DF Series Diaphragm Valve Technical Report

Scope

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

- P surface finish specifications
- static particle counting
- moisture analysis
- hydrocarbon analysis
- ionic cleanliness
- lab cycle test data.

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.

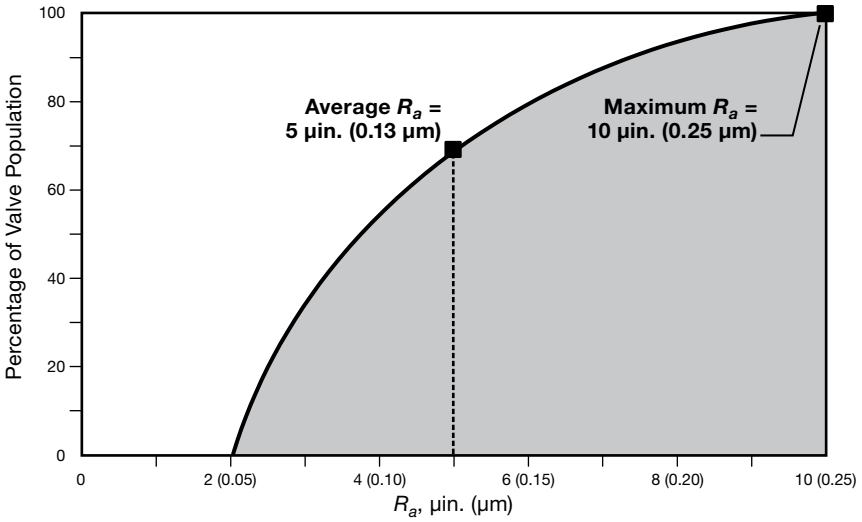
Particle counting data contrast test results from valves cleaned in accordance with SC-01 and with Swagelok *Photovoltaic Process Specification (SC-06)*, MS-06-64.

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 SC-01. The surface finish distribution at right illustrates the roughness average (R_a) specifications we have established for the wetted surfaces of DF series valves manufactured with the P finish:

- Surface roughness is 5 µin. (0.13 µm) R_a on average
- Surface roughness will not exceed 10 µin. (0.25 µm) R_a.

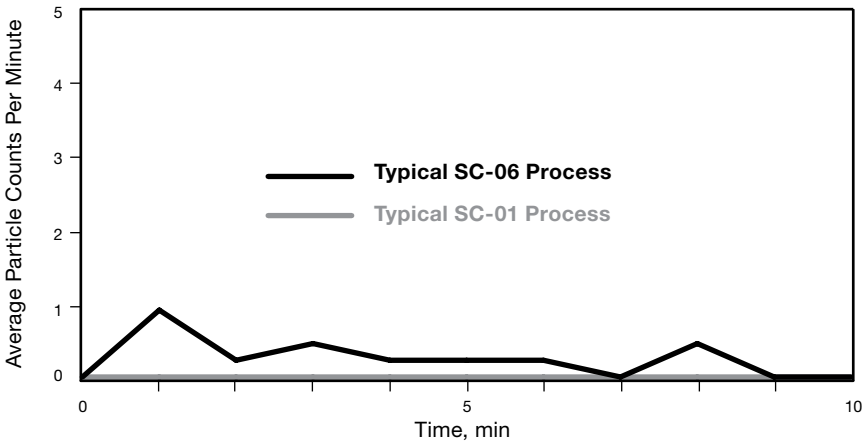


Particle Counting

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

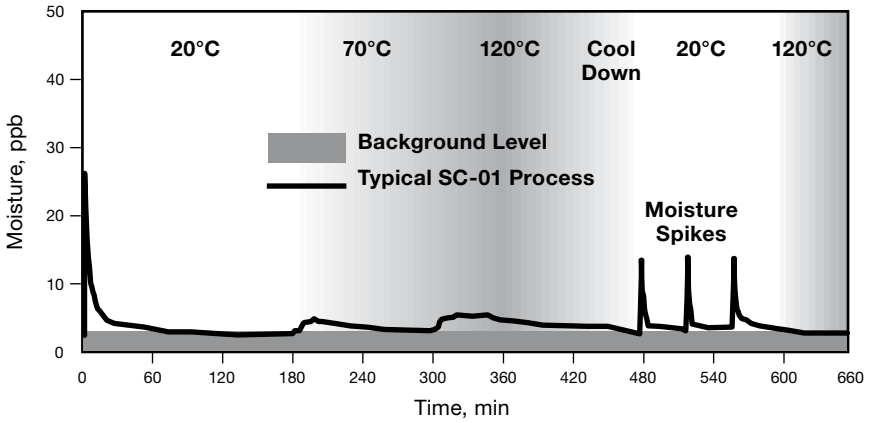
The DF series valves were tested in accordance with ASTM F1394:

