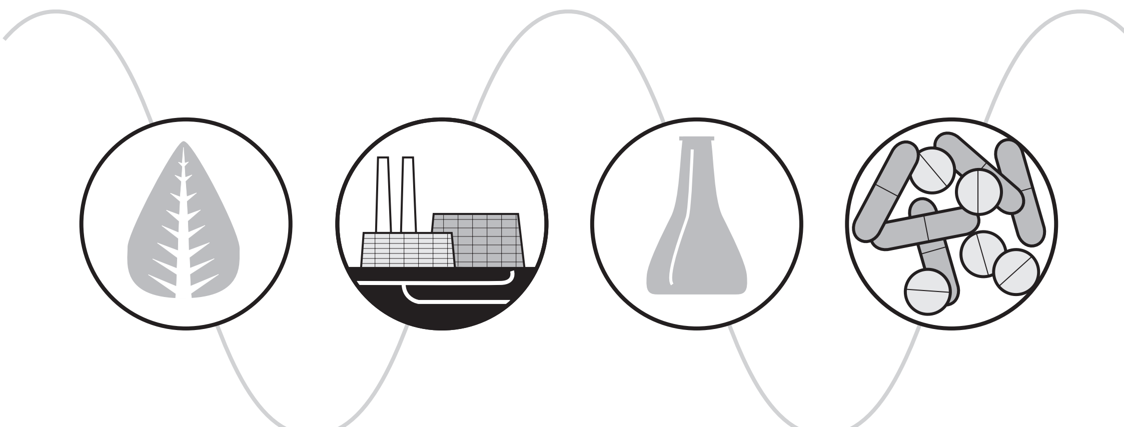
Waters 1525 Binary HPLC Pumps

Integral Vacuum Degasser/Plunger Seal Wash System Options Guide



34 Maple Street
Milford, MA 01757

71500150005, Revision A

NOTICE

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Note: *The Installation Category (Overvoltage Category) for this instrument is Level II. The Level II category pertains to equipment that receives its electrical power from a local level, such as an electrical wall outlet.*

Attention: *To meet the regulatory requirements of immunity from external electrical disturbances that may affect the performance of this instrument, do not use cables longer than 9.8 feet (3 meters) when you make connections to the screw-type barrier terminal strips. In addition, ensure you always connect the shield of the cable to chassis ground at one instrument only.*

Attention: *Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.*

Caution: *To protect against fire hazard, replace fuses with those of the same type and rating.*

Caution: *If the equipment is used in a manner not specified in this document, the protection provided by the equipment may be impaired.*

Caution: *Use caution when working with any organic polymer tubing under pressure.*

- *Always wear eye protection when near pressurized polymer tubing.*
- *Extinguish all nearby flames.*
- *Do not use Tefzel tubing that has been kinked or severely stressed.*

Caution: *Before you remove any fluidic connection on the pump, position the eluent reservoir below the height of the pump inlet manifold to prevent gravity flow of eluent through disassembled fluidic connections.*

Caution: *To avoid high temperature hazards, always allow adequate time to cool the system before you perform maintenance or troubleshooting. Wear protective clothing whenever you open the sample compartment or the analysis compartment.*

Caution: *To avoid possible electric shock, do not open the pump cover. The interior of the pump does not contain user-serviceable parts.*

Table of Contents

Preface

The *Waters 1525 Binary HPLC Pumps Integral Vacuum Degasser/Plunger Seal Wash Options Guide* is intended for users who use, install, and maintain Waters 1525 HPLC pumps with the Integral Vacuum Degasser or Plunger Seal Wash options. This guide is a supplement to the *Waters 1500 Series HPLC Pump Installation and Maintenance Guide* and the *Waters 1525μ and 1525EF HPLC Pump Installation and Maintenance Guide*, which provide comprehensive information about these HPLC pumps.

Organization

This guide contains the following:

Chapter 1 describes the optional 1525 Integral Vacuum Degasser and explains degassing theory. It contains setup and use information and also provides operational and chemical compatibility specifications.

Chapter 2 describes the optional Plunger Seal Wash system and explains how to install it on Waters 1525 analytical, 1525μ and 1525 EF (Extended Flow) Binary HPLC pumps.

Related Documentation

***Waters Licenses, Warranties, and Support*: **Provides software license and warranty information, describes training and extended support, and tells how Waters handles shipments, damages, claims, and returns.

***Waters 1500 Series HPLC Pump Installation and Maintenance Guide*:** Describes the procedures for unpacking, installing, operating, maintaining, and troubleshooting the Waters 1515 Isocratic and 1525 Binary HPLC Pumps. It also includes appendixes for specifications, spare parts, eluent considerations, validation support, and warranty information.

***Waters 1525μ and 1525EF HPLC Pump Installation and Maintenance Guide*:** Describes the procedures for unpacking, installing, operating, maintaining, and troubleshooting the Waters 1525μ and 1525EF Binary HPLC Pumps. It also includes appendixes for specifications, spare parts and accessories, and eluent considerations.

Documentation on the Web

Related product information and documentation can be found on the World Wide Web. Our address is http://www.waters.com.

