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# BALANCING VALVE STRAINER EFFECT

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What is "Balancing Valve Strainer Effect"?

"Strainer Effect" is the term that has been utilized to describe the situation when a balancing valve has been closed to a point that the valve opening is so small dirt and debris in the water system gets caught in the opening and prevents water flow from passing through the valve. The valve now is acting as a "strainer". This situation is most common for low water flow requirements such as reheat coils, chilled beams, fan coil units, convectors, etc.

Mr. Jeff Jones of Pro Hydronic Specialties has performed the calculations of the opening size for a standard globe style manual valve and that of a variable orifice balancing valve. The calculations show that opening of these valves can be smaller than the opening of a 10 mesh strainer. Reference the calculations in Table 1.

The balancing valve can become plugged in as little as a couple months or possibly a year or more. It is all dependent upon how far closed the valve is set and the cleanliness of the water system. If an element is not performing (heating or cooling), the position of the balancing valve serving the element in question should be checked. If the balancing valve is closed more than 40%, the valve should be cycled to 100% open. This should clear the dirt/debris from the balancing valve and the balancing valve can be reset to its original position. If possible, the balancing valve should be set slightly more open to prevent the valve from acting as a strainer in the future.

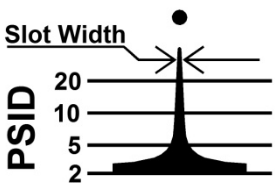
A balancing valve with a variable orifice could give an erroneous differential pressure reading when debris starts accumulating in the valve opening and restricting water flow. The differential pressure across the variable orifice will increase in this situation and the water flow will decrease. The higher differential pressure reading implies increased water flow, which is incorrect.

A balancing valve with a fixed orifice (a true venturi) will provide a correct differential pressure measurement for flow determination. As the pressure increases across the venturi the flow increases. As the pressure decreases across the venturi the flow decreases. If "strainer effect" is occurring in the valve located downstream of the venturi, the venturi will measure a low pressure differential indicating low water flow.

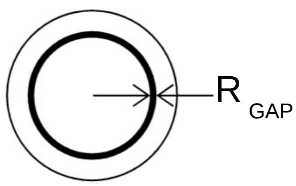
To minimize the chance of strainer effect, the balancing valve should be sized for water flow and not pipe line size. This will help prevent having to close a balancing valve more than 40% to 50%.

Physics Driven Solutions for Hydronic Balancing

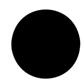
# Variable Orifice Strainer Effect Under Low Flow Conditions




Slotted Design




Globe or Disk Design

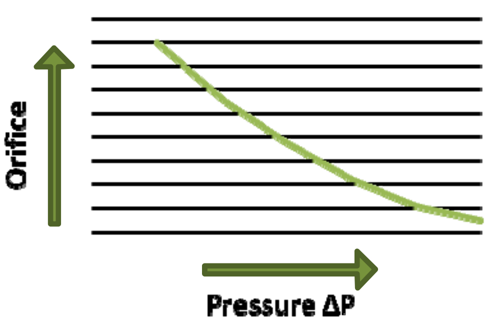


Static Orifice Design

| Pressure ΔP | Slot Width | Disk Gap (R-GAP) | Diameter of Static Orifice | Area In² |
|---|---|---|---|---|
| 2 | 0.350 | 0.0108 | 0.165 | 0.0186 |
| 5 | 0.060 | 0.0085 | 0.165 | 0.0118 |
| 10 | 0.015 | 0.0072 | 0.165 | 0.0083 |
| 20 | 0.008 | 0.0060 | 0.165 | 0.0059 |
| 30 | 0.002 | 0.0054 | 0.165 | 0.0048 |

**1.0 GPM Flow - Calculated**

Estimates of Area which vary depending on Coefficient of Discharge




For a Given Flow;

As the Pressure increases, the Orifice decreases.

Inversely, as the Orifice increases, the Pressure decreases.

General Relationship of Orifice/Pressure for a Given Flow

The calculations on this document are generalized due to the Flow Coefficient (K) being unknown and varying for diverse flow orifice conditions. While changes in K do effect the orifice size, these orifices are still very small for low flows. It is the purpose of this document to demonstrate that these orifices are often smaller than the strainer mesh openings, not to determine the exact size of the orifice for a given flow. The physical configuration of a Slotted Orifice or the gap from the Globe Design is smaller than the mesh opening for low flow requirements. A Static Orifice Pressure Independent design allows for optimal orifice size for an automatic flow limiting valve.

**WARNING: Cascade Failure Can Occur with a Variable Orifice Design!**

Why? These are pressure dependent for position (P1, P2). As the orifice becomes clogged, the differential pressure increases resulting in the piston closing further with even smaller orifices that clog more quickly. Cascade failure is imminent with total stoppage of flow once clogging begins.

