DP Series Springless Diaphragm Valves (1.125 in.) Technical Report

Scope

This technical report provides data on Swagelok® DP series diaphragm valves (1.125 in.). The report covers:

- surface finish
- inboard helium leak testing
- particle counting
- moisture analysis
- hydrocarbon analysis
- ionic cleanliness
- lab cycle testing.

Particle counting, moisture analysis, hydrocarbon analysis, and ionic cleanliness 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.

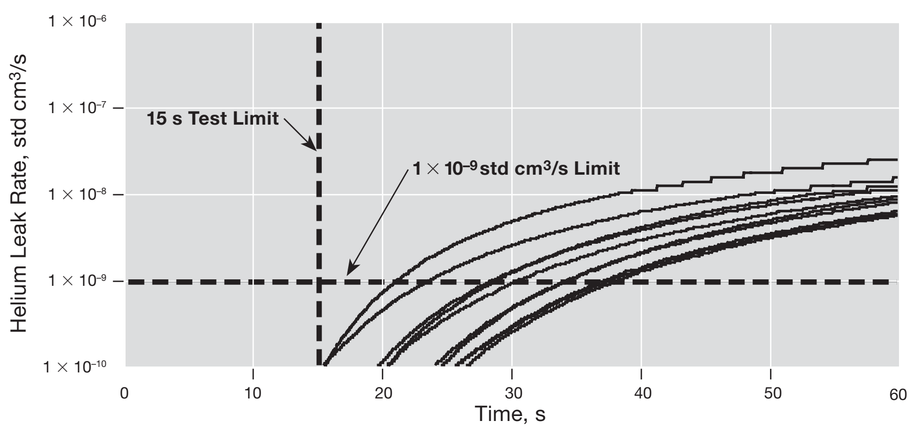
Surface Finish

Statistical process control (SPC) allows Swagelok to provide consistent surface finishes, as described in Swagelok *Ultrahigh-Purity Process Specification (SC-01),* MS-06-61. The roughness average (R_a) specification we have established for the wetted surfaces of Swagelok P or P1 finish is 5 µin. (0.13 µm) R_a on average.

Inboard Helium Leak Testing

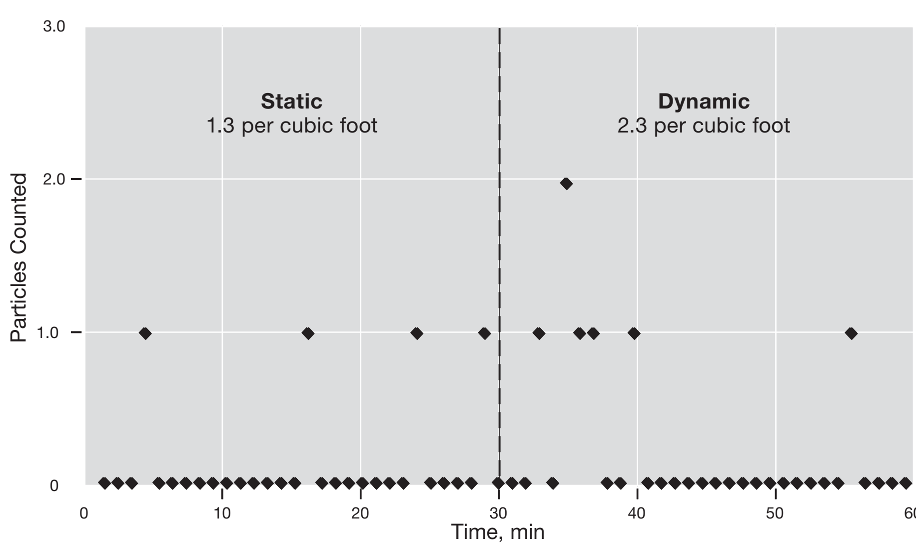
Swagelok DP series diaphragm valves (1.125 in.) processed to meet Swagelok *Ultrahigh-Purity Process Specification (SC-01),* MS-06-61, were evaluated for inboard helium leak integrity of the valve seat in accordance with SEMI-F1.

The 10 valves exhibited a helium permeation response that was significantly better than the 1×10^{-9} std cm^3/s leak rate at the 15 s test limit.



