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FURON® Pure Performance

Benchmark Report

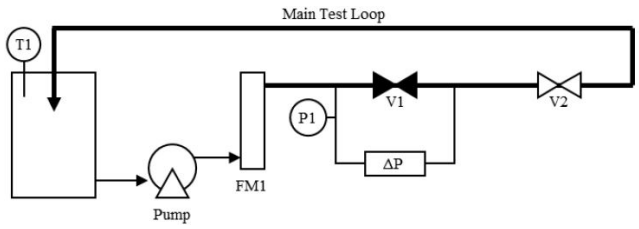
Flow Coefficient (C_V) Comparison of Three Major Valves Used in High-Flow Applications in the Semiconductor Industry

Three pneumatically actuated control valves with 2" union ends were tested to determine flow coefficients (C_V) in Ultra Pure Water by a third party semiconductor industry laboratory. The three valves tested were configured as normally closed. The make and model of the valves were: a Gemü® 600 with 50 mm PFA union ends, an Entegris pneumatic valve with 2" PFA union ends and a Furon® HGVM Valve with 2" PFA union ends. These tests were carried out using ANSI/ISA–75.02.01–2008, "Control Valve Capacity Test Procedures" as a guideline.

Flow Coefficient Test Method

The test apparatus was constructed according to the ISA standards[1]. A diagram of the apparatus is shown Figure 1 below:

Figure 1 – Effect of ΔP on C_V



All piping in the test loop was Schedule 40 PVC piping with a 2" nominal diameter, except ¼" PFA tubing used downstream of the pressure taps. Construction according to ISA specifications minimized flow disturbances in the main test loop. The valve flow coefficient (C_V) test procedure followed guidelines specified by ANSI/ISA–75.02.01–2008, Section 6.1. Test valves were installed in the main test loop without reducers. A visual inspection and level gauge were used to align the test loop and valve to ensure a uniform flow path. Test loop inner pipe diameter and valve inlet/outlet diameters were comparable.

Specific attention was taken in order to verify that the manufacturer-specified actuation pressure was delivered to the test valve, ensuring that all tests were carried out at 100% of valve travel. Flow was initiated and adjusted by varying the pump speed and throttling flow using V2. Recordings of upstream pressure (P1), pressure differential across the valve (ΔP), reservoir temperature (T1) and flow rate (FM1) were made during testing.

Results

The test was carried out at flow rates ranging from 45–80 GPM. Choked flow[2] could not be achieved with this test apparatus. As demonstrated in Figure 2, there was a continuous increase in flow as ΔP increased; however, the overlapping points at the end of each curve appear to be approaching a regime of

Figure 2 – Choked Flow Test

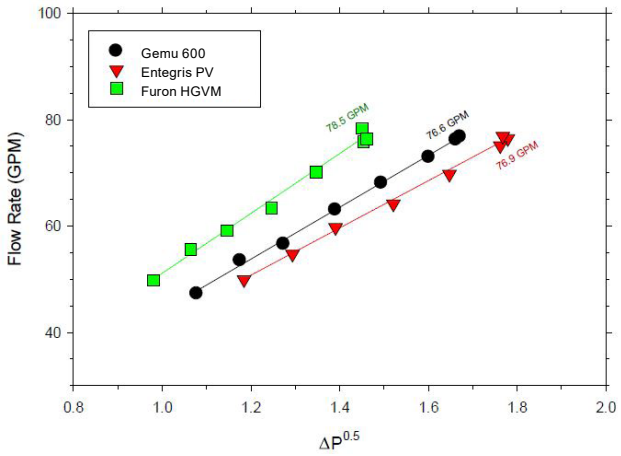
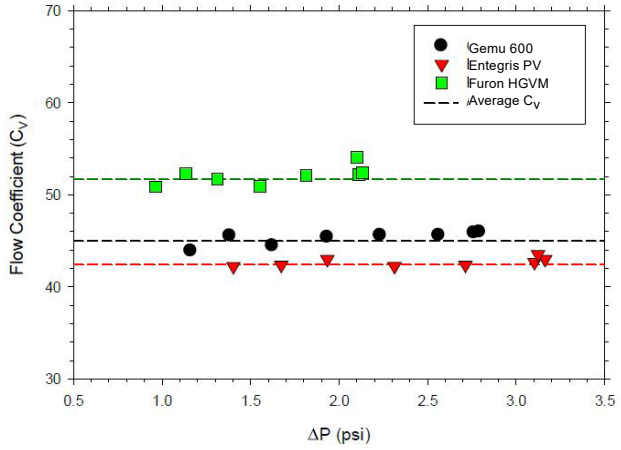


Figure 3 – Effect of ΔP on C_V



choked flow. The effective choked flow used for calculations during this analysis was the maximum flow achieved for each valve. Barometric pressure during testing was 30.02 in Hg and upstream pressure ranged from 20 to 100 psid. The resulting pressure differential across the control valves under test ranged from 0.7 to 3.2 psid. The effect of each of these variations on the flow coefficient (C_V) is shown in Figures 3-5. There is no discernible dependency of C_V on any of the measured variables.

