

Reliability of Furon® UPM-3 Valves in CMP Slurry

Furon UPM slurry valves are designed for use with chemical-mechanical planarization (CMP) slurry. Their PTFE diaphragms can withstand abrasion from slurries in long-term usage required by CMP applications. Ten UPM 3-way valves tested under simulated use conditions were cycled 869,000 times in slurry without failure. The 50% mean time to failure (MTF) was 970,000 cycles.

Test Method

Ten UPM3-61212 slurry valves were assembled in parallel in a slurry circulation test cabinet. Cabot Semi-Sperse® SS-25 slurry was circulated through the test system at a flow rate of 6.5 ± 0.5 gpm. Valves were actuated in pairs, directing flow through each port for two seconds of a twenty second cycle. Actuation pressure was 70 ± 5 psig, slurry inlet pressure was 50 to 70 psig and outlet pressure was 45 ± 10 psig. The test was continued until all valves had cycled 1,030,000 times.

Valves were inspected visually at least once daily for leakage through the leak port. When a leak was detected, slurry circulation was interrupted while the failed valve was removed from the system. The valve housing and diaphragm were examined to determine failure mode. The valve was repaired and reinstalled to maintain flow and pressure uniformity within the manifold.

Slurry replacement: Slurry samples were withdrawn during each of the first five days of circulation and analyzed by an independent lab. Measurements of particle size, suspension and agglomeration were used to determine how frequently to replace the slurry.

Results

Valve failure was defined as leakage through the leak port. All ten valves functioned without failure to 869,000 cycles when the first valve failed. When the test was discontinued after 1,030,000 cycles, two of the ten valves had not failed. The number of cycles at which each valve failed is listed in Table 1.

Table 1: Cycles of UPM valves in slurry until failure

Valve Number	Cycles to Failure
1	869,000
2	972,000
3	994,000
4	994,000
5	1,000,000
6	1,010,000
7	1,020,000
8	1,030,000
9	Not Determined
10	Not Determined

Failure Mode

All of the failed valves were inspected to determine the mode of failure. In all cases, the diaphragm had failed.

Statistics of Failure

Figure 1 presents the probability of failure with number of valve cycles. The x-axis of the graph is a probability scale; the y-axis is a logarithmic scale. The line represents the log-normal distribution of the data. The dotted lines show that the 5% probability of failure is at 880,000 cycles. 50% probability of failure occurs at 970,000 cycles. The statistics of failure are presented in Table 2.

Figure 1: Probability of failure of UPM valves when cycled in Semi-Sperse SS-25 slurry

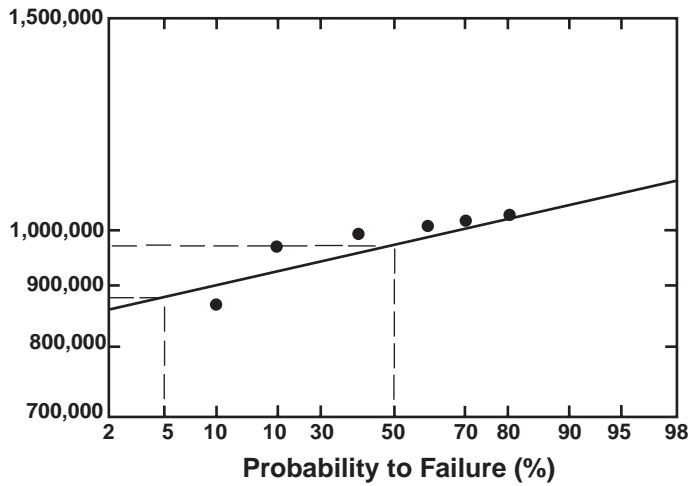


Table 2: Statistics of failure for UPM valves cycled in Semi-Sperse SS-25 slurry

Cycles to Failure		Statistics of Failure	
Probability 5%	Probability 50%	Median	Geometric Standard Deviation
880,000	970,000	970,000	1.07

Summary

Ten Furon UPM slurry valve were tested for reliability in Cabot Semi-Sperse® SS-25 slurry. The valves were cycled to failure in simulated use conditions. No failures occurred before 869,000 cycles. The test was discontinued after 1.03 million cycles although two valves had not failed. Inspection of the eight valves showed failure was due to wear on the diaphragm. Mean time to failure (MTF) was 970,000 cycles, with only 5% of the valves failing at 880,000 cycles.

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



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