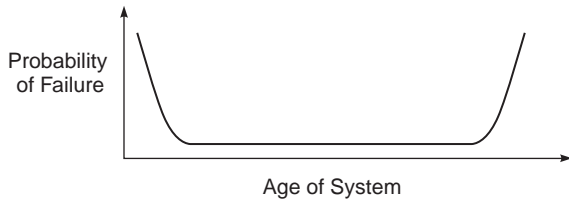


Filtration Requirements

HydraForce's experience concurs with data derived from other sources, notably Pall Corporation, that most systems track a "bathtub" curve for failures, with the highest probability occurring at system installation/run-in, following fluid replenishment, and again after the system ages and there has been significant component abrasive wear.

Typical Failure Curve:



Best Practices for Avoidance of Initial Start-Up/Run-In Failure:

- Hydraulic fluid and components should be cleaned and certified to the appropriate ISO 4406 level prior to installation. Many OEMs have established corporate cleanliness specifications for pre-installed components, which have proven useful in minimizing installation run-in failures.
- System should be flushed with a remote filter cart, where possible. Recommended practice is to use filtration rated at one-third of system filtration specifications. Attempting to flush system using shop air is usually counterproductive, since ambient air may introduce more contaminants than are eliminated.
- High-pressure filtration, non-bypass, high-collapse elements with condition indicators should be used to minimize valve inlet-side contamination.
- O-ring type fittings should be used. Never use tapered (i.e., NPTF) threads or thread sealant. Lubricate connectors with clean system oil. Do not grease.
- Purge all air and water from the system. Difficult-to-prime components (e.g., suction lines, valve wet-tube assemblies, etc.) should be located below the reservoir oil level.
- Protect small orifices with screens or other means to catch the "rocks" often generated at startup.

Best Practices for Proper Maintenance of Mature Hydraulic Systems:

- Treat every major rebuilding effort involving significant system intrusion as a "run-in" as described previously.
- Continuous use of high-pressure filtration, non-bypass, high-collapse elements with condition indicators.
- Return line filtration to clean oil of contaminants introduced through lines and actuators. Return line filters with beta ratios over 200 are typically a lower cost way to clean systems, with larger effective filter area and dirt-holding capacity.
- Regular oil analysis to monitor cleanliness and damaging water or air ingress. Studies indicate that up to 20% of component failures in hydraulic systems are the result of corrosion caused by free or dissolved water and/or entrained air.
- Typical 210 bar (3000 psi) valves are designed with clearances (adjusting for concentricity, lap, etc.) of 4 to 10 micron nominal per side diametrical clearances. Abrasive wear will be mostly generated by particles in this size range. According to Pall Corp., 50% of component failures are due to wear induced by abrasion particles at or near this "dynamic clearance".
- Regular inspections of actuator seals, reservoir filler-breathers, and other system entry points.

Minimum Filtration vs. Extended Life Filtration

- HydraForce laboratory and production test stands are installed with filtration capable to 14/13/11, at beta ratios over 200. It is well-established that the proper function and life-expectancy of a typical hydraulic system correlate closely with levels of contamination. With "Extended Life" filtration, as recommended herein, users of HydraForce products may expect to achieve the "million cycle" life, as designed-in to virtually all of our products and validated at the good filtration levels used on our life cycle test stands. To be sure, other factors affect product life, however good filtration is the best method to extend the life of any hydraulic component.
- Failure to provide and maintain required "Minimum Filtration" levels may result in premature malfunction or failure.

Type of System/Valve	Minimum Filtration ISO 4406:1999 SAE J1165 4µm / 6µm / 14µm	Recommended Filtration for Extended Product life 4µm / 6µm / 14µm
High performance systems; high operating pressures at 210 to 350 bar (3000 to 5000 psi); proportional controls, high-cycle applications, etc.	18/16/13	15/13/11
General industrial and mobile equipment operating at pressures to 210 bar (3000 psi); spool-type valves, valves with pilot orifices, etc.	20/18/14	17/15/13

HydraForce wishes to thank the Pall Corporation™ for the use of information from "Contamination Controls and Filtration Fundamentals" © 2000, 2001.