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Valve inlet/outlet and test loop inner pipe diameters were adequately matched as shown by calculating the piping geometry factor[3]. Issues associated with compressible flow have been ignored due to the negligible compressibility of water under these conditions. The valve Reynolds number (Re_V) was found to be >100,000 for all tests indicating turbulent flow[4].

A comparison of the manufacturer's stated C_V versus measured C_V is shown in Table 1. There is a reasonable agreement between the stated and measured C_V for the Furon valve. There is some deviation from the stated C_V for the Entegris and Gemü valves. This could be explained by the flow rate and pressure limitations of the system, or characteristics that differ in the test set-ups used by these manufacturers.

Table 1 – Cv Comparison for Tested Control Valves

Test Valve	Stated C_V	Measured C_V	% Diff.
Gemü® 600	53	46	-13.2%
Entegris 2" Pneumatic Valve EPLPV-P32N	60	43	-28.3%
Furon® HGVM HGVM2-73232-NC	52	52	-0.5%

Summary

The test was carried out at flow rates ranging from 45–80 GPM. Three pneumatic control valves were assessed to determine the flow coefficient (C_V). The Furon HGVM valve tested closely matched the manufacturer's stated value at 0.5% below the stated C_V. The Entegris and Gemü valves came in below the stated C_V by 28.3% and 13.2% respectively.

References

[1] Control Valve Capacity Test Procedures, ANSI/ISA–75.02.01–2008, Section 4.1, Figure 1.
[2] Ibid., Annex E.
[3] Ibid., Annex F.
[4] Ibid., Section 7.5.

Figure 4 – Effect of Upstream Pressure on C_V

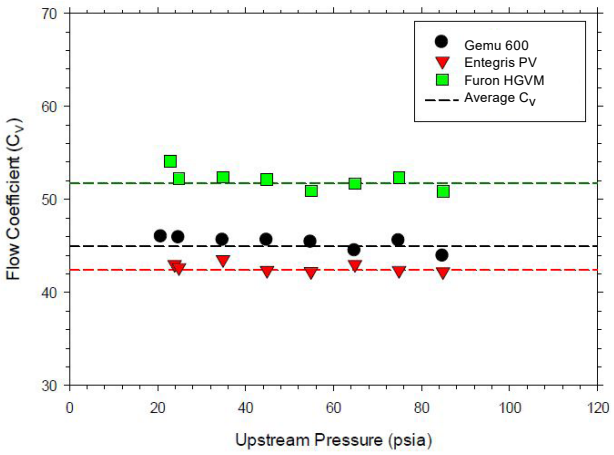
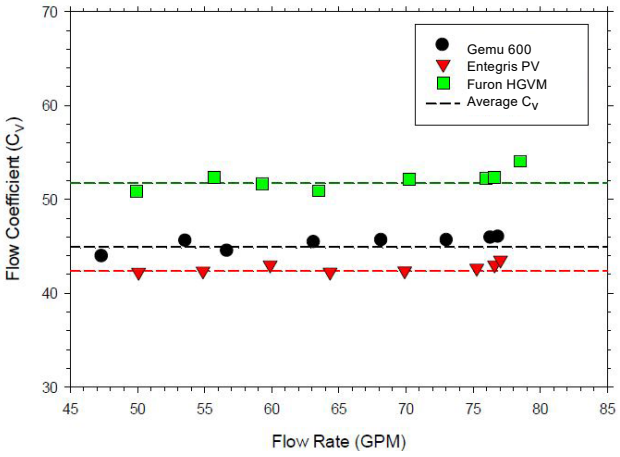


Figure 5 – Effect of Flow Rate on C_V



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Saint-Gobain Performance Plastics
7301 Orangewood Avenue
Garden Grove, CA 92841

1-800-833-5661
Tel: (714) 630-5818
Fax: (714) 688-2614

www.furon.com