Documentation Conventions

The following conventions can be used in this guide:

Notes

Notes call out information that is helpful to the operator. For example:

Note: *Record your result before you proceed to the next step.*

Attentions

Attentions provide information about preventing damage to the system or equipment. For example:

Attention: *To avoid damaging the detector flow cell, do not touch the flow cell window.*

Cautions

Cautions provide information essential to the safety of the operator. For example:

Caution: *To avoid burns, turn off the lamp at least 30 minutes before removing it for replacement or adjustment.*

Caution: *To avoid electrical shock and injury, unplug the power cord before performing maintenance procedures.*

Caution: *To avoid chemical or electrical hazards, observe safe laboratory practices when operating the system.*

Chapter 1
Integral Vacuum Degasser

This chapter introduces the Waters® 1525 Integral Vacuum Degasser. The following topics are covered:

- Description of the 1525 Integral Vacuum Degasser
- Theory of vacuum degassing
- Setup
- Troubleshooting
- Specifications

1.1 About the 1525 Integral Vacuum Degasser

The degasser is a standard feature of the 1525μ Binary HPLC Pump and an optional feature of the 1525 analytical and 1525 EF Binary HPLC Pumps. It provides HPLC systems with an automatic, continuous method of removing dissolved gases from mobile phases.

Removing dissolved gases from the mobile phase improves the performance and reliability of the pump and the detector. Dissolved gases in an eluent can result in

- Outgassing in a piston chamber, causing pressure fluctuations, flow rate inconsistency, and noise in the detector baseline.
- A vapor-locked check valve, which stops the eluent flow from a pump head.
- Outgassing downstream of the column, which can create bubbles that pass into the detector cell, causing baseline disruptions such as spikes.

Optimal operation of the pump and detector provides the following benefits:

- Stable baselines with reduced drift and pressure fluctuations
- Reduced detector baseline noise for improved signal-to-noise ratio and more reliable quantitation

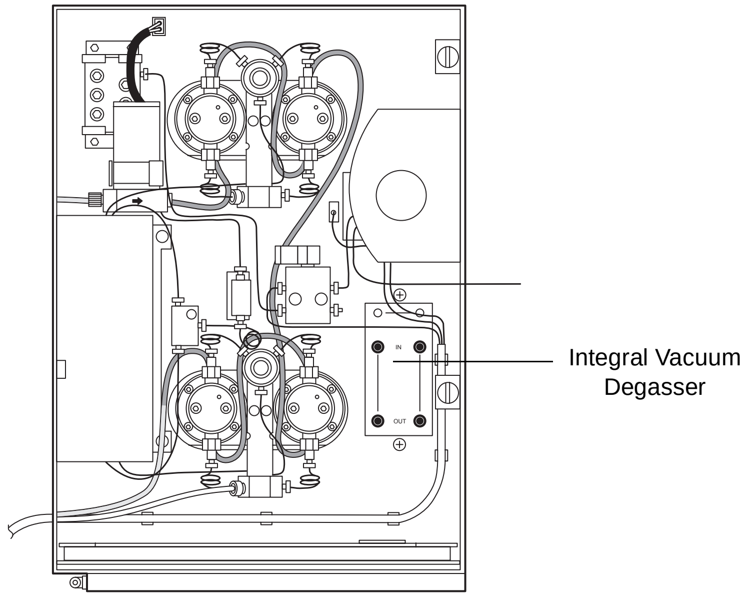

Figure 1-1 Waters 1525 HPLC Pump with Integral Vacuum Degasser

1.1.1 Degasser Systems

Figure 1-2 shows the degasser’s three major systems:

- Eluent system
- Vacuum system
- Control system

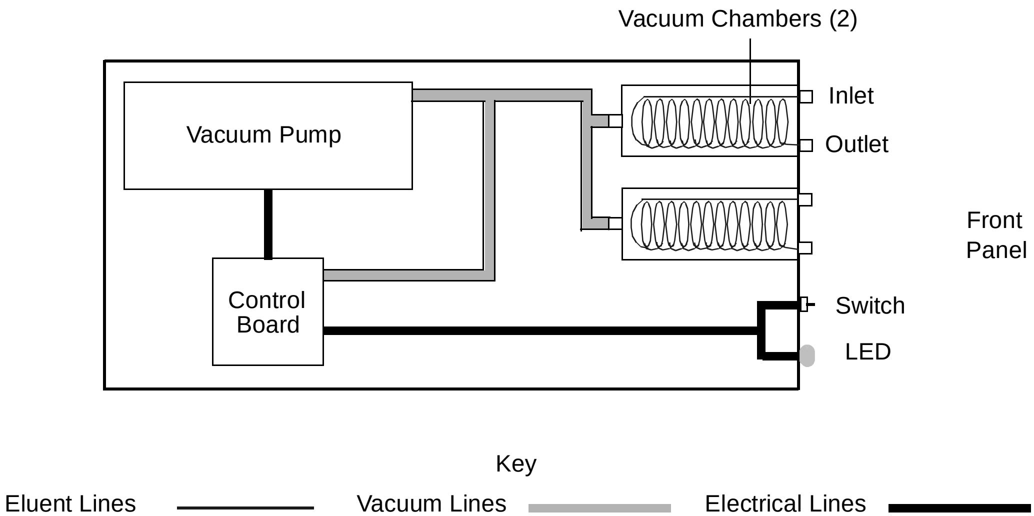

Figure 1-2 Major Systems in the 1525 Integral Vacuum Degasser

Eluent System

The degasser removes dissolved gases from the eluent as it passes through a tubular membrane. The membrane, enclosed in a vacuum chamber, is in the eluent flow path between the reservoir and the pump inlet.