Particle Counting

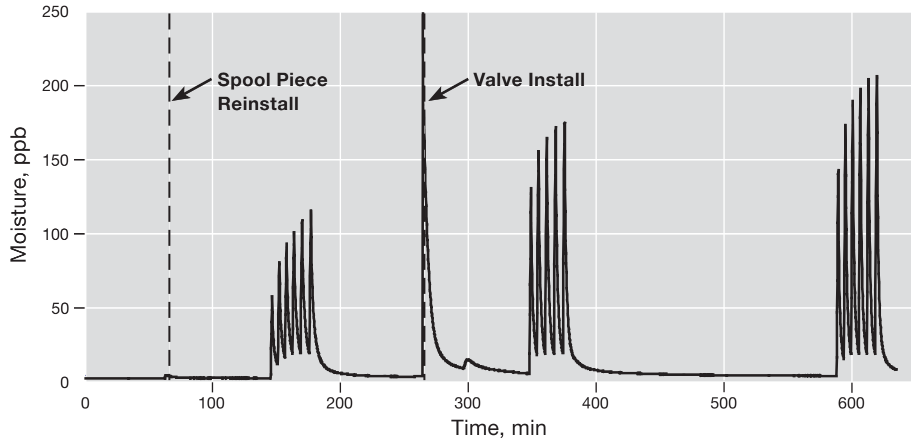
Testing was performed in accordance with ASTM F1394, measuring particles greater than 0.02 µm in size. Static particle emissions from a Swagelok DP series diaphragm valve (1.125 in.) meet the recommended performance of fewer than 20 particles per cubic foot, in accordance with SEMI E49.8.

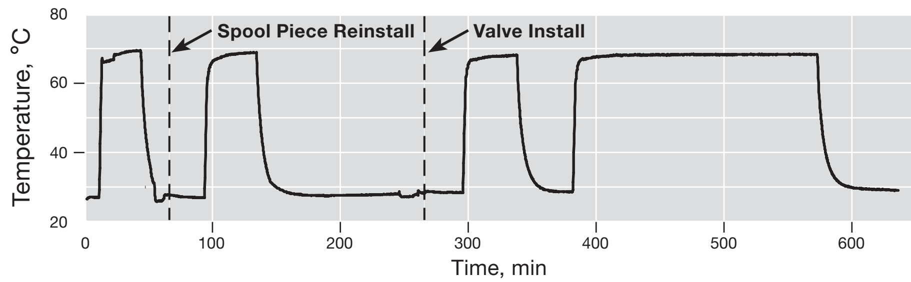


Moisture Analysis

A Swagelok DP series diaphragm valve (1.125 in.) recovered from a 200 ppb moisture spike in less than 10 min. This is much faster than the 1 h guideline of SEMI E49.8. Moisture analysis of Swagelok SC-01 processed products was performed in accordance with SEMASPEC 90120397B-STD guidelines.

The lower graph shows the pattern of elevated temperatures that were applied to the valve during testing to enhance the moisture sensitivity of the system.

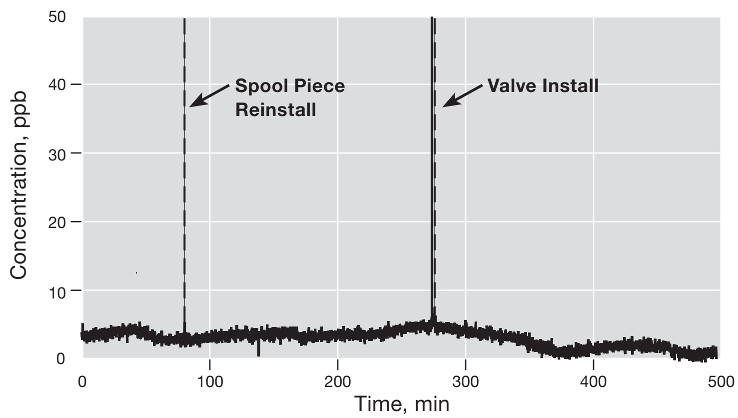


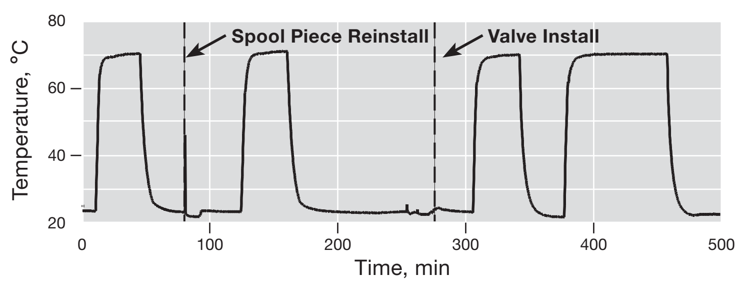


Hydrocarbon Analysis

Hydrocarbon residues in a Swagelok DP series diaphragm valve (1.125 in.) fall within the background level produced by the test instrument. Hydrocarbon analysis of Swagelok SC-01 processed products was conducted in accordance with SEMASPEC 90120396B-STD guidelines.

The lower graph shows the pattern of elevated temperatures that were applied to a valve during testing to drive off any hydrocarbon residues in the system.





