

Maintenance & Trouble Shooting Tips

The following tips are derived from our many years of working with HPLC pumps, and are presented here to assist the chromatographer or service technician to prevent problems from occurring, and diagnosing and solving them when they do occur.

Check Valves

■ Expected Service Life

The life of a check valve depends entirely upon service conditions. There are only three things that will compromise life of an *ASI* check valve: contamination from the mobile phase, contamination from pump seal wear material, and build-up of salts in the valve. If the guidelines below are adhered to, you can expect several years of reliable service from *ASI* valves (many of the *ASI* valves that were put into service for reliability testing in 1992 are still in service now).

However, for the best assurance of reliability and repeatable retention times, we recommend a policy of replacing the valves every second time the piston seals are replaced.

■ Keeping Them Clean

1. Solvent inlet filter

Always use a 10 micron or finer filter on the solvent intake line. Even if you use HPLC grade solvent, the solvent can become contaminated with dust particles by even a few hours of exposure to air in an open container. The reliability of a check valve can be seriously impaired by contamination. If you see your service technician “checking out” your pump and he is not using filters – **STOP HIM!** Even if the valves still work normally, your system is going to be contaminated!

2. Outlet valve filter

The purpose of the outlet valve filter is to guarantee reliability by preventing seal wear material and other contaminants from entering the outlet valve. For most chromatographers the added reliability is worth the extra effort to replace the filter every two or three years. However, users may elect to eliminate the outlet filter by substituting an inlet cartridge for an outlet, since for most pumps an *ASI* inlet valve is interchangeable with the outlet except for the filter. Please consult technical support if you need more information.

Inspect the filter on the outlet cartridge whenever you change a pump seal. If there is excessive residue on the filter, it is advisable to replace the filter. On most pumps the filter will last for at least 2 years before it needs to be changed, but if seals are wearing out frequently* then the filter life will be shorter due to a buildup of seal wear material.

Please see page 7, “Seal Life Unusually Short”.

3. Cleaning dirty valves

Use a syringe to flush the valve with 50 mL of clean HPLC grade IPA or water. This simple procedure works 90% of the time. If not, then place the valve in 20% nitric acid and sonicate for a maximum of 20 minutes. Follow this by flushing the valve with 50 mL of HPLC grade water (*wear safety goggles so you don't get acid in your eyes!*).

Note: Sonication will eventually cause fretting damage between the ball and seat, so do not sonicate more than 20 minutes.

■ Long Term Storage: stuck check valves

Highly polished surfaces such as the sapphire, ruby or ceramic ball and seat in check valves will tend to bond to each other when allowed to dry out. The severity of this problem depends on what solvent was last in contact with the ball and seat. With acetonitrile, the problem is quite severe; with most other solvents the problem is not quite so noticeable but will still occur occasionally.

While this problem will almost never occur when valves are installed in a pump (it is virtually impossible for a valve to dry out while installed), it can occur during long-term storage. The best way to prevent this from happening is to store the valve in the original bag that the valve was shipped in, and filling the bag with several ml of isopropanol. Water can also be used as long as 20% isopropanol is added to prevent biological growth. Valves that are stored in solvent (even acetonitrile) will not become stuck.

■ Diagnosing Valve Problems: distinguishing between inlet and outlet valve failure

Most valve problems are due to the inlet valve, since the outlet valve usually has a filter to protect it. If valve problems are suspected, the following test will help verify that the inlet valve is indeed the problem. Set the solvent bottle at the same level as the pump and introduce a small air bubble into the intake line. With the pump running under pressure, monitor progress of the bubble up the line. If the air bubble progresses towards the pump without any backward motion, then both inlet and outlet valves are working normally. If the air bubble moves back and forth in-sync with the pump stroke, then the inlet valve is failing to close properly. ***Please refer to the “Trouble Shooting Guide” (page 4) on check valves.***

If the air bubble does not move at all, then the outlet valve is suspect.
Please see page 6, “Failure to Prime”.

Pistons

It is hard to believe that sapphire, one of the hardest materials known to man, could ever be worn out or scratched by a soft material like Teflon or UHMW-PE. Unfortunately it does wear out. As the seal gets used, small particles of salt crystals, metal fragments, and other contaminants become embedded in the sealing surface of the seal. Over time these contaminants abrade the sapphire or ceramic plunger and form flat spots or longitudinal scratches. These wear spots will destroy any seal in a very short time.

It is extremely important to inspect the sapphire or ceramic plunger whenever you replace a seal. If there are any signs of scratches or glazed spots, replace the piston. Failure to do so will result in a shredded seal and a pump head full of seal wear material.

It is very difficult to see worn spots on a sapphire or ceramic piston. Hold the piston up to a bright light and inspect with a 10x magnifier or microscope. Any spot that appears dull, glazed, or scratched is a sure sign of a worn piston.

