Swagelok

HF Series Set-Pressure Regulator Technical Report

Scope

This technical report provides data on Swagelok® HF series regulators. The report covers:

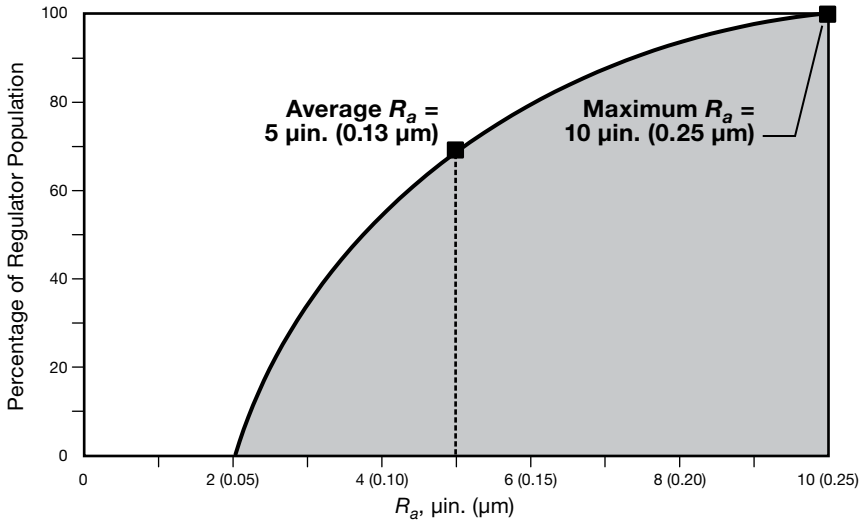
- P surface finish specifications
- static particle counting
- moisture analysis
- hydrocarbon analysis
- ionic cleanliness
- lab cycle test data.

Particle counting, moisture and hydrocarbon analysis, and ionic cleanliness data show test results from regulators cleaned with deionized (DI) water according to the techniques described in the 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 Specification SC-01. The surface finish distribution at right illustrates the roughness average (R_a) specifications we have established for the wetted surfaces of HF series regulators 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.

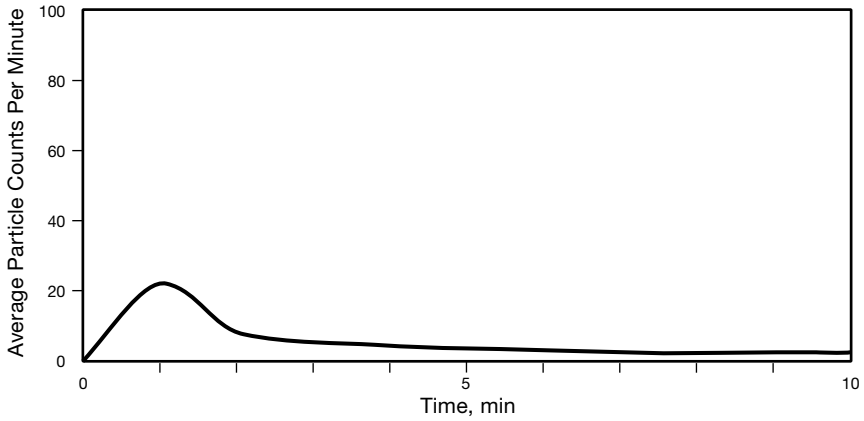


Particle Counting

Static particle counts from SC-01 processed HF series regulators are very low.

Fifteen HFS3B regulators were tested in accordance with SEMASPEC 93021510A-STD:

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

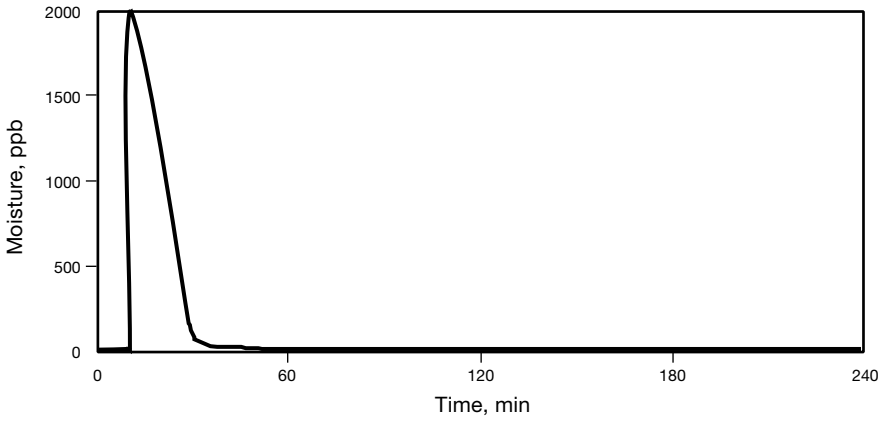


Moisture Analysis

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

Six HFS3B regulators were tested in accordance with ASTM F1397 guidelines:

