Swagelok

DP Series Diaphragm Valve Technical Report

Scope

This technical report provides data on Swagelok® DP series diaphragm valves with PCTFE seats. The report covers:

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

Moisture and hydrocarbon analysis data show test results from valves cleaned with deionized (DI) water in accordance with Swagelok *Ultrahigh Purity Process Specification (SC-01),* MS-06-61.

Particle counting data contrast test results from valves cleaned in accordance with SC-01 and with Swagelok *Photovoltaic Process Specification (SC-06)*, MS-06-64.

Ionic cleanliness data for SC-01 and SC-06 processed valves are comparable.

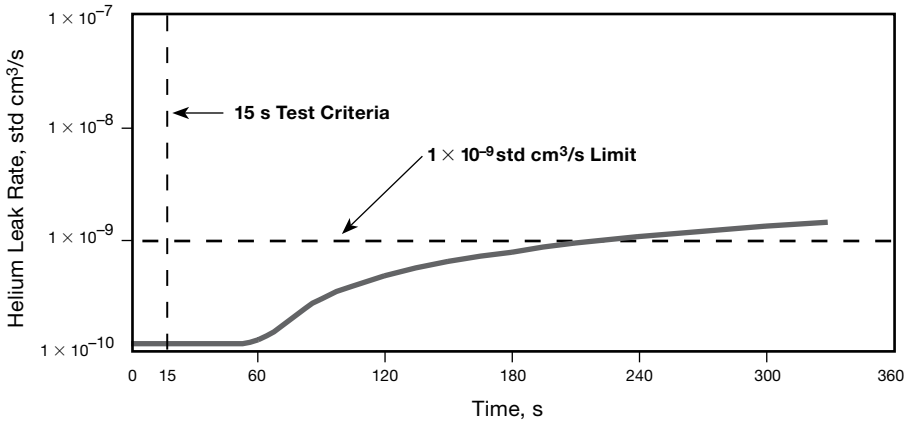
Surface Finish

Statistical process control (SPC) allows Swagelok to provide consistent surface finishes, as described in Specification SC-01. The roughness average (R_a) specification we have established for the wetted surfaces of DP series valves manufactured with a Swagelok P or P1 finish is 5 µin. (0.13 µm) R_a on average.

Inboard Helium Leak Testing

SC-01 processed valves maintained a helium leak rate of less than 1×10^{-9} std cm^3/s at the seat for an average of 200 s, which exceeds the required test time of 15 s, in accordance with SEMI F1-96. This result indicates that the PCTFE seat design has a high resistance to permeation.

The DP series valves were assembled in a class 100 environment and tested to ASTM E498, Method A, at the rated pressure of the valve.

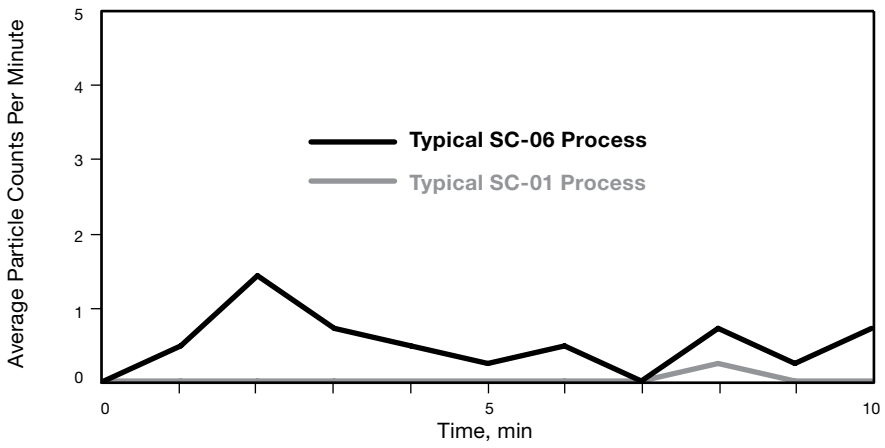


Particle Counting

Static particle counts from SC-01 and SC-06 processed DP series valves are very low.

The DP series valves were tested in accordance with ASTM F1394:

- Class 100 cleanroom
- Class 10 laminar-flow bench
- 2.4 std ft^3/min flow rate
- Particles greater than 0.014 µm in size detected.



