7641 N Business Park Dr, Tucson, AZ 85743 - (520) 290-6060 – alicat.com/mcd

Bidirectional Mass Flow Controllers
MCD Series

Alicat Scientific, Inc. was approached by a customer to make a mass flow controller that incorporated the principal aspects of a 'Double Block and Bleed' valve system along with flow and/or pressure control. 'Double Block and Bleed' valves are typically used to isolate instrumentation or process systems from their gas sources.

During the development process, a test unit was assembled that placed the feed and exhaust valves of a dual valve pressure controller at the inlet to a mass flow meter. By setting the firmware control parameters to control absolute pressure at the exit port of the meter, absolute pressure control was achieved. This control mode would automatically add gas to the process volume or extract (and vent) gas from the process volume as needed to maintain the pressure set-point. The meter still displayed all of the standard parameters of absolute pressure, temperature, volumetric flow rate and mass flow rate. This, in itself, provided an improvement in utility to the customer by telling him precisely how much gas was involved in maintaining the commanded pressure set-point.

By changing the controlled variable from absolute pressure to mass flow rate, the device exhibited proper mass flow rate control. Next, the set-point input was configured to accept bidirectional commands. In that mode, both positive and negative set-points could be commanded. Positive flow would be flow going from the controller to the process and negative flow would be flow coming from the process into the controller. This mode also worked flawlessly, without software modifications.

Following these initial tests, a tightly integrated mechanical configuration was designed, and a prototype manufactured. Both small flow and large flow configurations have been sold to customers for production line product testing. Here are several examples:

1. Testing the flow vs. pressure characteristics of respiratory assist equipment. In this application, both positive and negative flows were generated while pressure rises or drops were logged. As the equipment was switched between modes, different flow and pressure values were noted.

2. Flow and leak testing of a multi-port industrial valve product. Here, pressures were applied at a number of ports while the flow rates are logged. As the component was shifted from one mode to another, flows ceased along one path and started along another. By monitoring the flows at all of the ports, internal and external leakage paths may be characterized, as well as the characterization of flow path blockages.

3. A remote environmental monitoring station needed to have its accuracy periodically verified. Normally, separate mass flow controllers would be used to:
    a. Draw flow from the sample stack through the infrared analyzer to detect a variety of pollutants.

b. Send a controlled quantity of a calibration gas through the analyzer to verify proper operation.

Additional valves and/or manual operator intervention are required.

Instead of the usual arrangement, an Alicat MCD would be connected so that the inlet valve is fed by the calibration gas and the outlet valve is routed to a vacuum pump. The process connection would then be connected to the analyzer. For the majority of the time, the device is programmed for a 5 LPM volumetric flow rate in the negative direction, drawing a fixed volumetric flow rate through the analyzer from the sample stack. During the calibration cycle, the controller is commanded to deliver a positive 100 CCM flow from the calibration gas cylinder to the analyzer, ultimately exiting out of the sample stack. This cycle may be accomplished under local computer control with no additional control valves.

4. Testing a pressure relief valve. Here, the MCD is used to smoothly ramp the pressure seen by a pressure relief valve. This is done by commanding a fixed mass flow rate. The absolute pressure is monitored. When the relief valve opens, the pressure stops rising. Next the controller is commanded to stop flowing. The new indicated pressure is logged. A negative flow is then commanded for a short time to reduce the pressure, followed by a re-test of the cracking pressure.

The flexibility of the MCD series allows it to be used as a 'Universal Control Element'. For researchers in many fields, the ability to execute on their ideas in a timely manner is of paramount importance to their productivity. One experiment is worth a thousand hours of speculation. If, however, you have to wait that 'thousand hours' for special order instruments to arrive, much of that advantage can be lost. By having several Alicat MCD controllers on hand, researchers can quickly and easily assemble proof of concept experiments within minutes or hours instead of weeks or months.

Generic examples of how the MCD series devices can be used are:

1. Mass flow control from a pressurized source to a process at or above atmospheric pressure.
2. Mass flow control from a pressurized source to a vacuum process.
3. Volumetric (uncorrected) flow control into and out-of processes without changing connection configurations or programming.
4. Absolute pressure control of a closed volume, requiring smooth ramping of pressures, up and down, through bi-directional mass flow control.
5. Absolute pressure control of a flowing process.
6. Absolute back-pressure control of a flowing process.

MCD series controllers are, of course, equipped with all of the standard Alicat features, such as gas selection and multi-drop RS-232 serial communications.