Swagelok

ALD20 Valve Technical Report

Scope

This technical report provides data on Swagelok® ALD20 normally closed ultrahigh-purity bellows valves. The report covers:

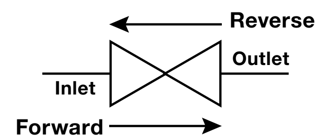
- valve high-flow consistency
- vacuum flow
- lab cycle testing
- pneumatic actuation speed
- helium seat leak testing
- surface finish
- particle counting
- hydrocarbon analysis
- ionic cleanliness
- moisture analysis

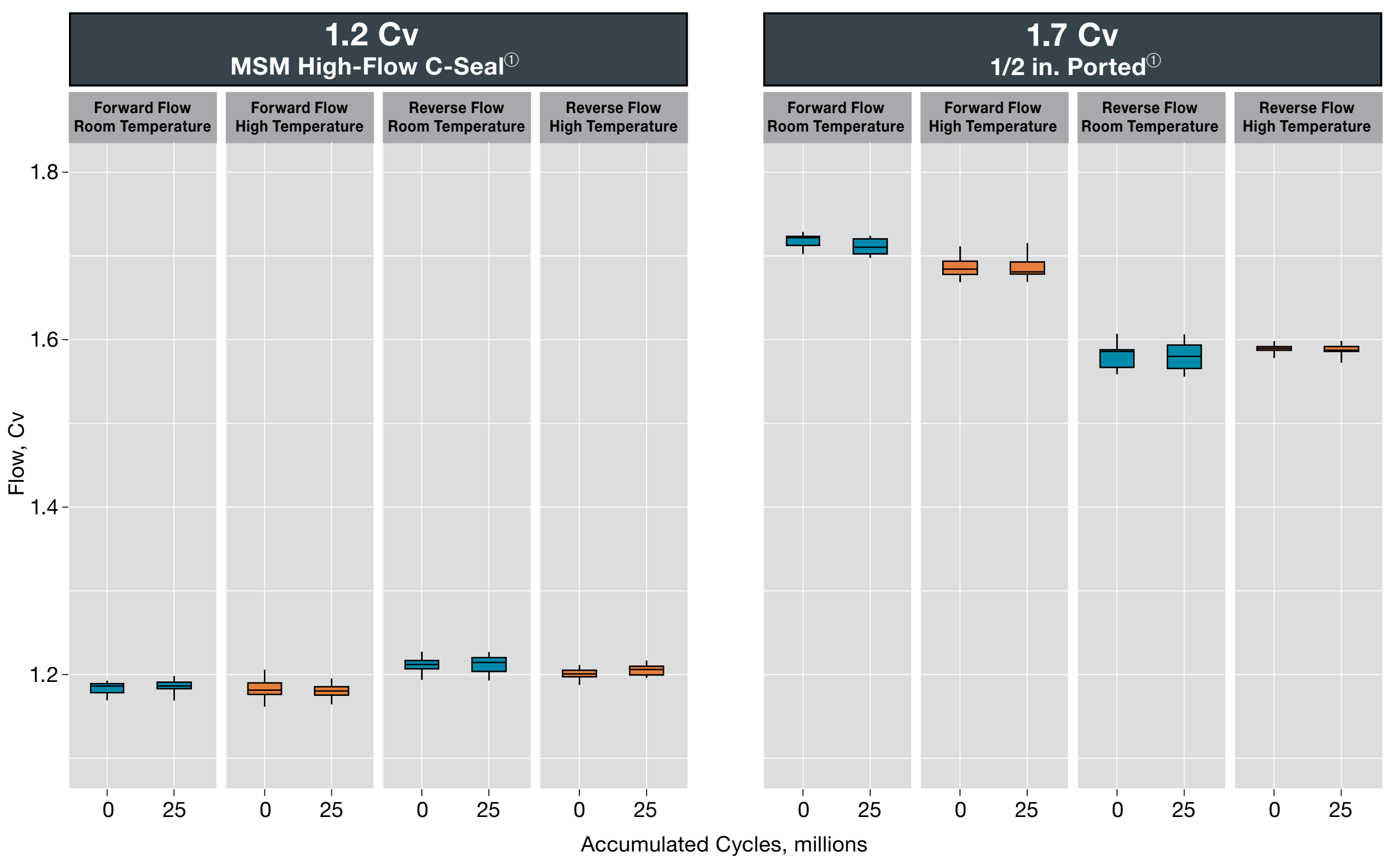
Particle counting, hydrocarbon analysis, and moisture analysis data show test results from valves cleaned with deionized (DI) water according to the techniques described in Swagelok *Ultrahigh-Purity Process Specification (SC-01),* MS-06-61.