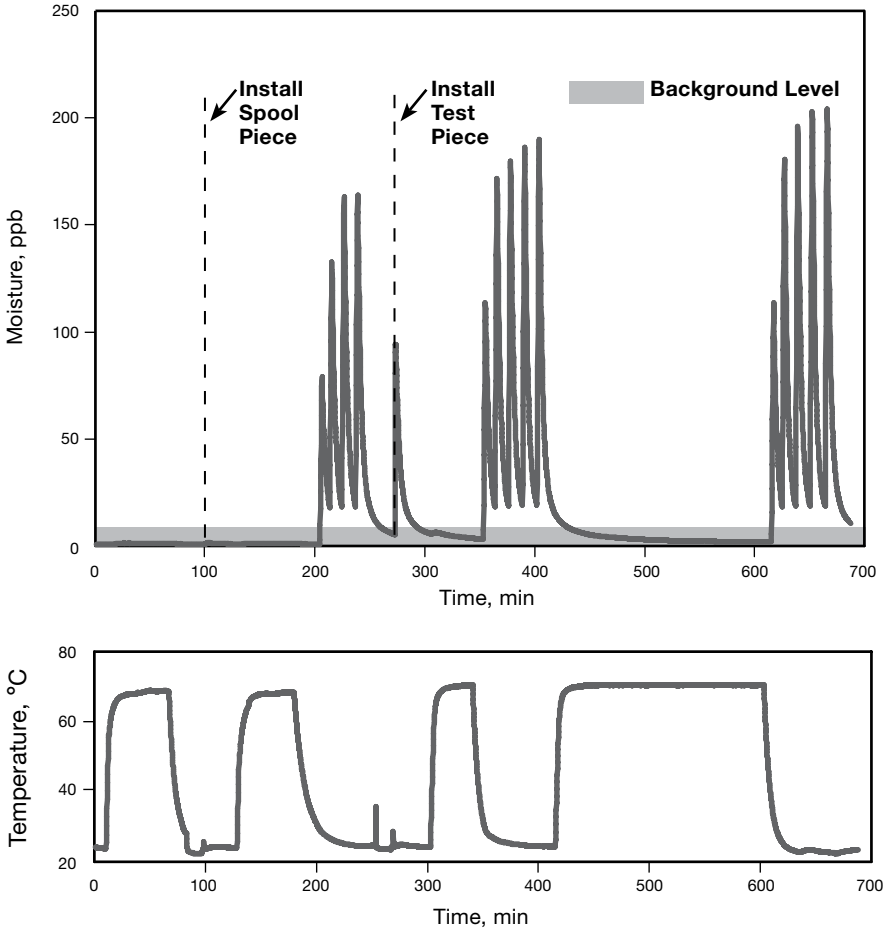
Moisture Analysis

SC-01 processed valves recover to background levels from a 2 ppm moisture spike within 30 min, much faster than the 4 h recommended by SEMI E49.8.

Three DP series valves were tested in accordance with SEMASPEC 90120397B-STD guidelines:

- The test gas was pure nitrogen.
- The flow rate was 1.28 std L/min at 30 psig (2 bar).