**Equation to Determine Approximate Orifice for a Given Flow**

$$A = \frac{Q}{25K\sqrt{\Delta P}}$$

**Equation to Determine Max Gap using Disk or Globe Restriction**

$$R_{GAP} = R - \sqrt{R^2 - \frac{A}{\pi}}$$

**Q = Flow**
**A = Area**
**K = Flow Coefficient = 1**
**ΔP = Pressure Differential**
**R = Radius of Orifice**

**NOTE: Actual orifice dimensions will vary depending on the flow coefficient**

**Equation to Determine Gap / Width of Slotted Design**

**Taken from Actual Measurements**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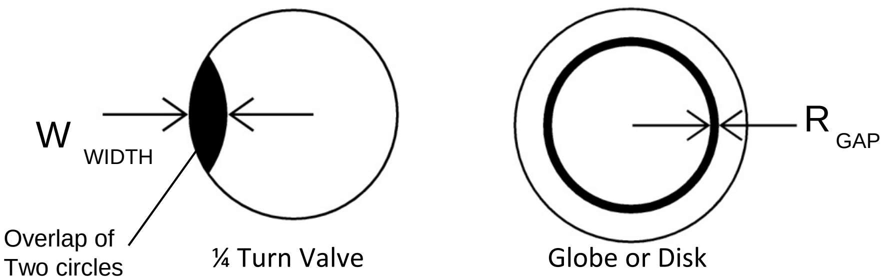
# Strainer Effect on Low Flow Globe Style Manual Valves

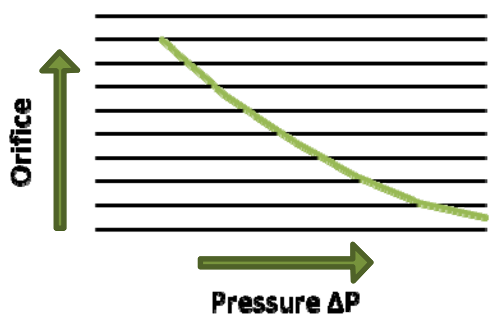



| Pressure ΔP | Area In² | Max Gap ¼ Turn Valve | Max Gap Globe Style |
|---|---|---|---|
| 2 | 0.0186 | 0.074 | 0.0108 |
| 5 | 0.0118 | 0.054 | 0.0085 |
| 10 | 0.0083 | 0.042 | 0.0072 |
| 20 | 0.0059 | 0.034 | 0.0060 |
| 30 | 0.0048 | 0.030 | 0.0054 |

All smaller than 10 mesh screen

**1.0 GPM Flow - Calculated**

Estimates of Area which vary depending on Coefficient of Discharge




For a Given Flow;

As the Pressure increases, the Orifice decreases.

Inversely, as the Orifice increases, the Pressure decreases.

General Relationship of Orifice/Pressure for a Given Flow

The calculations on this document are generalized due to the Flow Coefficient (K) being unknown and varying for diverse flow orifice conditions. While changes in K do effect the orifice size, these orifices are still very small for low flows. It is the purpose of this document to demonstrate that these orifices are often smaller than the strainer mesh openings, not to determine the exact size of the orifice for a given flow. The physical configuration of the gap from the Globe Design is smaller than the mesh opening for low flow requirements while a quarter turn valve allows for optimal orifice size for a manual balancing valve.

According to ASTM E 11-04 Specifications

Approximate Opening:
U.S. No 10 Test Sieve – 0.078”
U.S. No 20 Test Sieve – 0.033”

**Equation to Determine Approximate Orifice for a Given Flow**

$$A = \frac{Q}{25K\sqrt{\Delta P}}$$

**Q = Flow**
**A = Area**
**K = Flow Coefficient = 1**
**ΔP = Pressure Differential**
**R = Radius of Orifice**

**Equation to Determine Max Gap using Disk or Globe Restriction**

$$R_{GAP} = R - \sqrt{R^2 - \frac{A}{\pi}}$$

**NOTE: Actual orifice dimensions will vary depending on the flow characteristic**

**Equation to Determine Center of Two Circles Given Known Area of Overlap**

$$A = r^2 \cos^{-1}\left(\frac{d^2 + r^2 - R^2}{2dr}\right) + r^2 \cos^{-1}\left(\frac{d^2 + R^2 - r^2}{2dr}\right) - \frac{1}{2}\sqrt{(-d+r+R)(d+r-R)(d-r+R)(d+r+R)}$$

$$r = R = \text{Ball I.D.} = 0.5$$

**Equation to Determine Width of Overlap**

$$W_{WIDTH} = 2R - d$$

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