Swagelok Company
29500 Solon Road
Solon, Ohio 44139 U.S.A.

TITLE

High-Temperature Thermal Cycling and Hydrostatic Proof Test of Super Austenitic 254 SMO® (6-moly) Stainless Steel Tubing with Stainless Steel Swagelok® Tube Fittings

PRODUCT TESTED

Samples Tested	254 SMO SS Tubing Size OD × Wall in.	Tubing Hardness HRB	Part Description Ordering Number	Part Description Ordering Number
4	1/4 × 0.028	84	Union Straight SS-400-6	Union Elbow SS-400-9
4	1/4 × 0.065	95	Union Straight SS-400-6	Union Elbow SS-400-9
4	1/2 × 0.035	83	Union Straight SS-810-6	Union Elbow SS-810-9
4	1/2 × 0.083	87	Union Straight SS-810-6	Union Elbow SS-810-9
12	3/4 × 0.065	87	Union Straight SS-1210-6	Union Elbow SS-1210-9
12	3/4 × 0.095	90	Union Straight SS-1210-6	Union Elbow SS-1210-9
12	1 × 0.083	85	Union Straight SS-1610-6	Union Elbow SS-1610-9
12	1 × 0.120	86	Union Straight SS-1610-6	Union Elbow SS-1610-9

PURPOSE

These assemblies were tested under laboratory test conditions to observe the leakage performance (during and after thermal cycling) of stainless steel Swagelok tube fittings when installed on 254 SMO stainless steel tubing.

TEST CONDITIONS

Original test date: October 2011

Laboratory environment

TEST METHOD

Hardness Measurements of Tubing:

1. Performed five measurements equally spaced apart on each tube OD with the United Hardness Tester using the 15-T scale with the 1/16-inch diameter ball penetrator.
2. Reported the average of the five measurements.
3. Added the tubing cylindrical values taken from the Wilson Chart #53 Cylindrical Conversion Table.
4. Used the ASTM E140 Table 6—Austenitic Stainless Steel hardness conversion chart to convert the 15-T readings to the HRB values.

High-Temperature Thermal Cycling Procedure:

1. Assembled one tube length with one union straight and one union elbow according to Swagelok assembly procedures.
2. Attached the test samples to a high-temperature furnace and pressurized to test pressure.
3. Increased the samples to test temperature of 750°F (398°C) within a period of one hour. The samples were allowed to stabilize at temperature for a minimum of 2 hours while being monitored for pressure decay.
4. The temperature was then lowered to laboratory room temperature (within one hour) while the test pressure was maintained. Samples were then stabilized at room temperature for a minimum of two hours while being monitored for pressure decay.
5. Repeated the above cycle two additional times.
6. Monitored the samples for leakage during the test; the pass criterion was no pressure decay.

Hydrostatic Proof Test Procedure:

1. Upon completion of the high-temperature thermal cycling procedure, the samples were subjected to a hydraulic proof test at ambient laboratory temperature.
2. Samples were pressurized to 100 psig (6.8 bar) and held for a period of five minutes.
3. After 5 minutes at 100 psig (6.8 bar), the samples were pressurized to test pressure (1.5 times ambient working pressure) and held for an additional period of 5 minutes.
4. Monitored the samples for leakage throughout the test; the pass criterion was no visible leakage.

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TEST RESULTS

High-Temperature Thermal Cycle Test

254 SMO SS Tubing Size OD × Wall in.	Ambient Working Pressure① psig (bar)	Test Pressure at Elevated Temperature① psig (bar)	Test Results
1/4 × 0.028	4000 (275)	2360 (162)	Pass
1/4 × 0.065	10 200 (702)	6018 (414)	Pass
1/2 × 0.035	2600 (179)	1534 (105)	Pass
1/2 × 0.083	6700 (461)	3953 (272)	Pass
3/4 × 0.065	3700 (254)	3136 (216)	Pass
3/4 × 0.095	4900 (337)	2816 (194)	Pass
1 × 0.083	3600 (248)	2124 (146)	Pass
1 × 0.120	3600 (248)	2124 (146)	Pass

① A de-rating factor of 0.59 was applied to the ambient working pressures to determine the test pressures.

Hydrostatic Proof Test

254 SMO SS Tubing Size OD × Wall in.	Proof Test Pressure psig (bar)	Test Results
1/4 × 0.028	6000 (413)	Pass
1/4 × 0.065	15 300 (1054)	Pass
1/2 × 0.035	3900 (268)	Pass
1/2 × 0.083	10 050 (692)	Pass
3/4 × 0.065	5500 (378)	Pass
3/4 × 0.095	7350 (506)	Pass
1 × 0.083	5400 (372)	Pass
1 × 0.120	5400 (372)	Pass

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The tests were conducted beyond the product's recommended operating parameters and do not modify the published product ratings.

These tests were performed to consider a specific set of conditions and should not be considered valid outside those conditions. Swagelok Company makes no representation or warranties regarding these selected conditions or the results attained. Laboratory tests cannot duplicate the variety of actual operating conditions. Test results are not offered as statistically significant. See the product catalog for technical data.

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.

Referenced Documents

Wilson Cylindrical Correction Chart # 53, Wilson Instrument Division, 929 Connecticut Avenue, Bridgeport, CT 06602

ASTM E140*, Table 6—Approximate Hardness Conversion Numbers for Austenitic SS*, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2858