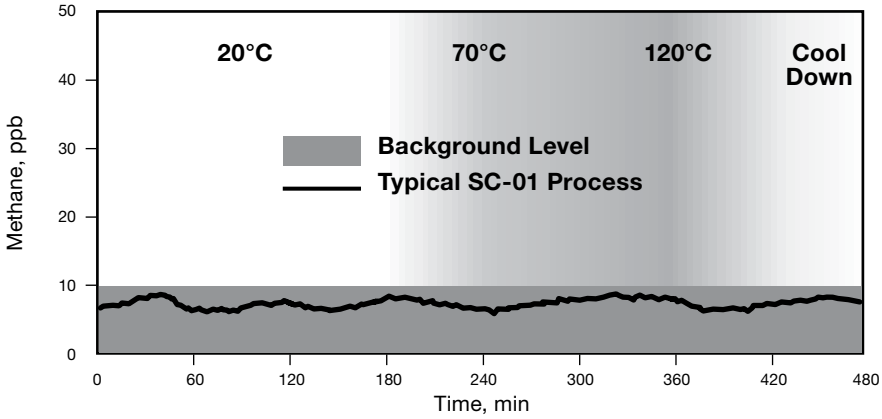
- The test gas was pure nitrogen.
- The flow rate was 1 std L/min at 30 psig (2 bar).



Hydrocarbon Analysis

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

Hydrocarbon analyses of SC-01 processed products are conducted in accordance with ASTM F1398 guidelines.



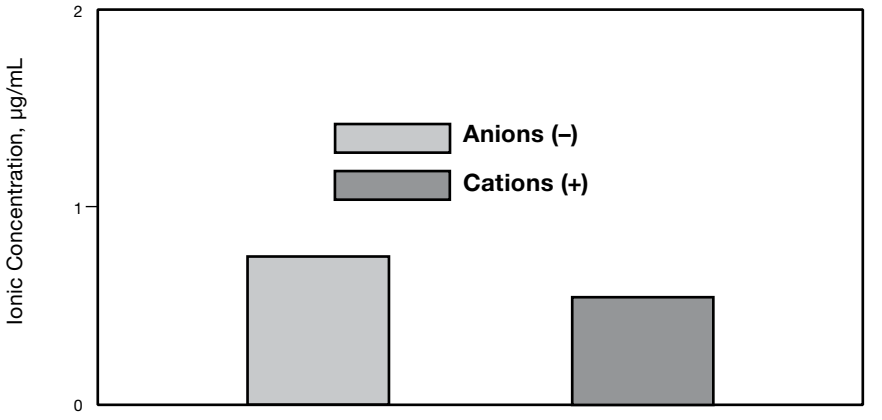
Ionic Cleanliness

Residual ionic contamination is very low for SC-01 processed regulators.

Four set-pressure and two adjustable-pressure regulator models were tested in accordance with ASTM F1374:

- Each regulator 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 HF series pressure regulator was tested to determine an estimated cycle life of the diaphragm under severe laboratory conditions (table at right).

Standard HF series pressure regulators with Inconel 625® diaphragms were tested.

- Each regulator was calibrated to deliver 30 psig (2.0 bar) outlet pressure at 1 std L/min flow rate with 80 psig (5.5 bar) inlet pressure.
- The regulator inlet was connected to the nitrogen supply, and the outlet was connected to the inlet of a pneumatically actuated valve.
- The valve was cycled at a rate of 30 cpm.

Diaphragm cycle life was evaluated at regular intervals for changes in outlet pressure with flow through the regulator. Failure was defined as a change in outlet pressure greater than 10 psig (0.68 bar) from the initial setting.

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

These tests are not a guarantee of cycles in service. 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	**HFS3**	**HFS4**
Quantity	12	13
Gas	Dry, filtered nitrogen	
Temperature °F (°C)	70 (20) ambient	
Inlet Pressure psig (bar)	80 (5.5) constant	
Outlet Pressure psig (bar)	30 (2.0) with no flow to 0 psig with flow	
Cycle rate, cpm	30	
Mean Time to Failure (MTTF)	215 000 cycles	1 275 000 cycles
Expected Cycle Life for 95 % of Regulators	> 8 500 cycles	> 50 000 cycles

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

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

F1398 Standard Test Method for Determination of Total Hydrocarbon Contribution by Gas Distribution Systems Components

SEMATECH SEMASPECS [2]

93021510A-STD Test Method for Determination of Particle Contribution by Low-Pressure Regulators in Gas Distribution Systems

SEMI Standard [3]

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.
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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