The eluent enters and exits through inlet and outlet fittings on the vacuum chamber. These are labeled on, and accessible from, the front panel of the 1525 pump.

Each tubular membrane is made of a proprietary, specially engineered, fluorocarbon polymer. The membrane is designed for

- **Minimum internal volume** – For rapid solvent changeover.
- **Minimum resistance to flow or pressure drop** – For ease in priming and accommodating of high flow rates.
- **Maximum external surface area exposed to the vacuum** – For greatest gas removal efficiency.
- **Maximum gas permeability** – For greatest gas removal efficiency.
- **Optimum chemical resistance** – For compatibility with a wide spectrum of liquids, including all mobile phases commonly encountered in HPLC. See Table 1-4 for more information about solvent compatibility.

The vacuum in the chamber accelerates the rate at which the dissolved gas diffuses through the polymer membrane and into the vacuum chamber. The gases are exhausted through a vent line. Section 1.1.2 describes the principles of vacuum degassing.

As with all degassing methods, some solvent vapor is also removed and vented with the gas. Section 1.2 describes the precautions necessary to minimize exposure to solvent vapors.

Vacuum System

The vacuum system provides vacuum at a preset level to the connected vacuum chambers. The vacuum system consists of the following elements:

- **Vacuum pump** – An electrical, two-speed, stepper motor pump that creates a vacuum in the vacuum chambers.
- **Vacuum sensor** – A sensor on the control board that monitors the vacuum in the system. The sensor signals the control board when the level of vacuum fails to reach a preset level.
- **Vacuum chambers** – Contain the gas-permeable eluent channel. Gases are removed from the eluent in these chambers. Each chamber is connected to the vacuum pump.

Control System

The control system consists of the following components:

- **Control board** – Contains the circuits that perform these tasks:
  - Monitor the vacuum
  - Start the vacuum pump and control its speed
  - Control the two-color front panel LED
- **LED** – Indicates the status of the degasser. Table 1-1 describes the operating statuses.

1.1.2 Theory of Operation

This section presents information on the following subjects:

- Operating principles
- Effects of dissolved oxygen in the mobile phase
- Methods of removing gases from eluents

Operating Principles

The degasser operates according to Henry's Law, removing dissolved gases from the eluent. Henry's Law states that the mole fraction of a gas dissolved in a liquid is proportional to the partial pressure of that gas in the vapor phase above the liquid. If the partial pressure of a gas on the surface of the liquid is reduced–by evacuation, for example–then a proportional amount of that gas comes out of solution.

The degasser uses a gas-permeable polymer membrane channel to carry the eluent through the vacuum chamber. When the eluent enters the vacuum chamber, the vacuum maintains a large differential in gas concentration across the membrane. This accelerates the rate at which the dissolved gases diffuse through the polymer membrane into the vacuum chamber. The gases are then carried away by the vacuum pump. Figure 1-3 is a simplified schematic diagram of the vacuum chamber.

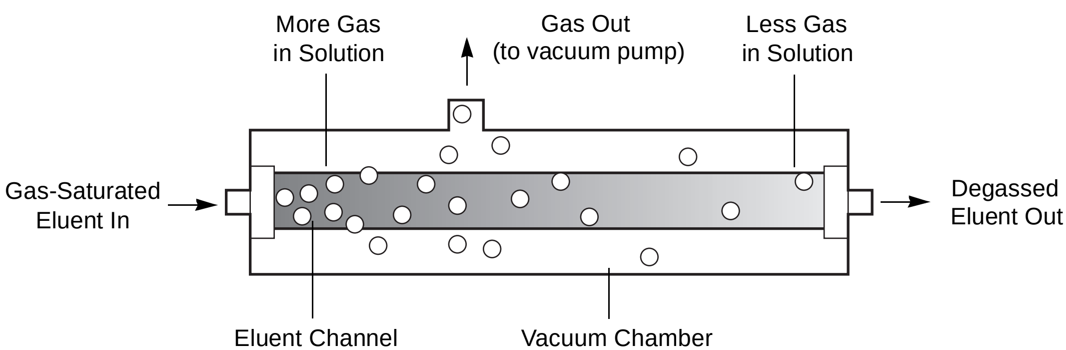

Figure 1-3 Vacuum Chamber Schematic

The longer the eluent is exposed to the vacuum, the more dissolved gases are removed. Two factors affect the amount of time the eluent is exposed to the vacuum:

- **Flow rate.** A lower flow rate increases the amount of time the eluent is exposed to the vacuum. "Degassing Efficiency" on page 13, addresses the effect of different flow rates on the concentration of remaining gas.
- **Surface area of degassing membrane.** The length of the degassing membrane is fixed in each vacuum chamber.

Effects of Dissolved Oxygen

Dissolved oxygen in the mobile phase may be of special concern. It can under certain circumstances interfere with the detection of analytes by UV/Vis, fluorescence, or electrochemical detectors.[1]

Effects on UV/Vis Detectors

Oxygen can form UV-absorbing complexes with solvents such as methanol or tetrahydrofuran (THF). These complexes increase the background absorbance, especially at lower wavelengths. This leads to a small decrease in sensitivity of detection. More importantly, however, they cause baseline shifts, or *ghost* peaks, during gradient separations. Also, a change in the dissolved oxygen level over time, especially when it results from reabsorption of ambient gases after using an offline degassing technique, causes baseline drift and irregularity.

