Defining Pressure Independence:

Testing Accuracy and Response

Introduction

Despite the industry moving toward pressure independent control valves, an agreed upon definition of pressure independence has not been established. As the inventors of pressure independent technology and industry leaders in performance, precision control and durability, Flow Control Industries has defined pressure independence as maximum of ±5% allowable deviation of total flow from setpoint. While nearly all other manufacturers of "pressure independent" valves claim to meet or exceed this specification, third party testing data clearly shows that the DeltaPValve is the only one to perform as advertised.

In order to understand the impact of pressure independent operation on a hydronic coil, it must first be defined. Simply put, pressure independence is the ability to maintain a constant flow while the differential pressure across the valve changes. Though the concept is simple, the practical application quickly becomes complex. Due to a multitude of factors, there are different degrees to which this relationship of differential pressure modulation and flow stability holds true.

The ideal pressure independent valve would hold the flow constant with no discernible fluctuation. The reality is that there will always be *some* fluctuation due to part inconsistencies, machining tolerances, etc. The acceptable amount of deviation from the setpoint is up to the end user. That said, the more stable the flow, the more precise the control and the more efficient the operation.

The importance of stable flow through a hydronic coil cannot be understated, as most operational issues in a hydronic system can be traced back to unstable operation at the coil. Assuming the entering water and air temperatures are within the design parameters of the coil, stable flow equates to maximum energy transfer between the air and water passing through the coil.

Compare a typical (pressure dependent) system to a hydronic system fitted with pressure independent control valves. In the pressure independent system, the operation of one valve does not affect another – assuming a relative degree of pressure independence. This results in stable leaving air temperatures and higher return water temperatures. All things being equal, better performance will be gained from better pressure independence. With this in mind, an investigation of the operational characteristics of some commonly available pressure independent control valves was undertaken.

Discussion

Testing Procedure

Five different ¾" pressure independent control valves were sourced and sent directly from their respective manufacturers to an independent university testing facility, utilizing a third-party shipping agent. The testing consisted of installing each valve into a test stand according to the manufacturer's requirements. Each valve was tested across its full pressure range at multiple flow rates. The data was then catalogued in a report.

The following was completed for each valve:

a) Set and record the valve position.
b) Set the desired differential pressure across the valve under test using an upstream control valve.
c) Record upstream pressure.
d) Record the pressure differential across the valve.
e) Record the volumetric flow rate.
f) Record the fluid temperature.
g) Record the barometric pressure.
h) Repeat for five additional differential pressures.
i) Repeat for 75%, 50% and 25% of the flow achieved at 100%.

Pressure independence was then calculated using the following formula:

$$PI = \frac{Q_{max} - Q_{min}}{Q_{avg}}$$

Where Q_{max} is the maximum flow rate over the differential pressure range while Q_{min} is the minimum flow rate over the differential pressure range. Q_{avg} is the average of these two values. The testing procedure commenced by setting the valves actuator at 100%. The pressure differential range for the valve under test was established and six data points were collected beginning at the lowest rated differential pressure and proceeding to the highest rated differential pressure.

Testing Results

The results clearly show that there is a wide swath of what is marketed as “pressure independent”. Figure 1 shows the operation of the DeltaPValve at 50% and 100%. With a pressure independence of only ± 1.85% at 50% and ± 2.68% at full open, the DeltaPValve bests the competition by far and can be used as a benchmark to catalogue the performance of the other valves.

