½" Integra® Valve Reliability Testing

Entegris has conducted a number of reliability tests on ½" Integra® valves in a variety of media and at various media pressures and temperatures. The purpose of the testing was to provide reliability estimates so users can more accurately schedule maintenance and better determine their own equipment mean-time-between failure (MTBF) estimates.

TEST DESCRIPTION

A typical reliability test involved cycling up to eight valves at rates of approximately 10 cycles/min with defined media, media pressure and media temperature. Tests were conducted between August 1996 and May 1998 at both Entegris' Product Test Laboratory and an independent test laboratory. Test conditions including media, media pressure and media temperature are shown in Table 1.

Valves were visually inspected and examined daily to ensure proper function and media containment. Valves were removed from test and checked for port-to-port seal integrity approximately every 250,000 cycles.

Testing continued until at least two failures occurred in a given test. A failure was defined by functionality loss, media leak or port-to-port seal failure.

Table 1: Test Conditions:

Media	Media pressure	Media temperature
HCl	552 kPa (80 psig) 345 kPa (50 psig)	23°C (73°F) 23°C (73°F)
Oil	552 kPa (80 psig) 414 kPa (60 psig)	23°C (73°F) 65°C (150°F)
Shipley MEGAPOSIT® MF® 701 Developer	345 kPa (50 psig)	23°C (73°F)

RELIABILITY ANALYSIS

The cyclic failure data generated by this test program was analyzed using maximum likelihood estimation to make reliable life estimates. The statistical software program ReliaSoft Weibull++™ was used to analyze the data.

The analysis produces the best fit regression line and regression parameters. Plots for reliability are then generated on a log-log scale with unreliability on the y-axis and cycles-to-failure on the x-axis. Unreliability is equal to 1 minus the reliability percentage. A confidence bound is used on the lower side of the best fit regression line to apply a known confidence factor to the data. Reliable life estimates can be made directly from the plots by choosing the desired reliability level and reading the corresponding cycles-to-failure.

RELIABLE LIFE PLOT INTERPRETATION

To make a 95% reliable life estimate, find the point where the 5% unreliability value intersects the best fit regression line. The cycles-to-failure value at this point is the number of cycles that 95% of valves would be expected to survive if cycled under the same conditions.

To add a lower 95% confidence bound to the 95% reliability estimate, determine where the 5% unreliability value intersects the lower 95% confidence bound. The cycles-to-failure value at this point includes a lower confidence bound on the reliability estimate. Since this takes the sample size into account, using the lower confidence bound is the more conservative method of determining reliability. As indicated by the heavy line on plots 1–4, all of our plots use a 95% lower confidence bound and a 95% reliability for reliable life estimates.

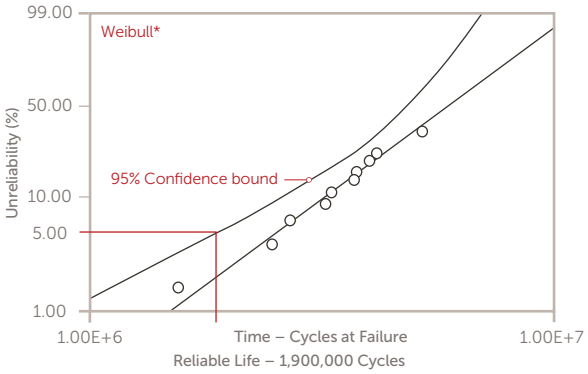
Reliable life estimates differs from a mean-time-to-failure (MTTF) or mean-time-between-failure (MTBF) analysis. MTTF and MTBF estimates are based on the average-time-(or cycles)-to-failure or average-time-(or cycles)-between-failures respectively. The MTTF can be calculated from the regression parameters determined for the best fit regression line shown in our plots.

The MTTF metric is based on an average time to the first failure, so it is an unsuitable reliability estimate for applications in which Integra valves are used. A reliable life estimate is much more appropriate.