Removing dissolved oxygen to a reproducible level greatly enhances the performance of UV/Vis detectors, especially below 254 nm and in gradient systems. This also improves sensitivity in certain fluorescence detection applications.

Effects on Fluorescence Detectors

For certain analytes at certain wavelengths, oxygen, under certain mobile phase conditions, can quench fluorescence response. Aromatic hydrocarbons, aliphatic aldehydes, and ketones are particularly susceptible to quenching, and decreases in sensitivity of 95% are possible.

Effects on Electrochemical Detectors

Oxygen can interfere with various electrochemical detection techniques, particularly reductive electrochemistry.

Effects on Refractive Index Detectors

Refractive index detectors are sensitive to changes in solvent density. Removing dissolved gases to a consistent level enhances the performance of refractive index detectors, reducing baseline drift and irregularity.

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1. Rollie, Mae E., Gabor Patonay, Isaiah M. Warner, Ind. Eng. Chem. Res., 1987, 26, 1–6.

Degassing Methods

The three degassing methods are:

- Offline
- Online
- Inline

Note: *Implement degassing methods carefully when using eluents containing volatile components. Chromatographic performance may be altered by minor changes in eluent composition.*

Offline Degassing

Offline degassing involves procedures that you perform physically removed from the HPLC system. Some common offline degassing methods[2] are

- Sonication, with vacuum assistance
- Vacuum filtration
- Boiling

Note: *Offline methods do not maintain the degassed condition. Reabsorbtion of ambient gases by the eluent begins immediately after you stop the degassing procedure. Within one to four hours, the eluent is once again gas-saturated.*

Online Degassing

Online methods of degassing involve procedures that you perform at the eluent reservoirs during a chromatographic run. The most commonly used method of online degassing is sparging.[2, 3]

Sparging consists of bubbling an inert, relatively insoluble gas through the eluent reservoir before and during a chromatographic run. Sparging, although considered a degassing method, does not degas the eluent. Sparging *replaces* the air in solution with a lower concentration of inert gas, typically helium.

Inline Degassing

Inline methods of degassing operate within the chromatographic fluid path. The 1525 Integral Vacuum Degasser uses this method. Because degassing occurs close to the pump, this method minimizes reabsorption of ambient gas into the eluent.

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2. Williams, D.D., and R.R. Miller, Anal. Chem., May, 1962, 34, 6.
3. Bakalyar, S.R., M.B.T. Bradley, R. Hoganen, J. Chromatogr., 1978, 158, 277.

The flow rate of eluent through an inline degasser determines the efficiency of the degassing. At low flow rates, most of the dissolved gas is removed as the eluent passes through the vacuum chambers. At higher flow rates, lesser amounts of gas per unit volume of eluent are removed. "Degassing Efficiency" on page 13, explains the efficiency of the degasser regarding flow rate.

1.2 Making Plumbing Connections

Required Materials

To make plumbing connections to the degasser, you need the following materials:

- A tubing cutter that suits the tubing type: razor knife or blade, or a file with a cutting edge
- Tubing: 1/8-inch OD thick-walled Tefzel® (included in the Startup Kit) or 1/16-inch OD stainless steel
- Four ferrules and compression screws (Startup Kit) for each channel
- Tubing, 0.149-inch OD TFE[4] (Startup Kit)

1.2.1 Connecting Tubing to the Degasser Inlet or Outlet

The connectors on the front panel of the degasser are 1/4-28 flat-bottom fittings. The Startup Kit contains the compression screws and ferrules needed to connect tubing to these fittings.

To assemble each connection

1. Use the appropriate tool to cut the tubing to the required length. Make sure the end is straight and free from burrs or debris.
2. Slide the compression screw and then the ferrule over the tubing end, as shown in Figure 1-4. Be sure the tapered end of the ferrule faces away from the end of the tubing.

4. Polytetrafluoroethylene

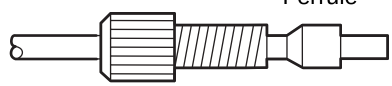

Figure 1-4 Ferrule and Compression Screw Assembly

3. Firmly seat the tubing end in the appropriate fitting.
4. Complete the connection by tightening the compression screw until it is finger-tight.

STOP ***Attention:*** *To avoid damaging the ferrule, do not overtighten the compression screw.*

1.2.2 Installing the Vent Line

Besides removing dissolved gases from the eluents, the degasser may vaporize some eluent components. The vapors may then condense, forming droplets in the exhaust system. The degasser exhausts these gases and droplets through a vent line that exits the instrument at the rear panel, as shown in Figure 1-5. Place the unattached end of the vent tubing in a waste container. The container catches any incidental leaks or condensates from the degasser.

