Performance Verification
Data Sheet

Particle Shedding and Metal Extraction from PFA Tubing

Furon's 1/2-inch PFA Teflon tubing is designed for transfer of high-purity liquids and corrosive chemicals used in semiconductor processes. It was tested by an independent lab to verify its low particle shedding and metal ion extraction.

Particle Shedding Tests

A test[1] was conducted to measure particle shedding from the internal walls of the tubing while being flushed with ultrapure water (UPW). All tests were run at room temperature in a Class 100 cleanroom.

Test methods: A 20-ft length of 1/2-inch PFA tubing was installed in a continuous flow system equipped with a PMS HSLIS M65 particle monitor. UPW was circulated through the system at a flow rate of 520 ml/min for a face velocity of 12 cm/sec. The downstream concentrations of particles of four sizes ranging from ≥0.065 µm to ≥ 0.20 µm were monitored continuously. After 24 hours the test was repeated with a second piece of tubing.

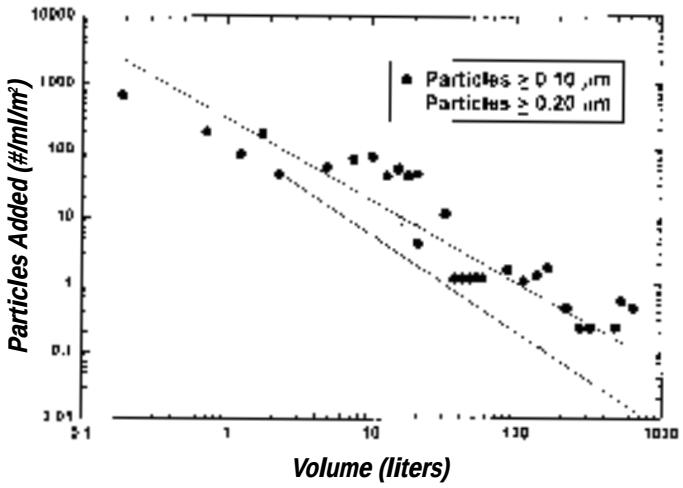
Results: The concentration curves for particles ≥0.1 µm and ≥0.2 µm downstream of the tubing are shown in Figure 1. The lines are a first order polynomial regression curve fit. Cleanup times and volumes, determined from the curve fit, are shown in Table 1. The concentration of particles ≥0.1 µm decreased to <2 particles/ml/m^2 after only 60 liters.

Metal Extraction

Measurements of metal extraction performed by an independent test lab verify that neither Furon's PFA tubing nor resin pellets release significant amounts of metals into process chemicals.

Test method for tubing: The DyconE$^{X\ SM}$ dynamic extraction procedure[2] was used to measure the total amount and rate of metal extraction from PFA tubing into 37% hydrochloric acid (HCl).

Figure 1: Particle cleanliness under steady-flow conditions

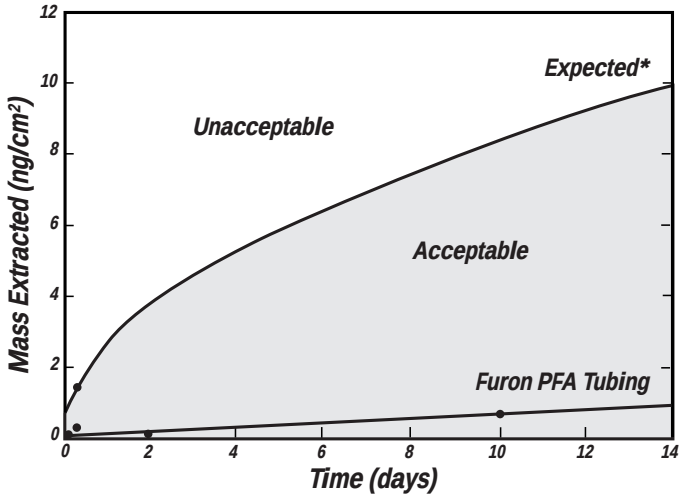


A 15-ft coil of tubing was rinsed with UPW and inserted in the circulation loop of a dynamic extraction system. An HCl sample was withdrawn and analyzed for trace metals. HCl was circulated through the system at 400 ml/min for 9 days. An acid sample was taken after 60 minutes to measure metal contamination removed from the tubing surface. Additional samples, taken at 2 hrs, 8 hrs, 2 days, and 9 days, were used to determine the masses and rates of metal extraction from the bulk of the tubing over time. All samples were analyzed for twenty metals by either inductively coupled plasma-mass spectroscopy (ICP-MS) or graphite furnace atomic absorption (GFAA) spectroscopy.