Another problem that is not discussed as often is the design of the liquid end of the pump. Some pumps are designed so that contact may occur between the piston and a metal or ceramic back-up ring. Such problems are usually due to a failure on the part of the pump designer to account for the accumulation of concentricity, or run-out tolerances between the piston and the metal back-up washers that support the seal. If you observe premature seal failure even after replacing your piston, then re-inspect the piston. If signs of scoring, or a glazed spot, appear on the new piston, then you may have a serious hardware design flaw that has nothing to do with your piston or seal. Contact ASI technical service for advice.

Piston Seals

■ Service Life

There are two ways that we define service life: one is when the leak rate becomes excessive (more than 1% of set point flow rate); the other is when the seal begins to shed so much wear material that the valves and other hydraulic components begin to fail from contamination. We have run a number of life tests here at *ASI* comparing UHMW-PE to Teflon. In general, they both last equally long if you consider only the leak rate. The UHMW-PE wears less, but because it is a stiffer material it will not continue to conform to the piston when the inside sealing surface begins to wear away. On the other hand, Teflon wears much faster, but it is more compliant and so it continues to seal despite being badly worn. However, if you consider the shed rate of wear material as the criterion, then UHMW-PE is the clear winner because it sheds far less material than the Teflon compounds. Due to the importance and expense of the hydraulic components in the HPLC system, we firmly believe that when a seal generates an excessive amount of wear material its useful service life has been exceeded. Accordingly, the UHMW-PE compounds have a much greater service life than Teflon.

■ Seal Compliance

Teflon is a softer and more compliant material than UHMW-PE, so it will conform better to a worn or out-of-round piston. Also, if the piston is worn or scratched, it may leak whereas a Teflon seal might still work for a while (*but don't count on that for long – replace that worn piston ASAP!*). If your newly installed UHMW-PE seals do leak when they are first installed, run the pump at 2,000 PSI or more for 30 minutes with IPA or Water, and the leak will stop as the seal conforms to the seal cavity and piston. If the leak doesn't stop after 30 minutes, then it was either damaged during installation or the piston is worn or scratched and must be replaced.

■ Solvent Compatibility

Teflon is absolutely inert to any HPLC solvent, period. UHMW-PE compounds may exhibit reduced life when used with very strong organic solvents like pure methylene chloride and toluene. However, it is important to bear in mind that solvent compatibility is a rather minor issue when compared to other factors such as what pump you have, the condition of the piston, and whether the seal was damaged during installation.

■ Installation

If the seal is badly worn, then the pump head will be contaminated with seal wear material. Remove the check valves and seal from the pump head and sonicate the head in 20% nitric acid for 30 minutes. Rinse thoroughly, then sonicate for 10 minutes in DI water. Blow dry with oil free compressed gas or air. The inlet valve should be flushed with 50 mL of HPLC grade isopropanol or water, and the outlet valve filter inspected (if there is no filter on the outlet, then flush with 50 mL of HPLC grade IPA or water). Carefully inspect the piston for worn spots or scratches.

Please refer to piston section (page 2).

Wet the seal and pump head with isopropanol prior to reassembly. IPA serves both as a lubricant and surface wetting agent, which will reduce the amount of air trapped in the head.

Install the new seal, using an installation tool if available. Use great caution not to damage the lip of the seal during installation.

Run the pump with IPA at about 2,000 PSI for 30 minutes to set the seal.

If the seal leaks after the first 30 minutes:

1. Check that the seal lip was not damaged during installation.
2. Carefully examine the piston for wear or scratches. It is difficult to detect a damaged or worn piston. Use a magnifying glass to identify any glazed or "frosted" spots, axial grooves or scratches. When in doubt, replace the piston.

Trouble Shooting Guide

The following trouble shooting guide has been prepared for the novice as well as experienced service technicians. Often it is more expedient to simply replace old parts with new ones and get back to work, but for the chromatographer who doesn't have the budget for that, or who is down on a weekend with no spare parts, we hope these tips get your HPLC pump up and running, and keep it running.

Problem	Cause	Remedy
Erratic Pressure	Dirty inlet valve	Remove inlet valve and flush with 50 mL of clean HPLC grade solvent.
	Dirty outlet valve	Replace with new valve (an inlet cartridge can be substituted for an outlet if no outlet valves are available). If there is no filter on the outlet, then it may be cleaned in the same manner as an inlet.
	Clogged solvent intake filter	Replace with new filter.
	Leak at solvent inlet line	Tighten fitting. Replace ferrule and fitting if no longer serviceable.
	Worn pump seal or piston	Replace seal. Inspect piston and replace if worn.