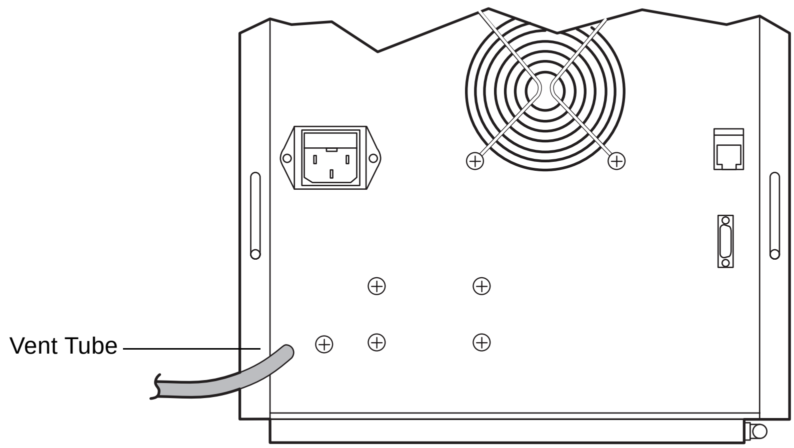

Figure 1-5 Integral Vacuum Degasser Vent Tubing

***Caution:** To avoid exposure to eluent vapors, connect the outlet vent on the rear panel of the 1525 pump to a suitable fume hood. Check local building and health codes for specific requirements regarding the venting of eluent vapors.*

1.3 Using the Degasser

Electrical power is supplied to the degasser whenever the 1525 pump's on/off switch is set to On. With the switch set to On, the degasser operates automatically while you perform HPLC runs. There are no controls to adjust as it removes gases from the eluents.

During normal operation, the degasser stops operating if the pump does not deliver flow for 30 minutes. During the startup sequence, the degasser stops operating if the pump does not deliver flow for 3 minutes.

Before you start the pump, make sure you correctly completed these tasks:

- Eluent tubing is connected to the eluent reservoirs
- The vent line is connected to a suitable waste container

The degasser's degassing membrane can withstand a maximum pressure of 10 psi (70 kPa).

STOP ***Attention:** To avoid damaging the degasser, do not apply more than 10 psi (70 kPa) to the eluent reservoirs.*

1.3.1 Controlling the Degasser

The degasser is enabled by default. It operates briefly, following power-up, and continuously during pump flow.

Enabled Mode (Default Setting)

These events take place when the degasser is enabled:

1. The LED on the 1525 pump front panel illuminates.
2. The vacuum pump begins its evacuation.

Normal operation begins when the vacuum pump reaches its vacuum target and changes from high to low RPM.

Disabled Mode

If the degasser fails, you can continue pump operation without the degasser by setting the degasser toggle switch to Off.

STOP ***Attention:*** *The degasser is intended for use at all times during pump flow. Set the toggle switch to Off only if the degasser fails.*

These events take place when you disable the degasser by setting the degasser toggle switch to Off.

1. Vacuum pump operation stops.
2. The LED on the 1525 pump front panel flashes yellow (0.5 seconds on and 2 seconds off).

The degasser remains in the disabled mode until you set the switch to On. PC-based software for 1525 control cannot override the disabled mode.

Operating Statuses

The LED on the 1525 pump front panel indicates the status of the degasser as described in Table 1-1.

Table 1-1 LED Indications

LED State	Description
Unlit	Pump main power off.
Steady yellow	Degasser operating with pump at high RPM, vacuum level above 60 mmHgA/1.16 psiA. Usually a brief, transitional state during initial evacuation.
Steady green	Degasser operating with pump at low RPM, vacuum level below 60 mmHgA/1.16 psiA. Typical operating conditions.
Green flash, 0.5 seconds on and 0.5 seconds off	Degasser operating but vacuum level unstable. Indicates a sudden change in degasser work load.
Yellow flash, 0.5 seconds on and 2 seconds off	Degasser not operating. Toggle switch set to Off. Operation will resume when switch is set to On.
Yellow flash, 2 seconds on and 0.5 seconds off	Degasser not operating. Vacuum signal out of usable range, indicating an electronic or pressure sensor failure.
Yellow flash, 0.5 seconds on and 0.5 seconds off	Degasser not operating. Target vacuum level not reached within 10 minutes. Indicates a vacuum leak.
Alternating yellow and green flash	Degasser not operating. Target vacuum level reached but then rose above upper limit. Indicates a vacuum failure.

Degassing Efficiency

The flow rate of eluent through the degasser determines the efficiency with which the degasser removes gases. As the flow rate increases, the time available to remove dissolved gases from the eluent lessens. Table 1-2 shows the relationship between the flow rate of an eluent (water) and the concentration of a gas (oxygen) dissolved in the eluent.

Table 1-2 Effect of Flow Rate on Final Dissolved Gas Concentration

Flow Rate (mL/min)	Final Oxygen Concentration (ppm)
1	≤1
2	≤1.3
5	≤2.3

To minimize degasser equilibration time, fill the degas tubing in any unused vacuum chambers with a fluid such as water or eluent. Install caps on the inlet and outlet of each fluid-filled chamber to prevent leaks.

1.4 Troubleshooting

Under normal operating conditions, the degasser requires no routine maintenance.

Customers in the USA and Canada should report maintenance problems they cannot resolve to Waters Technical Service (800 252-4752). Others should phone their local Waters subsidiary or Waters corporate headquarters in Milford, Massachusetts (USA), or they may visit http://www.waters.com, and click Offices.