Valve High-Flow Consistency

Swagelok ALD20 valves are factory set to provide a consistent high-flow performance.

A total quantity of 36 valves were tested in accordance with SEMI F32 over 25 million cycles and at multiple temperatures from room temperature (20°C) to high temperatures up to 200°C. The measured variation of flow across all temperatures and cycles was less than ± 2% for the MSM High-Flow C-Seal valves and less than ± 3% for the 1/2 in. Ported valves.

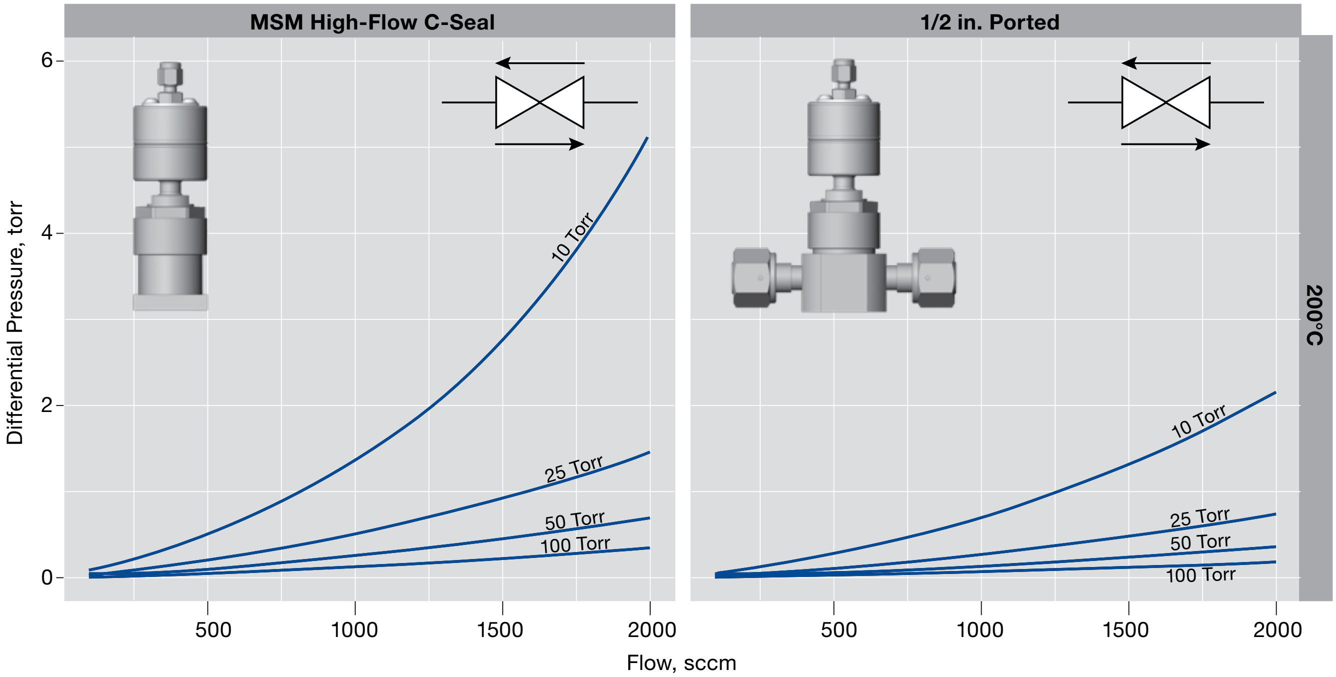




① Quantities tested: (27) MSM High-Flow C-Seal and (9) ½ in. Ported valves.