***Note:** This problem may not be easy to detect! On the intake side of the pump there is a slight vacuum, so air will leak into the pump rather than solvent leaking out. There will be no visible sign of a leak. To detect this problem, make sure that there is no air in the intake lines, then open the outlet fitting and watch for air bubbles coming out (place a drop of solvent at the outlet fitting to observe air bubbles). If you continue to observe air bubbles after 60 seconds, then air is probably entering the head from the inlet fitting, a leaky pump seal, or an insufficiently tightened inlet housing.*

***Note:** If your piston is worn, you can sometimes get a Teflon seal to work for a short time, until a new piston can be obtained. Teflon will generally conform to and seal with a worn piston better than UHMW-PE, but not for long. Also, Teflon will generate copious amounts of wear material when used with a worn piston. Replace the worn piston ASAP.*

Problem	Cause	Remedy
<p>Erratic Pressure continued</p>	<p>Air in pump head</p> <p><i>Note: This symptom is normal after replacing a pump seal or piston. Wet the seal and inside of the pump head with IPA to reduce the amount of time it takes to eliminate air from the head.</i></p> <p>Not using degassed solvents</p> <p>Air bubbles in inlet line</p>	<p>Purge pump for 30 seconds, then operate at 1,000 PSI or higher. The air will dissolve in the solvent and be expelled within about 30 minutes.</p> <p>Degas, preferably using vacuum and sonication.</p> <p>Degas solvent. Replace solvent inlet filter. Make sure solvent bottle still has solvent!</p>
<p>Frequent Check Valve Failure</p>	<p>Contaminated solvent</p> <p>No solvent inlet filter</p> <p>Worn pump seal or Piston</p> <p><i>Note: If the seal is badly worn, then the pump head will be contaminated with seal wear material. Remove the check valves and seal from head and sonicate the head in 20% nitric acid for 30 minutes. Rinse thoroughly, then sonicate for 10 minutes in DI water. Wet seal and pump head with IPA prior to reassembly. The inlet valve should be flushed with 50 mL of HPLC grade IPA or Water, and the outlet valve filter inspected (if there is no filter on the outlet, then flush with 50 mL HPLC solvent).</i></p> <p>Service life of check valves has been exceeded</p>	<p>Use clean HPLC grade solvent.</p> <p>Always use 10 micron or finer solvent filter.</p> <p>Replace seal. Inspect piston and replace if worn.</p> <p>Install new valves.</p>

Problem	Cause	Remedy
Failure to Prime	Excess back pressure in pump head	Open purge valve, or open fittings at outlet check valve.
	Valve installed upside down	Verify that arrow faces up for both inlet and outlet valve.
	Clogged solvent inlet filter	Clean or replace with new filter.
	Clogged outlet valve filter	Replace outlet valve filter.
<p>Note: The outlet valve filter should last at least 2 years in normal service. However, if piston seals are wearing out frequently, then wear material from the seal may cause premature clogging of the outlet frit, as well as contaminating the inlet valve. Replace the outlet filter, and inspect the sapphire piston for wear or score marks.</p>		
Operating Pressure is Lower than Normal	Worn seal or piston	Replace seal. Inspect piston and replace if worn.
	Air in pump head or intake line	Purge pump for 30 seconds, then operate at 1,000 PSI or higher. The air will dissolve in the solvent and be expelled within about 30 minutes.
	Clogged solvent inlet filter	Clean or replace with new filter.
	Dirty inlet valve	Remove inlet valve and flush with 50 mL of clean HPLC grade solvent.
	Dirty outlet valve	Replace with new valve (an inlet cartridge can be substituted for an outlet if no outlet valves are available). If there is no filter on the outlet, then it may be cleaned in the same manner as an inlet.

Problem	Cause	Remedy
<p>Operating Pressure is Lower than Normal continued</p>	<p>Leaky fitting</p> <p>Note: <i>If a slight amount of additional tightening does not slow stop the leak, then replace the ferrule. Over-tightening the fitting can damage the seat, strip the threads, or worse, cause the nut to shear off. Never exceed 15 in-lbs of torque.</i></p>	<p>Tighten fitting. Replace ferrule if badly deformed.</p>
<p>Seal Life Unusually Short</p>	<p>Worn or scratched piston</p> <p>Note: <i>It is not always obvious by visual inspection if a piston is worn or scratched. Use a magnifying glass to look for a glazed appearance, or axial grooves and scratches. The piston is badly worn if any such conditions are visible.</i></p> <p>Build-up of salts on piston</p> <p>Mobile phase incompatible with seal material</p> <p>Note: <i>The UHMW-PE blend that is used by ASI is resistant to almost all HPLC solvents. However, there are a few solvents for which Teflon is more suitable. These are 100% methylene chloride and 100% toluene. Refer to catalog section on seals.</i></p>	<p>Replace with new piston.</p> <p>Use the piston flush option if available. Always run DI water through the pump before shutting down for the day when running buffers.</p> <p>Use a Teflon seal.</p>