

Furon® Q Valve Reliability in 49% HF and 36% HCl

Furon Q valves have been tested for reliability in HCl and HF by an independent test lab¹ using the protocol of a major US OEM manufacturer. An accelerated life test was used to determine the the B₁₀ life, the number of cycles at which 10% of the valves would be expected to fail.

The HF life test included measuring particle cleanliness in ultrapure water after cycling. First the valves were tested for passive particle shedding during initial flush up of individual valves. Second, shedding was measured as two valves connected in parallel were alternatively cycled between open and closed.

Accelerated life test method

Test method: Eight 1/4" Q valves were assembled in a manifold allowing two parallel flow paths through each set of 4 valves. Each set was cycled 3 seconds open and 3 seconds closed at room temperature with an actuator pressure of 80 psig. One set was opened as the other set was closed to maintain a constant flow of acid through the system at 74-80 psig. Flow was provided by a double diaphragm pump. Valves were inspected every workday for leaks.

The accelerated life test was performed on two sets of eight valves: one in 36% HCl and one in 49% HF. Cleanroom grade HCl and HF were used. The acid was replaced halfway through the test to ensure that full chemical strength was maintained.

Valves were tested for cracking pressure and port-to-port leakage throughout the test. Cracking pressure was measured by applying increasing air pressure to the closed valve and measuring the pressure at which the valve opened. Both inlet and outlet ports were tested. A valve failed if the cracking pressure was less than 110 psig, or 110 % of the 100 psig specification. Port-to-port integrity was measured by applying the rated pressure (100 psig) to a closed outlet port and monitoring the pressure downstream of the valve. Failure was indicated by a rise greater than 2.1 psi in 10 minutes, which is equivalent to a water leak rate of 0.05 ml H₂O/hour.

Results

No valves failed during the 2.1 million cycle accelerated life test in either HCl or HF. Statistical analysis of the results are shown in Table 1. Since no valves failed during the test, the Weibayes method was used to determine the B₁₀ life of the valves. Valves in both tests meet the acceptable B₁₀ life requirement of > 2.0 million cycles.

Table 1: Results of accelerated life test

	36% HCl	49% HF
Cycles completed	2,100,000	2,100,000
Failures	0	0
B₁₀ life	≥ 2.1 million cycles*	≥ 2.0 million cycles*
Weibull mean time to fail	≥ 2.5 million cycles*	≥ 3.8 million cycles*

*Since no failures occurred, these values are lower bound estimates.

Particle Shedding

Test method: Four valves were tested in a Class 100 cleanroom for particle cleanliness. Individual valves were installed in a test system equipped with a PMS Liquistat 100 Optical Particle Counter. The valves were opened and flushed with ultrapure water at 300 ml/min as the con-concentration of particles downstream of the valve was measured. After all the valves had been flushed, the system was modified to accommodate two valves in parallel. The paired valves were cycled in an overlapping open/close cycle so that the 250 ml/min flow through the system was always maintained. The test continued for 10,000 cycles. The pressure was 30 psig during the tests. Background particle concentrations before each test were ≤ 0.05/ml for particles ≥ 0.10 μ.

Results

The average performance of the valves is shown in Figure 1. Data are graphed as the cumulative particle concentration added as a function of flush volume. Reference lines show the concentration specification, < 0.1 particle/ml added (horizontal line), and the acceptance criterion, <300 liters (vertical line), by which the specification must be met. Linear regression of the averaged values is shown. The valves added < 0.1 particle/ml within 21 liters of flushing Data from the cycle test are shown in Figure 2

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as the number of particles released per cycle as a function of cycles. The specification of < 10 particles released/cycle (horizontal line) within 10,000 cycles (vertical line) is included. On average, the Q valves reached the specification within 50 cycles.

Figure 1: Particle shedding during flush up

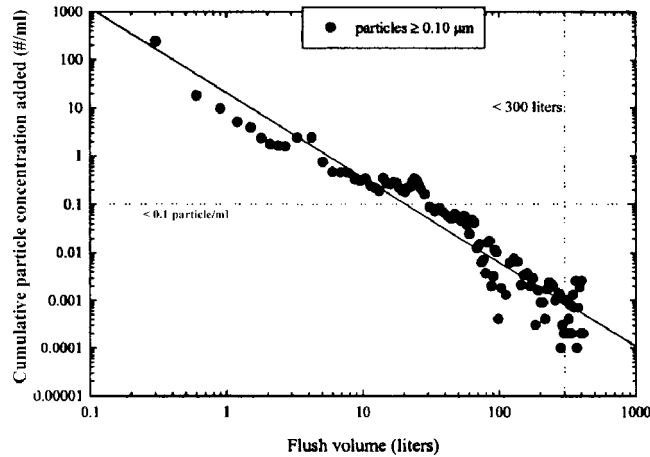
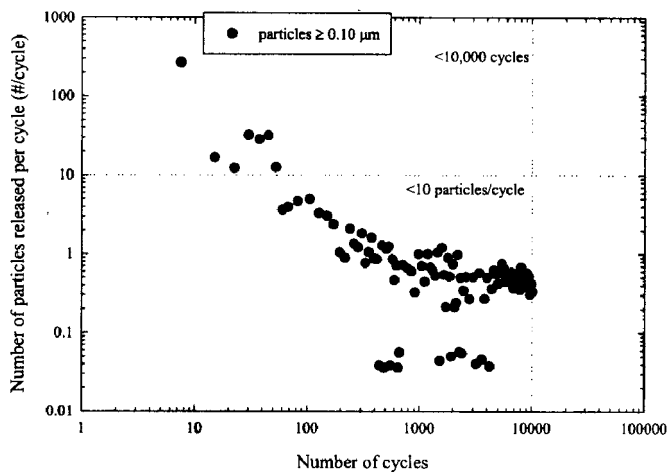


Figure 2: Particles released during the cycle tests



Summary

Eight Furon Q valves were tested for reliability and particle cleanliness following cycling. The valves were subjected to accelerated life tests in 36% HCl and 49% HF. The valves were cycled 2.1 million times with no observed leaks and no failures. Statistical analysis of the data show that the B₁₀ life of the valves was ≥ 2.0 million cycles.

After the HF life test was completed, the valves were tested for particle shedding. During the passive flush up test in ultrapure water, the valves reached the acceptance criterion of < 0.1 particle/ml added in 21 liters, considerably less than the maximum 300 liters. During cycling, the valves averaged < 10 particles/cycle shed within 50 cycles, far fewer than the requirement of ≤ 10,000 cycles

References

R. B. Abernethy, The New Weibull Handbook,
R. B. Abernethy, 2000.

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



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