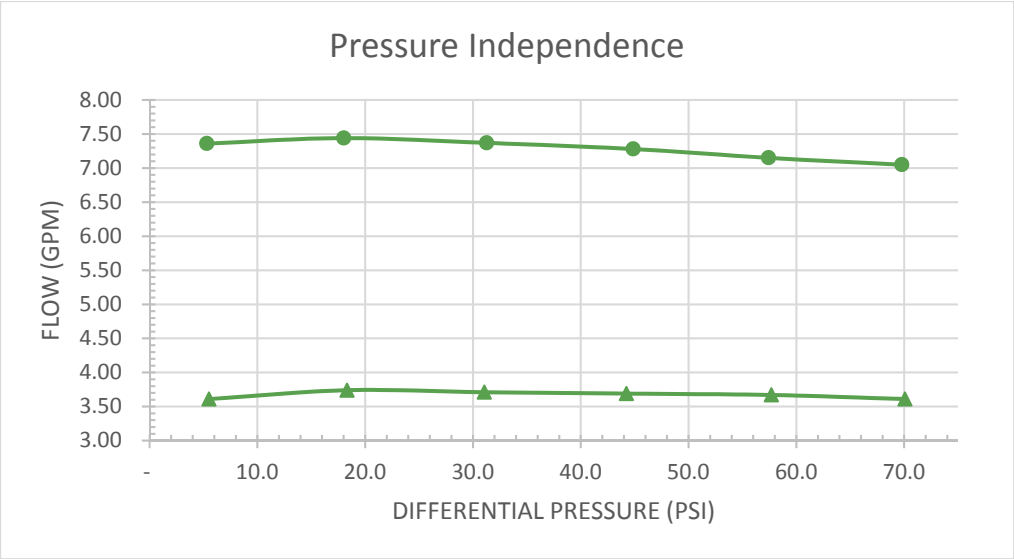

Figure 1: DeltaPValve Flow Testing at 50% and 100% Open

Figure 2 shows the performance at full open for the other 4 valves. All the competitor’s valves exhibit non-linear performance that fall far outside ±5% of the set flow rate. While the DeltaPValve displayed a stable flow rate throughout the pressure range, most competitor’s valves had difficulty at both the upper and lower ends of the range, or operated in a completely uncontrolled fashion.

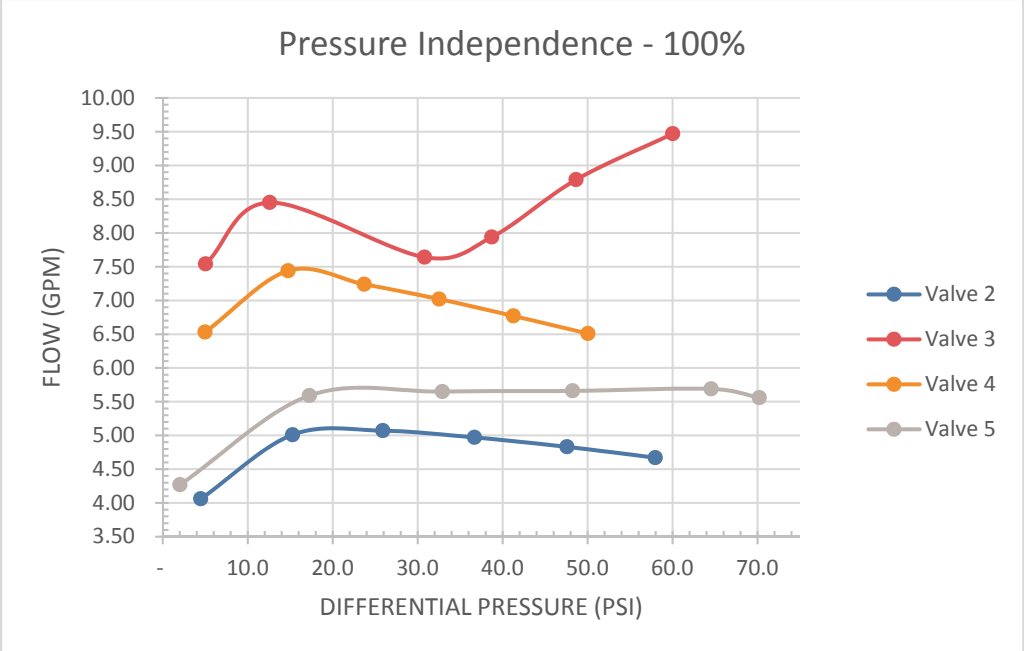

Figure 2: Competitive Valve Flow Tests at 100% Open

Valve 3 displayed the worst performance. While it was rated at 7.5 GPM at full open, testing revealed the flow to range from 7.5 GPM up to 9.5 GPM (± 14.35%). Standard design practice dictates that a pressure independent valve be selected by matching the valve flow rate to the coil flow rate. Installing this valve on a 7.5 GPM coil would result in overflowing it by nearly 27%. Assuming the control of the valve were to be targeting a set leaving air temperature, the unstable nature of the valve would result in hunting and a depressed chilled water return temperature and ΔT.

Figure 3 shows the flow variance of each valve at the 50% and 100% open positions, highlighting the pressure independent accuracy across the specified differential pressure range. A tighter grouping represents more accurate performance and stable flow, as desired with pressure independent control.

