EDITOR'S EMPHASIS

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Understanding High-Flow Valves

Luxury homes dominate the market trends for valves compatible with high-flow fixture demands.

The demand for 1¼-inch plumbing in residential applications is on the rise. Recent trends in new home construction have been towards larger homes with more plumbing fixtures. Twenty years ago, a typical home with 0.75-inch plumbing had two bathrooms, a kitchen sink, dishwasher, laundry sink and two hard water outside hose bibs. Many new homes today utilize 1-inch (or larger) plumbing to supply three or more bathrooms, two kitchen sinks, a bar sink, hot tub, laundry sink, mud room sink, soft water hose bib and two hard-water hose bibs. While not all new homes include such luxuries, the trend in even modest homes is toward including more fixtures and larger plumbing piping.

Already a Reality

According to Bruce Martin, industry expert and president of W/C Technology, a MASCO company, larger supply pipes have been a reality for years. "Any credible plumbing contractor or architect will specify plumbing supply lines and systems to meet the demands of the size of the household, as well as its plumbing fixtures. Bigger homes with numerous fixtures and higher water demand have led to the utilization of larger diameter piping such as 1¼ inch. I've even seen cases where 2-inch plumbing was used."

Flow Rates Predicted by Code

Providing a water conditioning system that meets the actual water flow demands of new homes as well as the Plumbing Code requirements for these homes is a challenge. Consider the requirements of meeting a strict interpretation of the Uniform Plumbing Code 2000 Edition. The flow rates required for a "typical" home and a "luxury" home are shown in Table 1. The typical home in this example includes two and a half baths, a kitchen sink, laundry sink, clothes washer and dishwasher. The luxury home in this example includes three and a half baths, two kitchen sinks, a bar sink, laundry sink, soft water hose bib, clothes washer and dish washer. These are not atypical in today's housing market, yet the flow rates required by code are 19 gallons per minute (gpm) for the typical home and 24 gpm for the luxury home.

Observed Flow Rates

Given the high flow rates predicted by the codes, how has the water conditioning industry been able to satisfy its customers' needs when the vast majority of the systems sold today

Table 1. Required Flow

		Typical Home
Fixture Type	Quantity	Fixture Units
Kitchen Sink	1	1.5
Water Closet (flush tank)	3	2.5
Bathtub	2	4
Shower	0	2
Lavatory	3	1
Laundry sink	1	1.5
Washing Machine	1	4
Dishwasher	1	1.5
Hose Bib (¾ inches)	0	2.5
Bar sink	0	1
Total Fixture Units		
Flow Rate (GPM)		
Required Pipe Size (inch - type M copper tubing)		
Required Pipe Size (inch - CPVC plastic tubing)		

- There were 12 sites in seven states/provinces and a total of 1,188 households in the study.
- Data was taken in both summer (peak) and winter (off-peak) seasons.
- A total of 28,015 days of data was accumulated.
- A total of more than 1.9 million flow events were recorded.
- The average house size was 1,800 to 2,000 sq. ft. (11 percent had less than 1,000 sq. ft., 22.6 percent had between 1,000 and 3,000 sq. ft.).
- Water used outside the home (i.e., irrigation, swimming pool, etc.) was not included in the study.
- The average household in the study included 2.8 people (2.13 adults, 0.22 teenagers and 0.45 children under 13).
- The average house had 2.3 bathrooms.

Analysis of the flow "events" include

- 95 percent were at 6 gpm or less
- 99 percent were at 7.5 gpm or less
- 99.9 percent were at 10 gpm or less
- 99.96 percent were at 12 gpm or less
- On average, peak flow events exceeding 12 gpm would occur only once every 1.14 years per site.

System Flow Ratings

The code requires that the maximum flow rate for a water conditioner be at a pressure drop of 15 psid or less. Valve manufacturers typically rate the flow rates of their valves as "valve only." Since the valve manufacturers do are not capable of providing such high flow rates? The answer is that when the fixture flow guidelines included in most plumbing codes are strictly interpreted they predict unrealistically high flow rates.

In March of 2001, the Water Quality Association issued a report entitled, *Analysis of Indoor Peak Demands in Single-Family Housing*, prepared by Aquacraft, Inc. Water Engineering and Management. The data was collected from May 1996 through March 1998. Some of the study's highlights include

Rates Predicted by Code

	Luxury Home		
Total	Quantity	Fixture Units	Total
1.5	2	1.5	3
7.5	4	2.5	10
8	2	4	8
0	1	2	2
3	4	1	4
1.5	1	1.5	1.5
4	1	4	4
1.5	1	1.5	1.5
0	1	2.5	2.5
0	1	1	1
27			37.5
19			**24**
1			1.25
1.25			1.5

Table 2. How System Components Contribute to Pressure Drop

Valve Size	21 gpm		27 gpm	
System Size (cu ft)	1	2	1	2
Flow (gpm) used for calculation basis	12	16	12	16
Collector (standard slot)	0.15	0.26	0.15	0.26
Distributor (standard slot in gravel)	0.84	1.49	0.84	1.49
Valve pressure drop	4.94	8.78	3.11	5.54
Flowmeter pressure drop	0.68	1.21	0.44	0.79
Resin Pressure drop (Standard Mesh)	6.79	5.09	6.79	5.09
Total System Pressure Drop @ 12 / 16 gpm	13.40	16.84	11.34	13.17
System Cv	3.28	3.90	3.56	4.41
Maximum system flow at 15 psid	12.7	15.1	13.8	17.1
Percentage of system pressure drop due to valve	37%	52%	27%	42%

not have control over the design and installation of the water softener, they cannot predict the "system flow." Valve only flow ratings do not include pressure drop due to resin, distribution system and accessories.

While advertised system flows must be based on third-party test results, it is interesting to note how the different system components contribute to the overall system pressure drop. The calculations in Table 2 compare 1 and 2 cu. ft. softeners assembled with valves rated at 21 gpm and valves rated at 27 gpm (flow rate for valve only at 15 psid).

From Table 2 we find

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- That there is only a 1.1 to 2.0 gpm difference in system flow ratings between a water softener constructed with a 21 gpm valve versus a 27 gpm valve.
- The valve contributes as little as 27 percent of the total system pressure drop.
- For smaller (1 cu. ft.) systems, the resin pressure drop exceeds the valve pressure drop.

Other things that have a significant impact on system flow include resin selection (uniform particle, standard or fine mesh), type of distributor, use of a gravel under bedding system and plumbing used in the installation.

For example, consider the effect of assembling a 1 cu. ft. system (21 gpm valve) as above but with a fine slot distributor and no gravel under the bedding. The fine slot distributor installed in a system with standard mesh resin and no gravel has a pressure drop of 3.17 psid at 12 gpm. This system design change would result in a system rating of 11.7 gpm at 15 psid. This is about the same change in system flow as assembling the system with a 27 gpm valve.

Recent trends in home construction and strict interpretation of plumbing codes are forcing the water conditioning industry to offer systems with higher flow ratings. While the need for higher flow rates in larger homes is genuine, the actual flow rates that are encountered are likely to be less than those predicted using the traditional fixture count method to calculate flows. The system manufacturer needs to carefully consider all components used to assemble the system when designing a water conditioner to meet a specific flow requirement. WQP

About the Author
Dave Averbeck is the director of engineering at Pentair Water Treatment (PWT) since 1999. In 1978, Averbeck started his career in the water treatment business. Prior to PWT he worked for Water Services, Inc. He has a BS in mechanical engineering from the University of Wisconsin Milwaukee.

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