1.5 Specifications

Table 1-3 Operational Specifications

Item	Specification
Chemical resistance	Unaffected by full range of organic solvents and aqueous solutions of acids, bases, salts, and surfactants
pH range	0 to 14
Gas removal efficiency	Varies with flow rate (see Table 1-2)
Typical operating flow range	200 µL/min to 10 mL/min (1525 model) 200 µL/min to 5 mL/min (1525µ model) 200 µL/min to 22.5 mL/min (1525EF models)
Equilibration time	<1 hour
Pressure drop (across one channel)	<0.08 psi (0.55 kPa) at 1 mL/min., Milli-Q® water, STP
Wetted surfaces	PPS[a], Teflon AF[b], Tefzel[c]
Inputs	DC power, QSPI serial data
Output	QSPI serial data
Eluent connections	1/4-28 reversed ferrule fittings; 2 inlet and 2 outlet fittings
Vacuum chambers	One chamber/eluent, two channels standard <0.5 mL internal volume/channel
Tubular membrane	1/vacuum chamber, Teflon AF
Vapor exhaust	1/8-inch inside diameter ID × 6 feet tubing
Vacuum source	Built-in, 2-head diaphragm pump, solvent resistant
Vacuum sensor	Detects vacuum from 0 to 15.6 psiA
Maximum pressure on inlet and outlets	10 psi (70 kPa)

a. High-density polyethylene
b. polytetrafluoroethylene
c. ethylenetetrafluoroethylene

Table 1-4 lists Teflon® AF chemical compatibility test results from Waters.

Table 1-4 Teflon AF Chemical Compatibility Test Results

Compatible[a]	**Incompatible**[b]
Acetonitrile	Fluorinert®
Chloroform	Fomblin®
Dimethyl acetamide	Freon®
Dimethyl formamide	Galden®
Dimethylsulfoxide	HFIP
Ethanol	Perfluorinated solvents
Ethylacetate	
Hexane	
Isopropanol	
Methanol	
Methylene chloride	
N-methylpyrrolidone	
Tetrahydrofuran	
Toluene	
Trichlorobenzene	
Water	

a. Compatible solvents are not so soluble that they change the appearance or weight of Teflon AF after prolonged exposure at 23 °C.
b. Incompatible solvents immediately and irreversibly damage Teflon AF.

Note: *Additional materials in the flowpath are PPS and PTFE.*

Chapter 2
Plunger Seal Wash System

The plunger seal wash system is an optional accessory for the 1525 Binary HPLC pumps. The seal wash solvent lubricates the plunger and flushes away any solvent or dried salts forced past the plunger seal from the high-pressure side of each piston chamber. This wash cycle extends the life of the seals.

STOP ***Attention:*** *Once the seal wash option has been installed, it must be used at all times when operating the instrument. Failure to do so may damage plungers and seals.*

The plunger seal wash system operates as follows:

Plunger seal wash solvent flows from a reservoir to the solenoid wash pump, which pumps the solvent through the fluid path.

- In the 1525 analytical and 1525EF models, the solvent flows through the pump head supports.
- In the 1525µ model, the solvent flows through the pump heads.

When the solvent has passed through all four pump heads or pump head supports, it flows to waste. The plunger seal wash solvent is not recycled.

Powering up the instrument triggers the seal wash pump’s priming sequence, which lasts for one minute. The seal wash pump then shifts to its normal operating mode, intermittently pumping seal wash solvent according to the duty cycles in Table 2-1. Once you stop using the instrument, seal washing continues for 30 minutes after the mobile phase stops flowing.

Note: *The seal wash pump returns to the priming sequence each time the instrument is powered up. However, the seal wash pump requires priming only for first-time use or when the line is dry.*

Table 2-1 Seal Wash Pump Duty Cycles

Mode	Operation
Priming	Solenoid energized for 0.5 seconds, solenoid off for 0.5 seconds, repeating.
Normal	Solenoid energized for 0.25 seconds, solenoid off for 59.75 seconds, repeating.

Table 2-2 shows the amount of seal wash solvent consumed during normal operation.

Table 2-2 Seal Wash Solvent Consumption

Model	Seal Wash Solvent Consumption
1525 analytical	12 mL/hr
1525µ	11 mL/hr
1525EF	13.5 mL/hr

Verifying Instrument Upgradeability

Before ordering the optional seal wash system, verify that your 1525 HPLC pump is compatible with the seal wash system by opening the instrument front cover and looking for the solenoid cable connector in the upper left corner of the instrument (Figure 2-9). If the solenoid cable connector is present, you can add the seal wash system to the instrument.

2.1 Installation

Gather the required materials and tools and familiarize yourself with the installation process before you begin.

Required Materials

- Plunger seal wash system kit. Use the appropriate kit for your 1525 model:
  - 1525 analytical – part number 205000251
  - 1525µ – part number 205000250
  - 1525EF – part number 205000252
- 5/16-inch open-end wrench (two required for 1525 analytical and 1525EF models)

- 1/2-inch open-end wrench (1525µ model only)
- 5/32-inch T-handle hex wrench
- 9/64-inch T-handle hex wrench
- T15 Torx wrench
- HPLC-grade methanol
- Tweezers or tape
- Razor knife or tubing cutter

2.1.1 Preparing the Instrument

Perform these steps for all 1525 analytical, 1525EF, and 1525µ models.

1. Purge the pump with methanol. If methanol is not miscible with your mobile phase, use an intermediate mobile phase.
2. Insert the priming syringe into the Luer fitting at the center of the draw-off valve handle, and then turn the handle counterclockwise, about 1/2-turn, to open the valve.
3. Remove the solvent inlet lines from the reservoirs.
4. Use the syringe to withdraw all the methanol from the instrument.