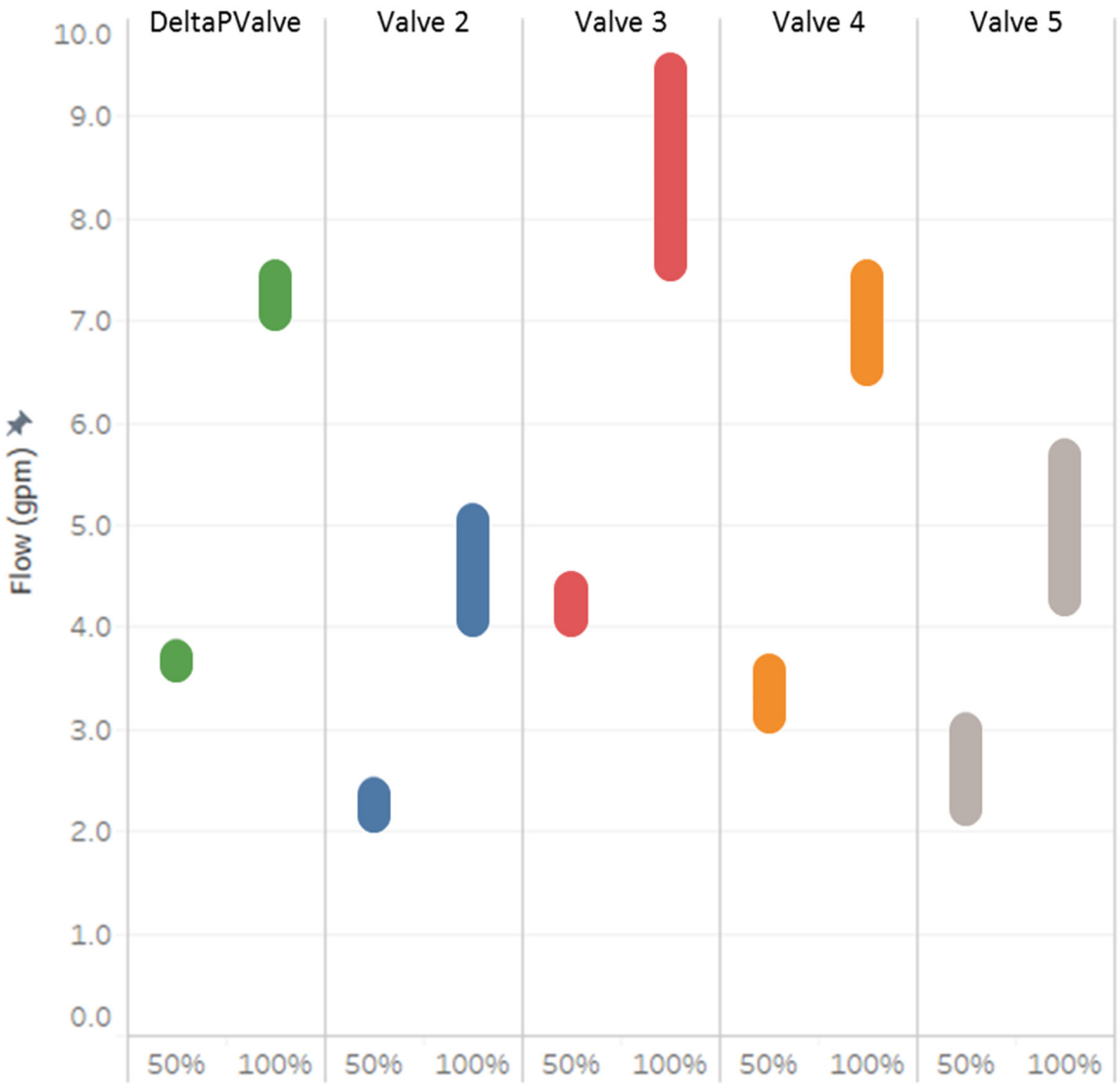

Figure 3: Flow Range at 50% and 100% Open

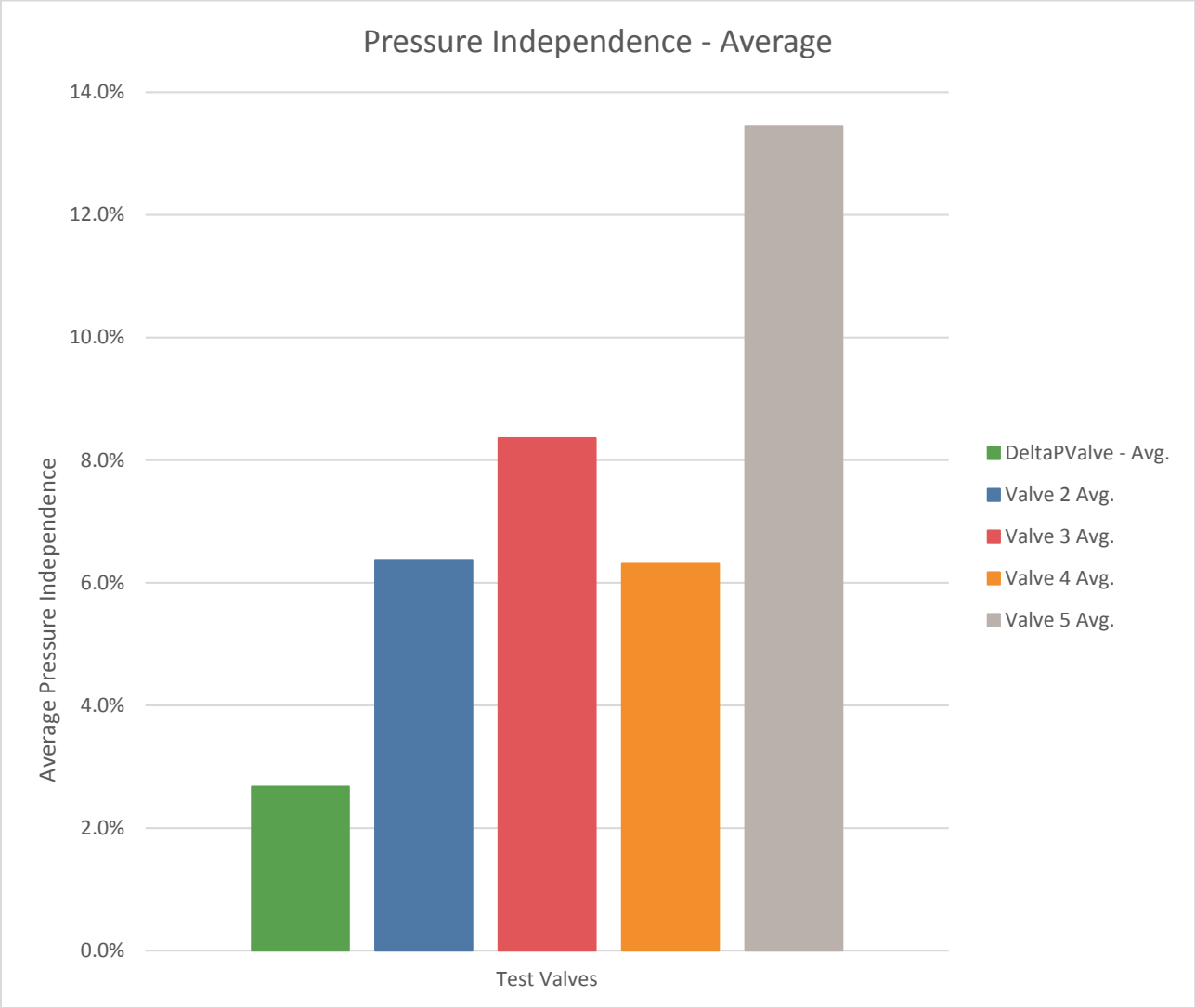

Figure 4: Average Pressure Independent Accuracy

In addition to exhibiting precision control and operating well within the specified pressure independence at all tested flow ranges, the DeltaPValve also performs with the most precise pressure independence. Figure 4 shows the average pressure independence of each valve with the DeltaPValve being the lowest at 2.7% and valve 5 the highest at 13.4%

Conclusion

A high-quality pressure independent control valve will allow for precision control and maximum energy transfer in a hydronic system. While many valves claim to be "pressure independent", most fall short. The only way optimum performance can be achieved is through the use of the highest quality precision control valves, utilizing the best materials and methods. DeltaPValves not only set the quality and performance standard, they are backed by a 10-year guarantee that covers the construction and the performance of the valve for many years of unmatched operation.