Bi-Directional Mass Flow Controllers

Bi-directional mass flow controllers are able to control the flow of a gas both into and out of a process. A good example of an application is automated “breathing” apparatus for inhalation/exhalation research.

The product line originated following the request of 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. This particular customer required that the feed and exhaust valves be placed at the inlet to a mass flow meter. The firmware control parameters were set to read the output of the onboard absolute pressure sensor thereby enabling control of the absolute pressure at the exit port of the meter. This control mode would automatically add gas to the process or extract (and vent) gas from the process as required to maintain the pressure set-point. The meter still displayed all of the standard parameters available on all Alicat instruments, namely absolute pressure, temperature, volumetric flow rate and mass flow rate. This solution provided an improvement over their existing process by not only controlling the pressure but also reporting on precisely how much gas was being consumed in maintaining that pressure set-point.

The customer then realised that it was possible for the user to change the onboard controlled variable from absolute pressure to mass flow rate thereby changing the instrument from a pressure controller to a true mass flow controller. The set-point input was configured to accept bidirectional commands and in that mode both positive and negative set-points could be read.

This tightly integrated mechanical configuration has been applied to both small flow and large flow applications for a number of widely differing application that include :

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 valves. Pressures wereapplied at a number of ports whilst the flow rates were 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 ofpollutants and (b) send a controlled quantity of a calibration gas through the analyzer to verify proper operation.Additional valves and/or manual operator intervention was required. By contrast, an Alicat MCD was connected such that the inlet valve was fed by thecalibration gas and the outlet valve routed to a vacuum pump. The process connectionwould wasconnected to the analyzer. For the majority of the time, the Alicat MCD wasprogrammed for a 5 LPM volumetric flow rate in the negative direction, drawing a fixedvolumetric flow rate through the analyzer from the sample stack. During the calibrationcycle, however, the controller was commanded to deliver a positive 100 CCM flow from thecalibration gas cylinder to the analyzer, ultimately exiting out of the

sample stack. Thiscycle was accomplished under local computer control without additional valves.

4. The testing of a pressure relief valve. The MCD was used to smoothly ramp the pressure seen by a pressure relief valve. This was achieved by commanding a fixed mass flow rate whilst the absolute pressure was monitored. When the relief valve opened, the pressure stops rising and this can be noted. The controller was then commanded to stop flowing and the new indicated pressure was logged. Lastly, a negative flow was 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. A fast acting supplier such as Alicat Scientific has short lead times and even special designs and modifications can be delivered within very short periods of time.

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 in and outof 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 benefit from the standard features of Alicat instruments; very fast reaction times in the order of 50-100ms, multivariate parameter measurement, 98+ onboard stored gases, no conversion factors (k-factors), 200:1 turn-down, immediately on – no warm up time and the capability to compensate for and not be affected by humidity up to 100%RH (non condensing).

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Photos
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Links

www.pctflow.com/our-products/flow-meters/mass-flow-controllers/alicat-mcd-series-bidirectional-mass-flow-controller/

Video
www.youtube.com/watch?v=6jPHKCqh-iw