be substituted for the safety relief valve.

j. If the discharge piping on the BPR Outlet port becomes blocked, the BPR will open and fill the discharge piping to the same pressure as the maximum pressure in the system. The discharge piping must be rated to contain this pressure or have a safety relief valve to limit this pressure at or below the safe pressure of the discharge piping.

k. Do not use the BPR as a structural member. All piping and plumbing connections to the BPR should be adequately supported. The BPR series is available with a mounting bracket to facilitate the installation.

l. The BPR has been carefully designed by skilled engineers to provide proper safety ratios and adequate pressure regulation. Do not attempt to modify the BPR in any way, including adding or enlarging orifices or ports or replacing wing nuts.

m. Never perform maintenance or inspections on a system when pressurized fluids are present. De-pressurize the system before performing this work. De-pressurize inlet pressure before reference pressure, otherwise a quick drop in reference pressure can lead to a violent exhaust of the upstream pressure through the regulator.

Equilibar's quality system is **ISO 9001:2015** certified.