Vacuum Flow

Swagelok ALD20 valves have high conductance, providing low pressure drops at subatmospheric flow conditions. Valve conductance was modeled at 200°C with computational fluid dynamics (CFD) and verified with laboratory testing at various inlet pressures from 10 to 100 torr, and differential pressure drops. The flow response of ALD20 valves at these conditions is independent of flow direction.



Lab Cycle Testing

The Swagelok ALD20 valve was evaluated to determine an estimated cycle life under controlled laboratory conditions. All valves were electronically monitored during testing for envelope seal integrity. At regular intervals, the valves were removed and evaluated for seat seal integrity, envelope seal integrity, and actuator seal performance. **A total of 94 valves were cycled to a minimum of 25 million cycles with no failures.**

These tests are not a guarantee of a minimum number of cycles in service. They indicate that in tests under these laboratory conditions the probability of early failure is low. Laboratory tests cannot duplicate the variety of actual operating conditions and cannot promise that the same results will be realized in service.

Quantity		32	22	16	8	8	8
Gas		Dry, filtered nitrogen					
External (Oven) Temperature		392°F (200°C)	70°F (20°C)	392°F (200°C)	302°F (150°C)	212°F (100°C)	70°F (20°C)
Valve Temperature		392°F (200°C)	392°F (200°C)	392°F (200°C)	302°F (150°C)	212°F (100°C)	70°F (20°C)
Valve Pressure		Vacuum/ 20 psig (1.3 bar)①	Vacuum/ 20 psig (1.3 bar)②	Vacuum	Vacuum	Vacuum	Vacuum/ 20 psig (1.3 bar)③
Cycle Rate		12 cycles per second, 50% actuation duty cycle					
Cycles Accumulated (Millions)		25 suspended	25 suspended	50 suspended	25 suspended	25 suspended	25 suspended
Envelope Leakage > 1 × 10^{-9} std cm³/s He		NONE	NONE	NONE	NONE	NONE	NONE
Actuator Air Leakage > 1 L/min at 80 psig input	**Room Temperature 70°F (20°C)**	NONE	NONE	NONE	NONE	NONE	NONE
	High Temperature 392°F (200°C)	NONE	NONE	NONE	NONE	NONE	NONE

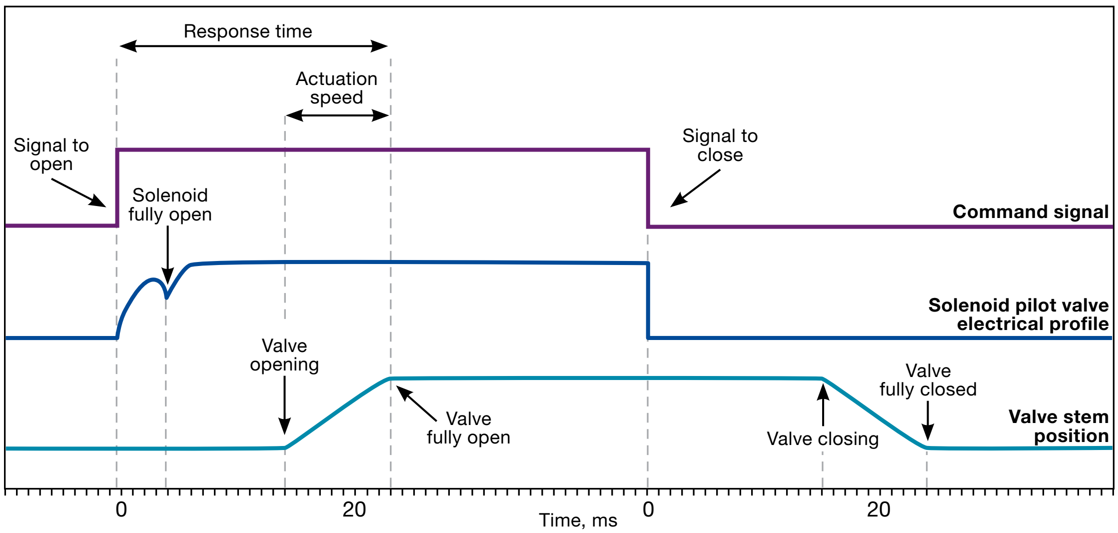
① Valve quantities tested: (24) vacuum and (8) 20 psig.
② Valve quantities tested: (18) vacuum and (4) 20 psig.
③ Valve quantities tested: (5) vacuum and (3) 20 psig.