2.1.2 Removing Pump Head components

Perform these steps for all 1525 analytical, 1525EF, and 1525µ models.

STOP ***Attention:*** *When installing the seal wash system, work on one pump head support at a time. Complete the procedure for one pump head before removing another.*

1. In your Waters software, set Flow to 0.3 mL/min.
2. Operate the pump until the indicator rod fully retracts into the pump head to be removed, and then stop the pump. This ensures that the relatively heavy pump head will not rest on the plunger as you remove the head.
3. Loosen and remove the inlet and outlet tubing assemblies from the pump head:
   - If you have the 1525 analytical or 1525EF model, use a 5/16-inch open end wrench to hold the knurled portion of the check valve housings in place while loosening the inlet and outlet tubing assemblies with another 5/16-inch open-end wrench (Figure 2-1).

- If you have the 1525µ model, use the 1/2-inch open end wrench to hold the check valve housings in place while loosening the inlet and outlet tubing assemblies with the 5/16-inch open-end wrench.

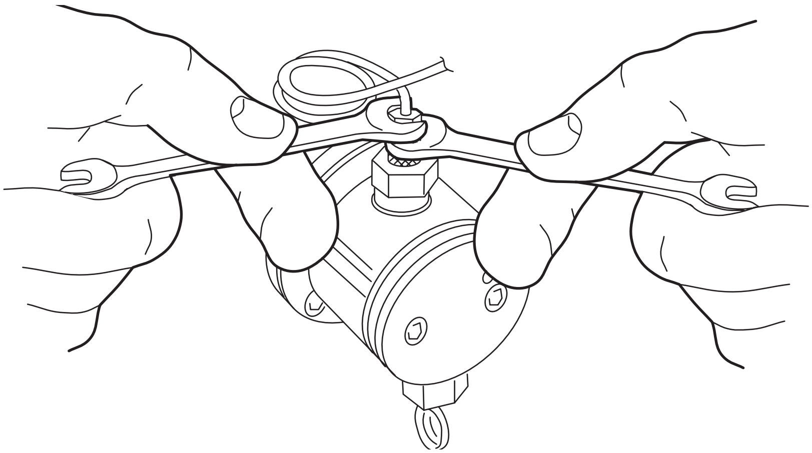

Figure 2-1 Loosening Fittings (1525 Analytical and 1525EF Models)

4. While holding the pump head in place, use the 5/32-inch T-handle hex wrench to remove the two pump head mounting screws. Alternately loosen the screws 1/2-turn at a time for the first two turns (Figure 2-2).

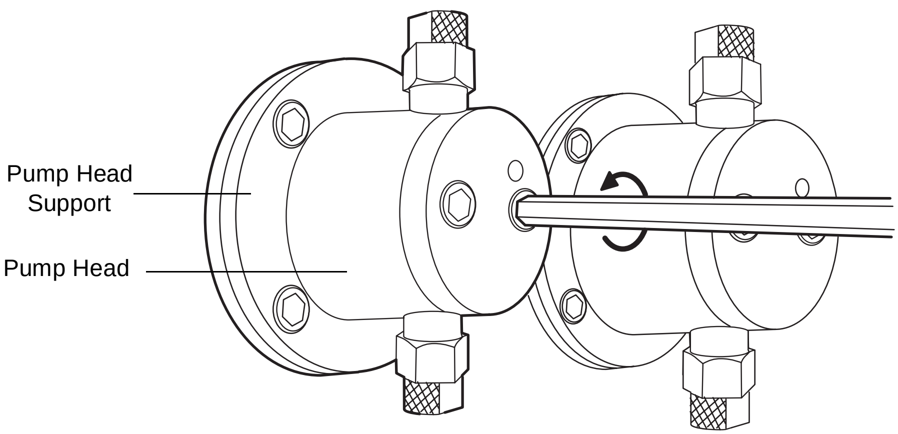

Figure 2-2 Removing Head Bolts (1525 Analytical and 1525EF Shown, 1525µ Similar)

STOP ***Attention:*** *To avoid breaking the plunger, pull the pump head off straight toward you.*

5. Carefully remove the head from its support.
6. If you are installing the seal wash kit in a 1525µ model, stop here and follow the instructions in Section 2.1.5. If you are installing the seal wash kit in a 1525 analytical or 1525EF model, continue with step 8 below.
7. While holding the head support in place, use the 9/64-inch T-handle hex wrench to remove the four head support mounting screws.

   STOP ***Attention:*** *To avoid breaking the plunger, pull the head support off straight toward you.*

8. Carefully slide the pump head support straight off.
9. Complete Section 2.1.3, Installing Head Support Components (1525 Analytical Model) or Section 2.1.4, Installing Head Support Components (1525EF Model) as appropriate for your instrument.

2.1.3 Installing Head Support Components (1525 Analytical Model)

Perform these steps only if you have the 1525 analytical model.