Test method for resin: The DyconE$^{X\ SM}$ procedure was also used to test the PFA resin. Resin pellets were weighed, rinsed with UPW, and placed in a preconditioned PFA bottle containing 37% HCl. The bottle was shaken and samples withdrawn for

Results: The major contaminant in the tubing and resin was iron. During the entire test period, the mass of iron extracted from the bulk of the tubing was 0.005 µg/linear foot and from the bulk of the resin was 2.9 µg/kg. Extraction of all other individual metals was less than 0.003 µg/linear foot or 1.1 µg/kg of resin. Figure 1 shows the total mass of all 20 metals extracted from the bulk of the tubing over time. The extraction rate for the tubing calculated at 7 days was 0.02 ng/cm²-day. The extraction rate for the resin was 0.002 ng/cm²-day at 7 days. Both extraction rates were well below the 0.5 ng/cm²-day specification set by a major chemical distribution system manufacturer for delivery system components[3].

Figure 1: Cumulative total metal extraction during a 9-day dynamic extraction test



***for a component meeting semiconductor OEM specifications**

SEMI Standards

The DyconE^{X} extraction test was more rigorous than the test used by SEMI to measure metal extraction from components[4]. The limits recommended by SEMI for metal extraction are based on a 7-day extraction in UPW at 85 ± 5ºC. The DyconE^{X} procedure used an aggressive acid for a longer period of time under flow conditions.

Table 2 compares the SEMI recommendations to the extracted masses. Even when exposed to an aggressive acid under dynamic extraction conditions, both the tubing and resin exceeded all recommendations for metal extraction.

Table 2: SEMI recommendations for metal extraction in 85˚C water compared to mass extracted from the tubing and resin by 35% HCl

Metal	SEMI (µg/m²)	Mass extracted (µg/m²) Tubing	Resin
Al	≤10	0.61	0.32
Ba	≤15	<0.1	0.05
B	≤10	<0.1	<0.1
Ca	≤30	0.47	0.26
Cr	≤1	0.13	0.32
Cu	≤15	0.40	<1.0
Fe	≤5	1.2	2.6
Pb	≤1	<0.1	<0.1
Li	≤2	<0.1	<0.1
Mg	≤5	<0.1	0.27
Mn	≤5	<0.1	0.03
Ni	≤1	0.52	0.96
K	≤15	0.58	<0.1
Na	≤15	0.62	0.05
Sr	≤0.5	Not Done	Not Done
Zi	≤10	<0.1	<0.1

Summary

Two 15-ft samples of 1/2-inch PFA tubing were tested in UPW to determine their particle shedding characteristics. Only 60 liters of UPW were required to reduce the concentration of particles ≥0.10 µm shed from the tubing to < 2 particles/ml/m².

The DyconE$^{X\,SM}$ dynamic extraction procedure was used to measure the total amount and rate of metal extraction from PFA tubing into 37% hydrochloric acid (HCl). The extraction rate for the tubing calculated at 7 days was 0.02 ng/cm²-day. The extraction rate for the resin was 0.002 ng/cm²-day at 7 days. The extraction from both tubing and resin into 37% HCl exceeded the SEMI recommendations for metal extraction into hot water and met the specifications set by a major manufacturer of chemical delivery systems.

Table 1: Cleanup volume required to reach defined particle shedding rates

	Particles ≥0.1 µm			Particles ≥0.2 µm		
	<10/ml added	<1/ml added	<0.1/ml added	<10/ml added	<1/ml added	<0.1/ml added
UPW Volume	4	27	173	2	10	49

References

1. Grant, DC, W Kelly, G Van Schooneveld, D Carrieri, D Smith, A Rodemeyer and D Henderson, "The Effect of Fluid Dynamics on Particle Shedding from Semiconductor Fluid-Handling Components," presented at the Fine Particle Society Meeting, Dallas, TX, 1998.

2. Grant DC, T Lemke, G Duepner, D Wilkes, and N Powell, "Measurement of inorganic contaminant extraction from fluid handling components by dynamic extraction " *JIES*, 39(2): 29-37, 1996.

3. Grant DC, T Lemke and D Carrieri, "Specification and verification of metallic extractables in fluid handling components by dynamic extraction," in *Proceedings of the Semicon West Workshop on Contamination in Liquid Chemical Distribution Systems,"* July, 1997.

4. SEMI Draft Document 2840B, "Provisional specification for polymer components used in ultrapure water and liquid chemical distribution systems."

The data provided here were obtained under defined test conditions. The tests were designed to mimic use or worst case conditions. However, Furon makes no specific claims about the performance of the valves in other chemicals or systems.

Table 1: Cleanup volume required to reach defined particle shedding rates

The DyconE^{XSM} procedure is patented by BOC Edwards Chemical Management Division (US patent No. 5,641,895).

For Technical Information or Customer Support ***1.800.833.5661*** *(USA)*

3501 Orangewood Avenue
Garden Grove, California 92841-1411
USA
Phone: 714.630.5818
Fax: 714.688.2614
www.plastics.saint-gobain.com

SAINT-GOBAIN
PERFORMANCE PLASTICS

FC 10037 Printed in U.S.A.