Pneumatic Actuation Speed

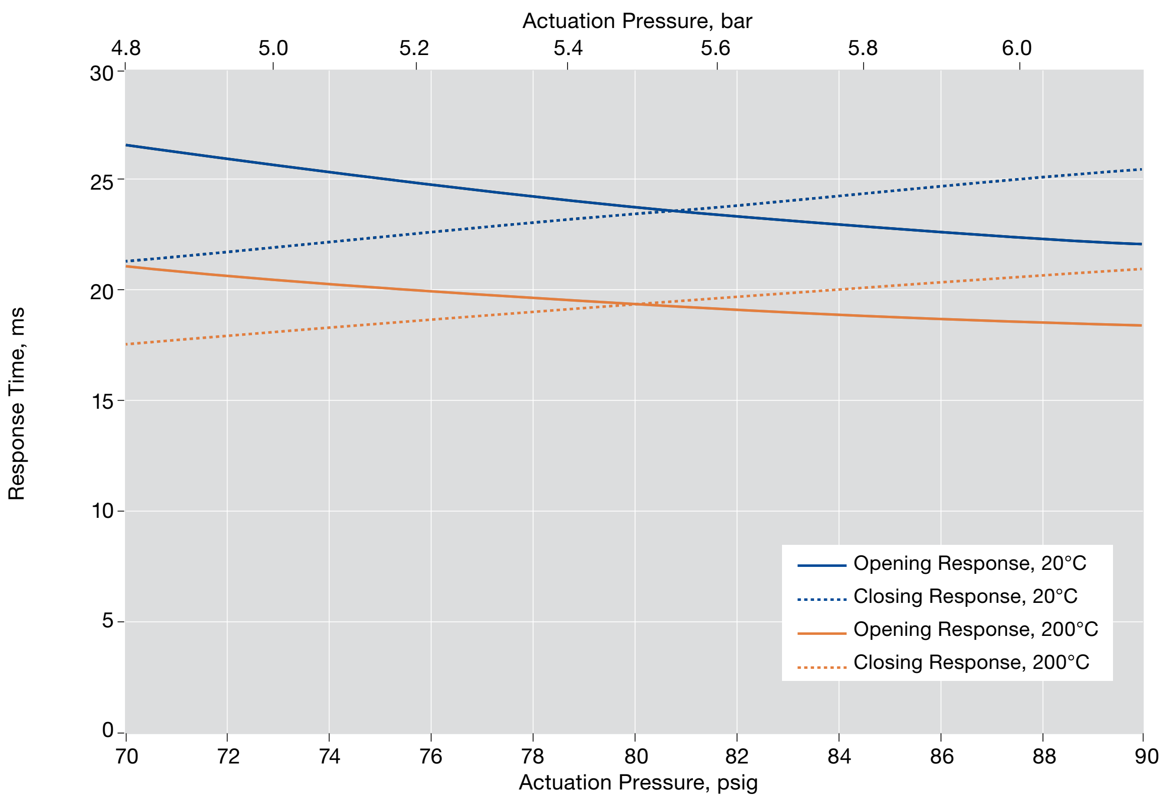
The actuation speed of Swagelok ALD20 valves was electronically evaluated using an oscilloscope and a linear variable displacement transducer (LVDT) in direct contact with the valve stem. The measured valve opening profile is compared to the control signal and response of the solenoid pilot valve. The ALD20 valve is capable of actuation speeds less than 10 ms with a response time of less than 30 ms.

