Balancing valve technology:

Influencing performance

As discussed in "Complete System Balancing" (Mechanical Business, March/April 2008), we learned that circuit balancing valves can be used to measure and regulate fluid flow in the HVAC system, as required to ensure that at least design flow is available to every terminal unit. We also learned that variable speed pumping can be used to limit excess flow in a balanced system, thereby achieving optimum energy efficiency, while maintaining adjustment capability should system needs or design change.

Circuit balancing valve performance, and the ability of the balancer to accurately adjust flowrates in the system, varies widely depending upon the valve design technology incorporated. Most balancing specifications prepared to standards set out by North American balancing associations such as AABC, NEBB, and TABB, require that the balancer be able to adjust the flow to +/- 5% accuracy. Surprisingly, many valve designs used in North America, are not capable of achieving this level of accuracy.

A circuit balancing valve must perform three key functions:

Positive shut off,
for use as an isolation valve to facilitate terminal unit servicing.

Flow regulation,
by allowing adjustable restriction of the flow stream.

Flow measurement,
usually by means of differential pressure to flow correlation.

Positive Shut-Off

Most every valve design can perform this duty quite well, right down to a common ball, gate, or butterfly valve.

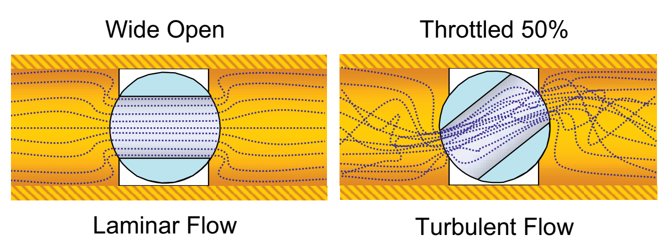
Beware of valves that incorporate a metal to metal seal, however. Should the metal component surface finish be damaged, either during assembly at the factory, installation on-site, or due to corrosion or erosion in operation, the effectiveness of the seat seal can be compromised.

Instead, look for a valve design that incorporates a plastic or polymer seat seal that is capable of shedding mineral or contaminant build-up, is not subject to corrosion or erosion, and is capable of compensating for variation in mating metal surface finish.

Flow Regulation

This requirement is where most valve designs start to fall short for use as a balancing valve where precise flow regulation is required. Ball, gate, and butterfly valve designs induce a significant amount of turbulence in the flow stream. Turbulence is the enemy of accurate flow measurement and when these valve designs are throttled, the induced turbulence becomes intolerable.

Ball Valve
Top View (Cross Section)



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Another aspect of flow regulation that affects the performance of the valve is the adjustment precision and repeatability. This is where more sophisticated valves also shine. A 90-degree ball or butterfly valve – which shouldn't be used in the lower 60% of the throttling range – really only has 36 degrees of adjustment precision. Additionally, these valves usually incorporate a simple graduated scale that makes it virtually impossible to accurately read the valve handle position, or to return the valve to a precise throttle set-point.

Variable Orifice: Up to +/- 15% when throttled.

In contrast, globe style valves can provide multiple turns of adjustment. Additionally, because these valves induce less turbulence when throttled, they can be used over a wider range of operation, in some cases providing over 1600 degrees of adjustment precision. Look for valves that include a micrometer-style handle-turns indicator that enables precise valve adjustment and repeatable flow regulation.

An adjustable valve opening high limit is also desirable so that the valve can be used for isolation and returned to the calibrated flow set-point, without need for recalibration. Avoid valves that have a locking handle. Once the handle is unlocked for use as an isolation valve, most maintenance people will simply turn the valve wide open when the job is complete, thereby losing the precise calibration performed by the balancer.

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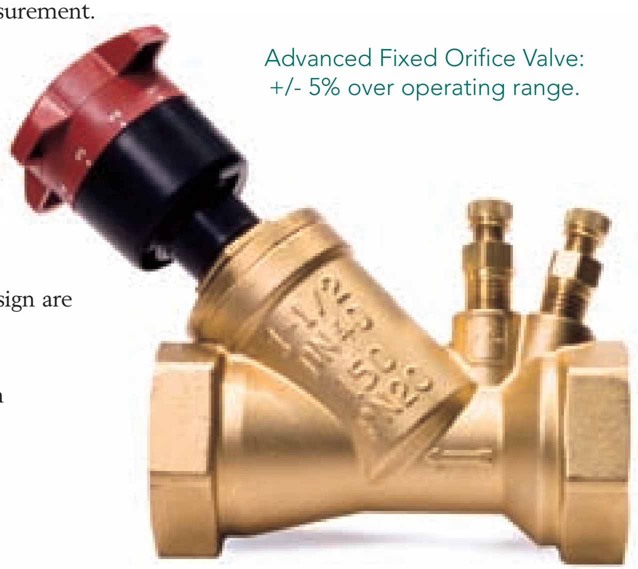
Flow Measurement

Most balancing valves provide pressure tappings, which are measured with a differential pressure manometer, for proportional flow correlation.

The two most prevalent technologies for differential pressure to flow correlation, are either by a fixed orifice primary measuring device (PMD), or by measuring the pressure drop directly across a valve seat.

1. Fixed orifice PMDs usually consist of either a precision machined venturi or squared edged circular orifice plate. Either design is capable of providing +/- 5% accuracy over a wide range of valve throttling. Of the two technologies, a venturi helps to train the flow into the valve, minimizing the influence of upstream flow turbulence and the downstream valve restriction on the flow measurement. For larger valves, square edged orifice plates are often used as the metal and machining of a large venturi is cost prohibitive.

2. Measuring the pressure drop across a valve seat for flow correlation, often referred to as variable orifice flow measurement, is unacceptable where higher accuracy is required. This technology can provide required accuracy only when the valve is wide open, diminishing to +/- 15% deviation or more, as the valve is throttled. Surprisingly, many valves of this design are still used in North America, even though the valve isn't capable of meeting most balancing specifications, as soon as the valve is throttled even a fraction of a turn. Instead, these valves should be used in conjunction with an alternate technology fixed orifice flow measuring device, such as a venturi or orifice plate.



Advanced Fixed Orifice Valve: +/- 5% over operating range.