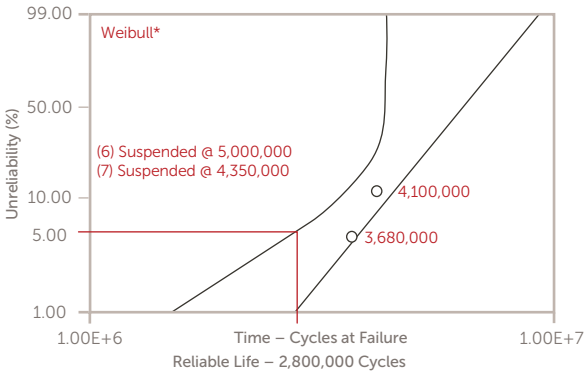
For example, the MTTF estimate for all 41 valves tested including the 10 failures is 5,975,000 cycles. The 95% reliable life estimate from the same valve population is 1,900,000 cycles. The estimates are significantly different. Since the MTTF value is an estimate of the cycles at which approximately half of the valves will have failed, it is obviously not suitable for determining equipment maintenance schedules in critical applications where a single component failure can be catastrophic. The reliable life estimate provides a more suitable estimate of a component's life enabling you to more accurately determine preventive maintenance intervals.

PERFORMANCE DATA

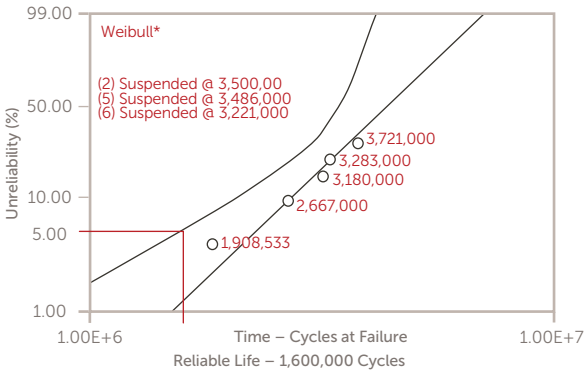
½" Integra Valve Reliability Testing
All (41) ½" Integra valves, various medias and conditions



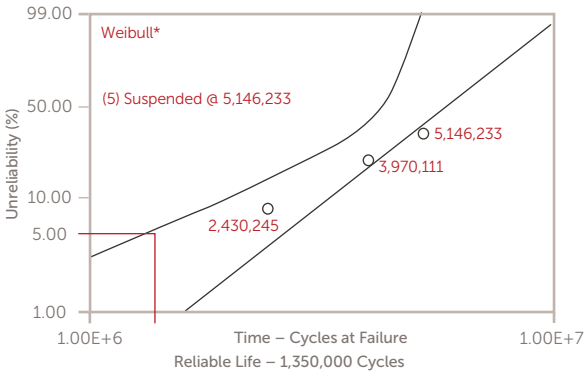
½" Integra Valve Reliability Testing
Oil, 23°C (73°F) @ 552 kPa (80 psig) and 65°C (150°F) @ 414 kPa (60 psig)



½" Integra Valve Reliability Testing
HCl, 23°C (73°F) @ 552 kPa (80 psig) and 23°C (73°F) @ 345 kPa (50 psig)



½" Integra Valve Reliability Testing
Shipley MEGAPOSIT MP 701 Developer, 23°C (73°F) @ 345 kPa (50 psig)



ReliaSoft Weibull++ 5.0

CONCLUSION

Reliable life estimates for ½" Integra pneumatic valves have been produced using reliability analysis methods. Testing to produce the failure data for analysis took place over 18 months and was conducted in a variety of conditions both at Entegris and an independent test lab. Even after using a very conservative analysis approach, reliable life estimates of 1.3 million cycles for the test condition producing the lowest results, and 1.9 million cycles for all combined test conditions resulted.

The hazardous chemicals you run through our products present significant safety issues. Valve cycle life claims should be based on reliability testing using standard procedures, not deceptive estimates. Entegris has adopted statistical reliability analysis as a means of making life estimates available to our customers so you can more accurately determine your equipment's reliability and preventive maintenance schedules.

DISCLAIMER

The reliable life estimates provided here have been determined for, and are specific to, the conditions under which the valves were tested. Entegris makes no representations about how the reliable life of the valve will be affected by conditions different from those in which the valves were tested (including media type, media pressure, media temperature, ambient conditions or other unspecified conditions).

FOR MORE INFORMATION

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