- MAC® 34C-ABA solenoid pilot valve
- 70 to 90 psig (4.8 to 6.2 bar) actuation pressure
- Tubing from solenoid pilot valve to actuator: 1/8 × 0.028 × 18 in.
- Tubing to solenoid pilot valve inlet: 1/4 × 0.065 in.
- Unrestricted solenoid pilot valve exhaust port
- Valve immersed at temperatures of 20°C and 200°C

Actuation Speed Test Diagram



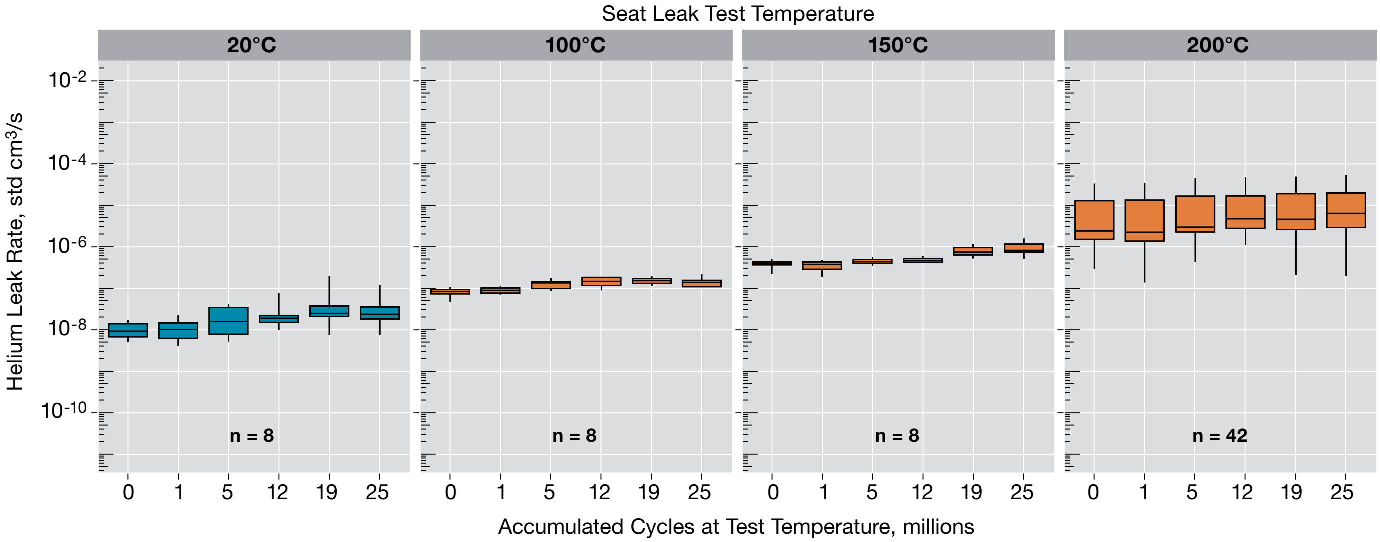
Actuation Response Versus Actuator Supply Pressure by Actuation Direction and Temperature



Helium Seat Leak Testing

Swagelok ALD20 valves processed to meet Swagelok Ultrahigh-Purity Process Specification (SC-01), MS-06-61, were evaluated for internal helium leak integrity of the valve seat in accordance with SEMI F1. Valves were cycled at the test temperature and seat testing was performed at regular intervals throughout the 25 million cycles.

The increasing valve seat seal response shown at elevated test temperatures is predominantly a function of the helium permeation through the plastic seat material. Room temperature seat seal leak rates will also increase after cycling at elevated temperatures.

