

RELIABILITY AND ENHANCEMENT PROGRAMS

Waters Alliance Systems: Guidelines for Ensuring Optimum Performance

Waters

Introduction

Since their introduction in 1996, Waters Alliance® Systems have become established as the ultimate standard of performance and reliability in high performance liquid chromatography (HPLC) systems worldwide. These systems have been successfully used for an ever-expanding range of applications, including mass spectrometry (MS) detection techniques.

Alliance Systems are based upon the family of Waters Separations Modules (the 2695, 2695D, and 2795). These systems employ leading-edge engineering design and continued technology improvements to provide durable high-performance platforms for HPLC and LC/MS system solutions.

The reliability of such instrumentation is clearly of paramount concern in today's laboratories, many of which run in a "24/7" environment that does not tolerate unscheduled system downtime.

This paper presents guidelines for ensuring that your Alliance System consistently performs at its highest level, focusing on solvent management for Alliance System operation:

- Mobile phase considerations (proper preparation and degassing)
- Solvent manager components (sapphire plungers and plunger seals)
- Plunger seal wash
- Check valves
- Performance maintenance

Mobile Phase Considerations

Mobile phase problems account for 70 percent or more of all liquid chromatographic challenges.

The mobile phase required for a separation can affect baseline noise and drift, reproducibility, and maintenance requirements. It is often prescribed by the application and cannot be altered. In such cases, proper preparation of the mobile phase can reduce the potential for problems.

Use only clean, HPLC-grade solvents. A dirty solvent can cause baseline noise and drift and clog solvent filters with particulate matter. HPLC-grade solvents generally maintain their purity from lot to lot; use them to ensure the best possible results. After adding solvent modifiers (buffers) and adjusting pH, filter the solvents using a 0.45-micron filter. Use water from a high-quality water purification system. Mobile phase changes involving two miscible solvents may be made directly.

Changes involving two solvents that are not totally miscible (for example, from chloroform to water) require an intermediate solvent (such as methanol). Buffers dissolved in water may precipitate when mixed with organic solvents.

When you switch from a strong buffer to an organic solvent, flush the buffer out of the system with high-quality water before you add the organic solvent. You should also flush buffer out of the system when shutting the HPLC system down, since the solution may precipitate when left standing in the system.

Waters 2695 and 2795 Separations Modules are constructed of high-quality stainless steel components that, with some minor restrictions, can be used with all solvents. Please refer to Appendix C ("Solvent Considerations") in your operator's guide for details of potentially troublesome solvents.

Vacuum degassing will improve system reproducibility. The PerformancePLUS™ Inline Degasser is standard on 2695 and 2795 Separations Modules. It achieves high degassing efficiencies with low-volume chambers that substantially reduce prime effort, speed up solvent changeover, and increase overall system performance and reliability. Degasser systems work best if unused solvent lines are filled with solvent that contains enough organic content (typically greater than 20 percent) to prevent the formation of bacteria.

Waters recommends the consistent use of AutoStartPLUS (2695) and SystemPrep (2795) routines during daily system preparation and shutdown to minimize solvent-related problems. These routines are built into the system firmware.

For further information on HPLC solvents, please refer to Appendix C ("Solvent Considerations") in your operator's guide.

Solvent Manager Components

Waters Separations Modules are assembled with the highest-quality components available. Standard components optimize the system for the widest variety of applications. However, for applications that must meet more demanding performance expectations, Waters offers alternative components. Ask your Waters field service engineer for specific recommendations. You can also use the information below as a general guide. As always, some experimentation will be necessary to find the best configuration for your application.

Sapphire Plungers

Sapphire plungers are among the most important components in your solvent management system. The condition of the sapphire plungers is critical. They must be clean and smooth in order to keep the plunger seals performing efficiently. Change the plungers once each year, in accordance with the Waters Performance Maintenance (PM) strategy.

Waters offers two types of sapphire plungers for use with Separations Modules (see table):

- Standard sapphire plunger: Manufactured using processes traditional to Waters and other instrumentation vendors.
- PerformancePLUS Sapphire Plunger: The crystalline structure of the plunger is oriented lengthwise, rather than randomly. This results in a harder surface around the circumference of the plunger, extending its expected lifetime. This part will provide the best sealing surface and durability.

It is included in the Performance Maintenance Kit and is also available as a spare part.

Sapphire Plungers			
Description	Part Number	Included in Performance Maintenance Kit	Application
Sapphire Plunger	WAT270959	No	Industry standard
PerformancePLUS Sapphire Plunger	WAT271067	Yes	Hardest surface, longest lifetime

Plunger Seals

Another component critical to solvent management is the plunger seal material. Waters offers a choice of plunger seal materials to meet the various needs of different applications (see table).

- The standard plunger seal is yellow and made primarily from ultra-high molecular weight polyethylene (UHMWP).
- Two alternative plunger seals are available:
 1. Black plunger seal made of graphite-filled polymer (GFP)
 2. Clear plunger seal made of ultra-high molecular weight polyethylene

Plunger Seals			
Description	Part Number (2 per package)	Included in Performance Maintenance Kit	Application
Plunger Seal UHMWP (Yellow)	WAT270938	Yes	General; supplied as standard
Plunger Seal GFP (Black)	WAT271066	No	High organic concentration
Clear Seal UHMWP	700001326	No	High organic concentration

Plunger seal life is typically six months to one year; if your plunger seal lifetime is lower, you may try the alternative seals.