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

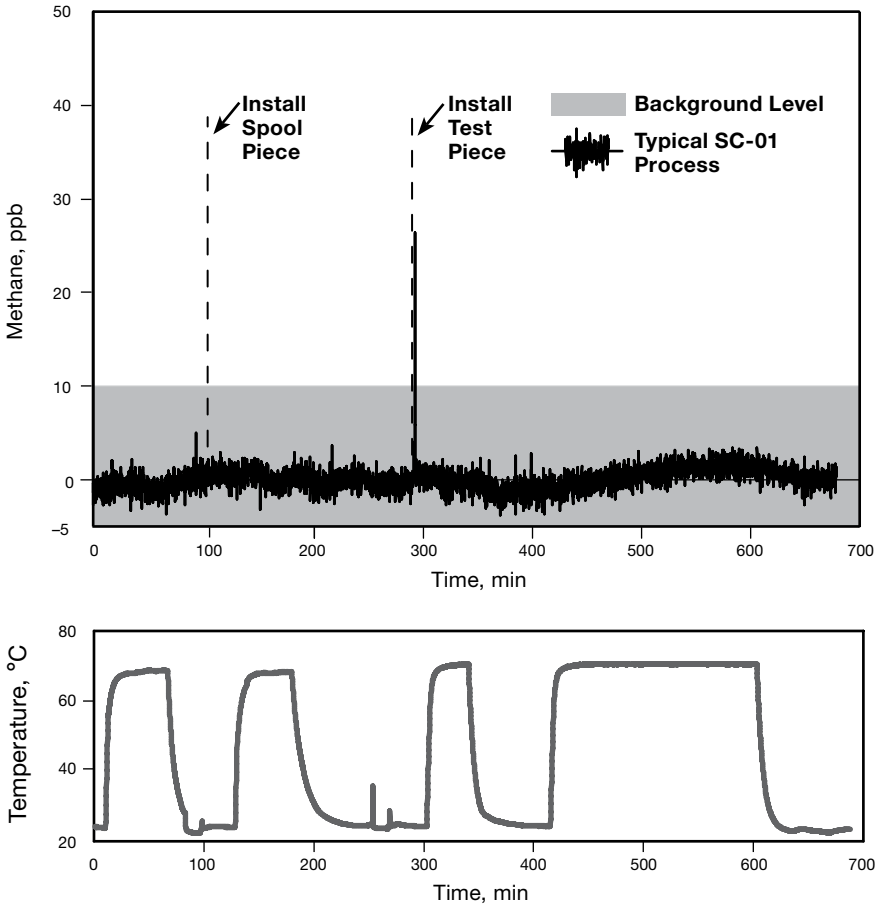


Hydrocarbon Analysis

Hydrocarbon residues in SC-01 processed valves fall within the background level produced by the test instrument.

Hydrocarbon analyses of SC-01 processed products are conducted in accordance with SEMASPEC 90120396B-STD guidelines.

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



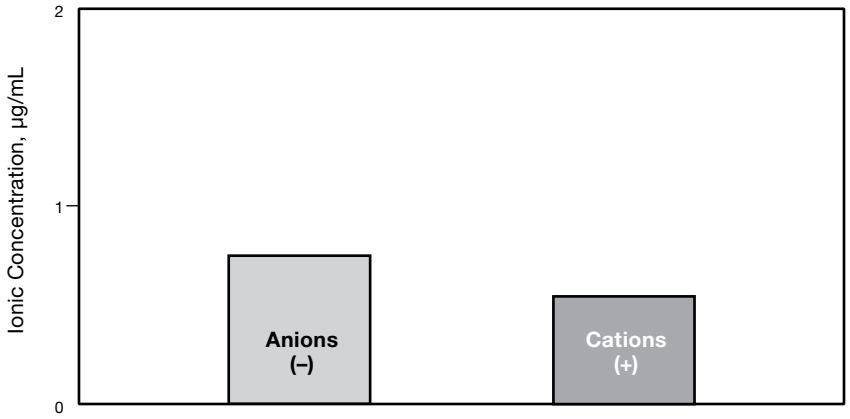
Ionic Cleanliness

Residual ionic contamination is very low (less than 1 µg/mL for SC-01 and SC-06 processed valves).

The DP series valves 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 DP series diaphragm valve was tested to determine an estimated cycle life of the diaphragms under severe laboratory conditions (table at right).

Both high- and low-pressure DP series pneumatically actuated valves with cobalt-based superalloy (UNS R30003) diaphragms were tested. Valve cycle life was evaluated for leakage at regular intervals. Failure was defined as a helium leak rate greater than 1×10^{-9} std cm^3/s for envelope (inboard) or seat leakage.

The tests predict the mean time to failure (MTTF) and the expected cycle life for 95 % of the valves.

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 endless variety of actual operating conditions and cannot promise that the same results will be realized in service.

Test Data

Model	**High-Pressure**	**Low-Pressure**	**Low-Pressure**
Mode of Actuation	Normally closed pneumatically actuated		
Quantity	10	10	20
Gas	Dry, filtered nitrogen		
Temperature °F (°C)	70 (20) ambient		
Inlet Pressure psig (bar)	3045 (210)	145 (9.9)	250 (17.2)
Outlet Pressure psig (bar)			
Actuator Pressure psig (bar)	100 (6.8)	70 (4.8)	70 (4.8)
Cycle Rate, cpm	30		
Mean Time to Failure (MTTF)	130 000 cycles	2 600 000 cycles	1 000 000 cycles
Expected Cycle Life for 95% of Valves	> 50 000 cycles	> 520 000 cycles	> 290 000 cycles

Referenced Documents

ASTM Standards[1]

E498 Standard Test Method for Leaks Using the Mass Spectrometer Leak Detector or Residual Gas Analyzer in the Tracer Probe Mode

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]

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

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

Swagelok Specifications

Photovoltaic Process Specification (SC-06), MS-06-64

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

1. American Society for Testing and Materials, 100 Barr Harbor Dr., West Conshohocken, PA 19428.
2. SEMATECH, Inc., 2706 Montopolis Dr., Austin, TX 78741.
3. Semiconductor Equipment and Materials International, 3801 Zanker Rd., San Jose, CA 95134.

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.

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