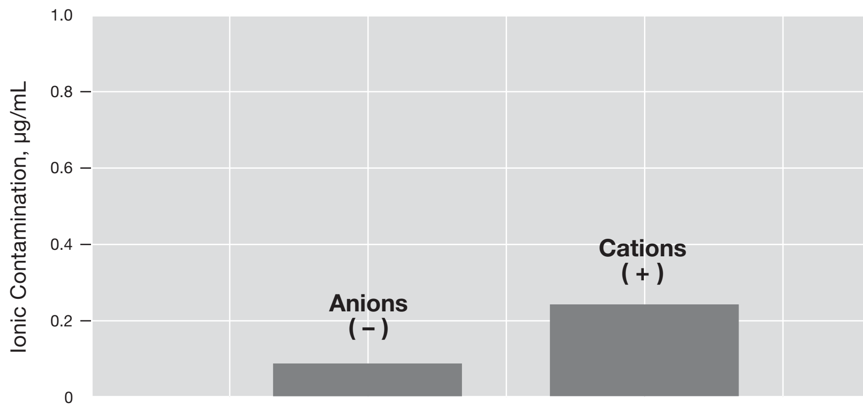
Ionic Cleanliness

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

Swagelok DP series diaphragm valves (1.125 in.) were tested in accordance with ASTM F1374:

- Each valve was filled with deionized (DI) water.
- After 24 h, the sample was extracted and analyzed.

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



Lab Cycle Testing

The Swagelok DP series diaphragm valve (1.125 in.) was evaluated for 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, flow performance, and actuator seal performance.

These tests are not a guarantee of a minimum number of cycles in service. Laboratory tests cannot duplicate the variety of actual operating conditions and cannot promise that the same results will be realized in service.

Normally Closed Pneumatically Actuated Valves

Model	DP series diaphragm valve (1.125 in.)①				
Mode of Actuation	Normally closed pneumatically actuated				
Quantity	6	6	6	6	5
Gas	Dry, filtered nitrogen				
Temperature, °F (°C)	70 (20)	70 (20)	70 (20)	–10 (–23)	302 (150)
Inlet and Outlet Pressure psig (bar)	125 (8.6)	Vacuum	125 (8.6)	125 (8.6)	125 (8.6)
Actuator Pressure psig (bar)	75 (5.1)	75 (5.1)	120 (8.2)	120 (8.2)	120 (8.2)
Cycle Rate, cpm	600	600	600	420	60
Number of Cycles	1 million	1 million	1 million	1 million	1 million
Final Seat Seal Leakage std cm^3/s He	$< 1 \times 10^{-9}$②	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$
Final Envelope Leakage std cm^3/s He	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$

① C-seal design only.

② One seat failure at 1 million cycles with assignable cause. Final leakage = 1×10^{-8} std cm^3/s He.

Normally Open Pneumatically Actuated Valves and Manually Actuated Valves

Model	DP series diaphragm valve (1.125 in.)①							
Mode of Actuation	Normally open pneumatically actuated		Manual					
Quantity	5	5	12	12	6	12	12	6
Gas	Dry, filtered nitrogen							
Temperature, °F (°C)	70 (20)	302 (150)	70 (20)	302 (150)	–10 (–23)	70 (20)	302 (150)	–10 (–23)
Inlet and Outlet Pressure psig (bar)	35 (2.4)	125 (8.5)	0	0	0	145 (10)	145 (10)	145 (10)
Actuator Pressure psig (bar)	80 (5.4)	80 (5.4)	—	—	—	—	—	—
Cycle Rate, cpm	60	60	10	10	10	10	10	10
Number of Cycles	1 million	1 million	15 000	15 000	15 000	30 000	30 000	30 000
Final Seat Seal Leakage std cm^3/s He	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$②	$< 1 \times 10^{-9}$③	$< 1 \times 10^{-9}$
Final Envelope Leakage std cm^3/s He	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$	$< 1 \times 10^{-9}$

① C-seal design only.

② One valve exhibited seat seal leakage above 1×10^{-9} std cm^3/s He after 30 000 cycles. Final leakage = 2.1×10^{-9} std cm^3/s He.

③ One valve exhibited seat seal leakage above 1×10^{-9} std cm^3/s He after 30 000 cycles. Final leakage = 2.9×10^{-9} std cm^3/s He.

Referenced Documents

*ASTM Standards*①

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

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

*SEMATECH SEMASPECs*②

90120396B-STD Standard Test Method for Determination of Total Hydrocarbon Contribution by Gas Distribution Systems Components

90120397B-STD Standard Test Method for Determination of Moisture Contribution by Gas Distribution Systems Components

*SEMI Standards*③

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

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 SEMATECH, Inc., 2706 Montopolis Dr., Austin,TX 78741, U.S.A.

③ 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. 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.

June 2007, R1
MS-06-21-E