Plunger Seal Wash

All 2695 and 2795 Separations Modules are supplied with programmable, continuous active plunger seal wash (see table).

Plunger Seal Wash Kit			
Description	Part Number (2 per package)	Included in Performance Maintenance Kit	Application
Plunger Seal Wash Kit	WAT271018	Yes	General

Seal wash solvent lubricates the plungers and flushes away any solvent or dried salts forced past the plunger seal from the high-pressure side of the piston chamber. This wash cycle extends the life of the seals.

To keep the plunger seal wash operating effectively, position the plunger seal-wash reservoir in a visible location above the solvent management system, and refill the reservoir as necessary with a solvent that is suited to your application:

- For reversed-phase HPLC applications, use an aqueous plunger seal-wash solution with enough organic content to inhibit bacterial growth. For example, use 80% water with 20% methanol or acetonitrile, depending on your application.
- For all GPC (normal phase) separations, use a 50/50 mix of methanol and water for your seal wash solution.

Note: You must use separate solutions and containers for the plunger-seal wash and sample management system needle wash. Because the functions of these solutions differ, the use of one solution for both functions may compromise the effectiveness of either needle washing or plunger-seal washing.

Change the plunger seal-wash seals whenever you change the main plunger seals.

Check Valves

Check valve failures are a common cause of reproducibility problems. There are a number of check valve failure modes—including sticking (failure to open or close) and intermittent leaks—that result in variable retention times and pressure fluctuations.

Intermittent leaks are often caused by particulate matter that sticks to the check valve ball. This particulate material can come from the mobile phase, shedded seal material, dirty glassware, or poor laboratory cleanliness.

Waters offers four inlet check valve cartridges for Separations Modules (see table):

1. The PerformancePLUS R/S inlet check valve cartridge contains a 1/8 in. ruby ball and sapphire seat. This cartridge provides excellent performance, and is installed in instruments at the factory.
2. The 2X95 R/S inlet check valve cartridge option contains a 1/16 in. ruby ball and sapphire seat, and is optimized for low internal volume and excellent performance. It can provide smoother pressure profile than the PerformancePLUS Cartridge at low flow rates, typically less than 0.2 mL/min.
3. The PerformancePLUS C/C inlet check valve cartridge option contains a ceramic 1/8 in. ball and ceramic seat, which can be helpful when check valves with the ruby ball and sapphire seat exhibit problems with sticking.
4. The 2X95 C/C inlet check valve cartridge option contains a ceramic 1/16 in. ball and ceramic seat, which can be helpful when check valves with the ruby ball and sapphire seat still exhibit problems with sticking. It can provide smoother pressure profile than the PerformancePLUS C/C inlet check valve cartridge at low flow rates, typically less than 0.2 mL/min.

Inlet Check Valve Cartridges				
Description	Ball & Seat Material	Part Number (2 per package)	Included in Performance Maintenance Kit	Application
Performance PLUS R/S CV Cartridge (2)	Ruby/Sapphire 1/8 in.	700000254	Yes	General: supplied as standard
2X95 R/S CV Cartridge (2)	Ruby/Sapphire 1/16 in.	WAT270941	No	Lower internal volume
Performance PLUS C/C CV Cartridge* (2)	Ceramic/Ceramic 1/8 in.	700002399	No	Sticking issues, general use
2X95 C/C CV Cartridge (2)	Ceramic/Ceramic 1/16 in.	700002761	No	Lower internal volume

*Requires PerformancePLUS Check Valve Housing, part number 700002332 (2 per package)

Check valves should perform within specification for a year or more for most customers. Laboratory practices, solvent preparation, choice of plunger seal material, and mobile phase can greatly affect their performance. You may experiment with different ball and seat sizes and materials as needed to minimize check valve sticking and optimize the performance of your particular application.

Performance Maintenance

To ensure uninterrupted operation of your 2695 or 2795 Separations Module, we recommend that you or your Waters field service engineer complete Performance Maintenance (PM) once a year. Scheduled, pre-failure PM is a cost-effective way to ensure accurate, reproducible results and the highest level of reliability. All the normal-wear and maintenance parts that are necessary to perform annual scheduled maintenance are included in the PM Kit (see table).

PM Kit Contents	
Description	Part Number
2690/2695 PM Kit	WAT270944
2790/2795 PM Kit	201000107

Performance Maintenance consists of replacing the following parts:

- Seal-wash seals
- Plunger and plunger seals
- Inlet check valves and cartridges
- Inline filter
- Injection needle and seals
- Syringe

Note: If you use the system continuously (for example, during nights and weekends), or if you use aggressive solvents such as buffers, you may need to perform PM more frequently.

Conclusion

Customers who follow proper laboratory practices, pay attention to cleanliness, and perform annual Performance Maintenance will benefit from less downtime and lower maintenance costs.

Waters Separations Modules are configured to provide the best overall performance in the largest variety of applications. When the specific application demands enhanced performance, you may select from alternative configurations of plunger seal material, sapphire plunger structure, and check valve material and size.

Please contact your local Waters office for any further assistance or to schedule a visit from a Waters field service engineer.

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