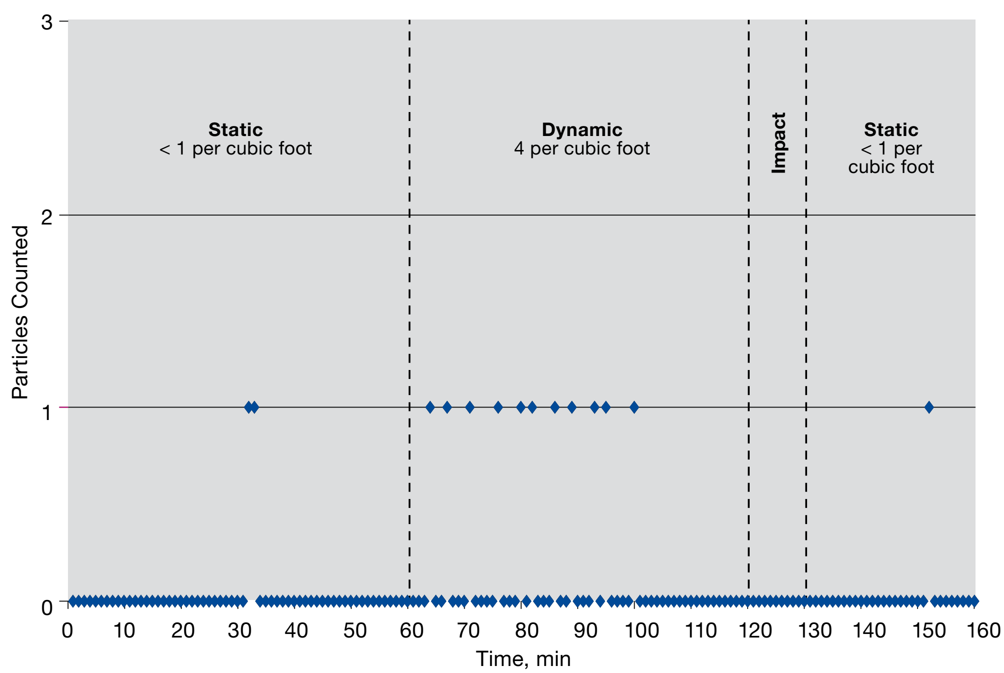


Surface Finish

Manufacturing process controls allow Swagelok to provide consistent surface finishes, as described in the Swagelok Ultrahigh-Purity Process Specification (SC-01), MS-06-61. The roughness average (R_a) specification established for the wetted surfaces of Swagelok ALD20 valves is 5 µin. (0.13 µm) R_a on average.

Particle Counting

Testing was performed in accordance with ASTM F1394, measuring particles greater than 5nm in size. Static particle emissions from a Swagelok ALD20 valve met the recommended performance of fewer than 20 particles per cubic foot, in accordance with SEMI E49.8.



Hydrocarbon Analysis

An analysis of hydrocarbon residues in a Swagelok ALD20 valve was conducted as referenced in ASTM G93. Residue levels were less than 0.26 mg/ft^2 (2.8 mg/m^2).

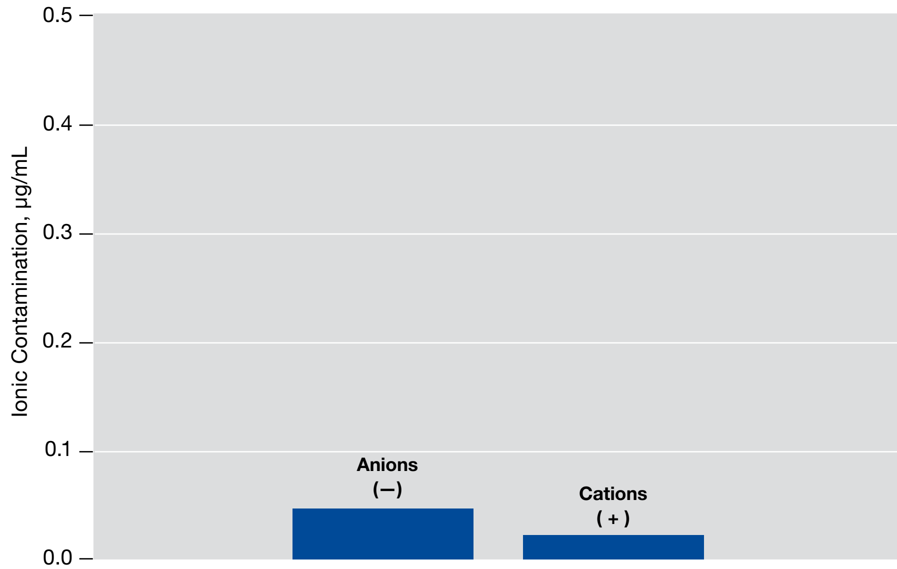
Ionic Cleanliness

Residual ionic contamination is very low (less than 1 µg/ml) for Swagelok SC-01 processed valves.