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



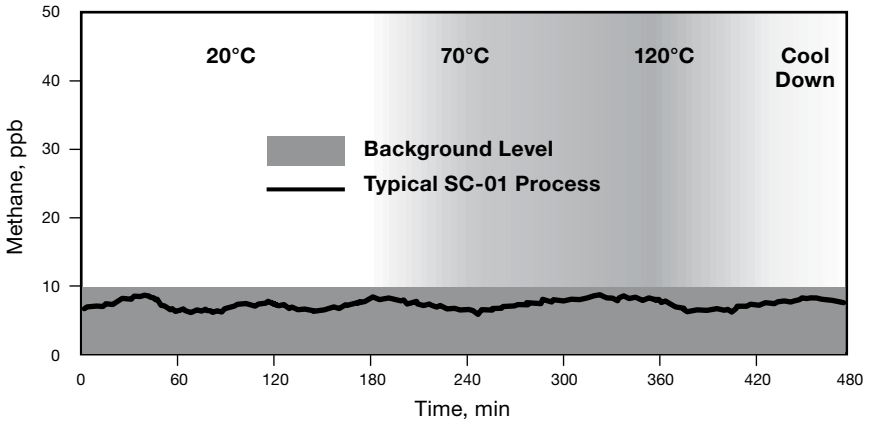
Moisture Analysis

SC-01 processed valves dry down very quickly to the background level produced by the test instrument. The valves also recover quickly following the introduction of moisture spikes.



Hydrocarbon Analysis

Test results for hydrocarbon residues in SC-01 processed valves fall entirely within the background level produced by the test instrument



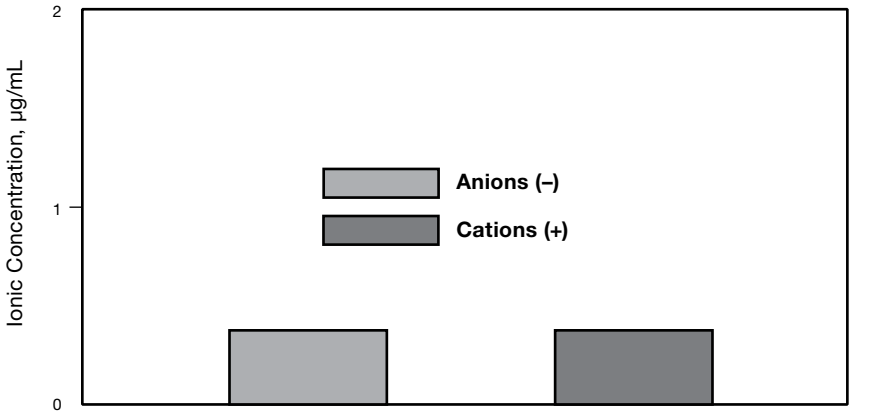
Ionic Cleanliness

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

The DF 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 DF series valve was tested to determine an estimated cycle life of the diaphragm under a set of controlled laboratory conditions (table at right).

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

The tests predict the mean time to failure (MTTF) to be approximately 2 million cycles. The tests also demonstrate that 95 % of the valves can be expected to last more than 1 million cycles. The number of samples tested gives a confidence level of 90 % for these predictions.

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

Quantity	30 normally closed pneumatically actuated valves
Gas	Dry, filtered nitrogen
Temperature, °F (°C)	70 (20)
Inlet pressure, psig (bar)	20 (1.3)
Outlet pressure	Atmospheric
Actuator pressure, psig (bar)	100 (6.8)
Cycle rate, cpm	30

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

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.

Safe Product Selection
When selecting a product, 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-06-14, RevE