A Swagelok ALD20 valve was tested in accordance with ASTM F1374:

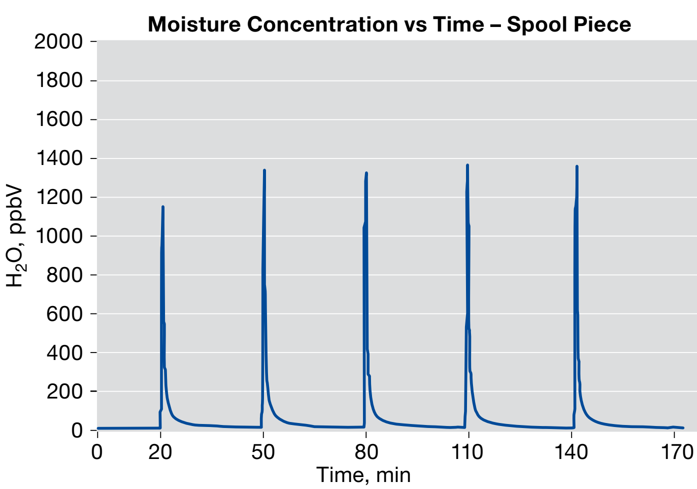
- Valve was filled with deionized (DI) water.
- After 24 hours, the sample was extracted and analyzed.

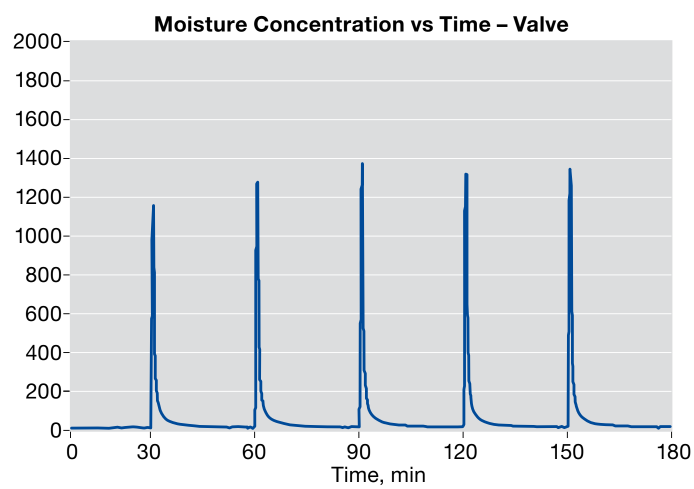
Anions (—)	**Cations (+)**
Fluoride	Lithium
Chloride	Sodium
Nitrate	Ammonium
Phosphate	Potassium
Sulfate	Magnesium
	Calcium



Moisture Analysis

Moisture analysis of Swagelok SC-01 processed products was performed in accordance with ASTM F1397 guidelines. A Swagelok ALD20 valve had 2 ppm moisture pulses introduced every 30 minutes and recovered from each pulse in less than 12 minutes. This is much faster than the 1 hour guideline of SEMI E49.8.





Referenced Documents

*ASTM Standards*①

F1374 Standard Test Method for Determination of Ionic/Organic Extractables of Internal Surfaces—IC/GC/FTIR for Gas Distribution System Components

F1394 Standard Test Method for Determination of Particle Contribution from Gas Distribution System Valves

F1397 Standard Test Method for Determination of Moisture Contribution by Gas Distribution System Components

G93 Standard Guide for Cleanliness Levels and Cleaning Methods for Materials and Equipment Used in Oxygen-Enriched Environments

*SEMI Standards*②

F1 Specification for Leak Integrity of High-Purity Gas Piping Systems and Components

E49.8 Guide for High-Purity and Ultrahigh-Purity Gas Distribution Systems in Semiconductor Manufacturing Equipment

F32 Test Method for Determination of Flow Coefficient for High-Purity Shutoff Valves

Swagelok Specification

Ultrahigh-Purity Process Specification (SC-01), MS-06-61

① American Society for Testing and Materials, 100 Barr Harbor Dr., West Conshohocken, PA 19428, U.S.A.

② Semiconductor Equipment and Materials International, 3081 Zanker Road, San Jose, CA 95134, U.S.A.

These tests do not simulate any specific application and are not a guarantee of performance in actual service. Laboratory tests cannot duplicate the variety of actual operating conditions. The results are not offered as statistically significant. See the product catalog for technical data.

Safe Product Selection
When selecting products, the total system design must be considered to ensure safe, trouble-free performance. Function, material compatibility, adequate ratings, proper installation, operation, and maintenance are the responsibilities of the system designer and user.

MS-06-123, Rev-, February 2020