Note: *Waters recommends replacing the high pressure seal while the head is removed. See the* Waters 1500 Series HPLC Pump Installation and Maintenance Guide *for more information.*

1. Lay the head support on a hard surface, back side up.

   Note: *You can identify the back side of the pump head support by its larger wash seal cavity. Figure 2-3 shows the back side of the pump head support.*

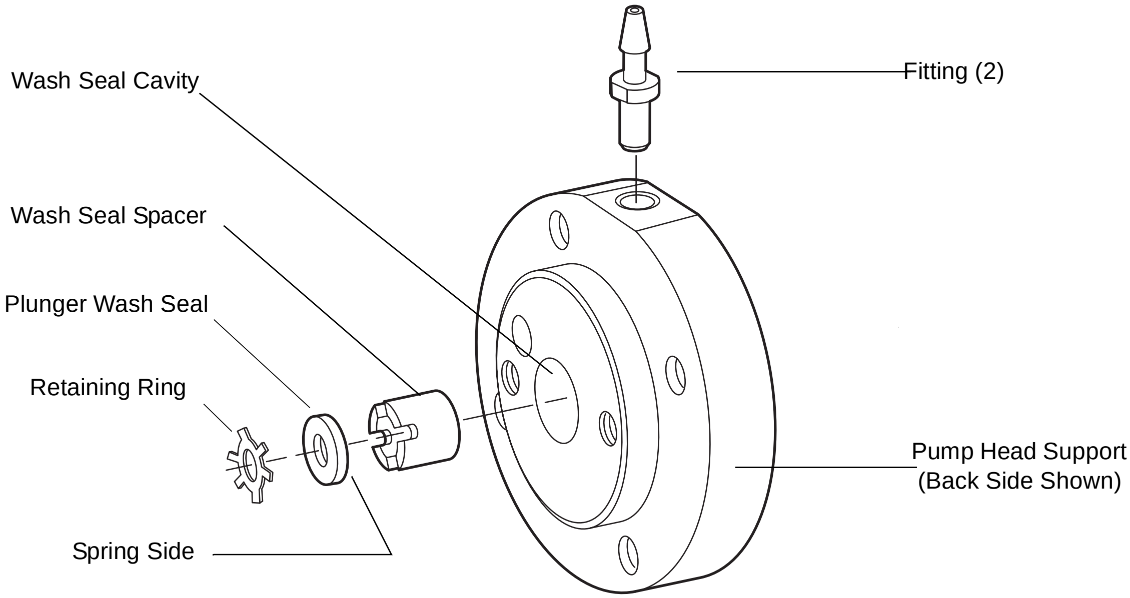

Figure 2-3 1525 Analytical Head Support Components

2. Insert the wash seal spacer into the wash seal cavity in the center of the head support. Because the spacer fits tightly, you may need to start its edge into the cavity at a slight angle and then rotate it into the cavity while pressing down.
3. Using the wash seal installation tool (Figure 2-4), press the wash seal spacer until it bottoms in the wash seal cavity.

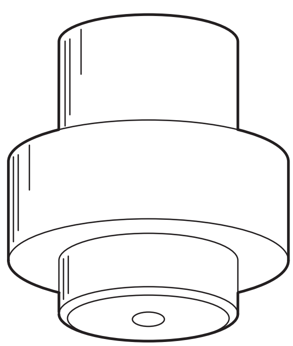

Figure 2-4 Wash Seal Installation Tool

4. Rotate the wash seal spacer with a screwdriver until the slots line up with the holes in the edge of the head support. This creates a fluid path for the seal wash solvent.
5. Check the fluid path for obstructions by holding the head support up to a light source and looking through the holes in the edge of the head support. The fluid path should be unobstructed. If it is not, blow through the hole, or use a thin wire to clear any obstructions.
6. Lay the head support on a hard surface, back side up.
7. Insert the plunger wash seal (spring side down) into the wash seal cavity in the center of the head support.
8. Use the wash seal installation tool to bottom the plunger wash seal against the wash seal spacer.
9. Slide the retaining ring onto the thin end of the wash fitting installation tool (Figure 2-5). The raised edges of the retaining ring should point downward onto the wash fitting installation tool.

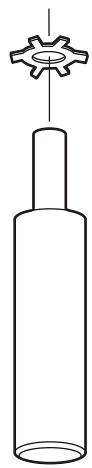

Figure 2-5 Wash Fitting Installation Tool

10. Hold the wash fitting installation tool upright and carefully lower the head support onto the tool so that the retaining ring fits into the center of the wash seal cavity and the thin end of the tool slides through the hole in the plunger wash seal.
11. Hold the wash fitting installation tool and the head support together and lay the head support on a hard surface, back side up.
12. Press down on the wash fitting installation tool to start the retaining ring into the wash seal cavity.

13. Carefully remove the wash fitting installation tool, and then use the wash seal installation tool (Figure 2-4) to bottom the retaining ring against the wash seal.

STOP ***Attention:*** *The retaining ring must be bottomed against the wash seal. If the retaining ring is not properly seated it can damage the plunger.*

14. Insert a tube fitting, barbed end out, into each hole on the edge of the head support. Slide the tubular end of the wash fitting installation tool over the fitting and press down until the fitting flange is firmly seated against the flat area on the head support edge (Figure 2-3).
15. From the back side of the head support, slide the plunger indicator rod through the hole in the head support.
16. Lubricate the plunger rod and seals with methanol.
17. Align the head support on the pump housing face. The back side of the head support should be against the pump housing face. When viewed from the front of the pump, the indicator rod should be oriented to the upper right of the head support.

STOP ***Attention:*** *Support the head support securely at all times while installing and tightening the screws.*

18. Insert the four 9/64-inch hex screws, and alternately tighten them with a T-handle wrench.
19. Ensure the indicator rod slides freely.
20. Lubricate the pump head seal with methanol.

STOP ***Attention:*** *Support the pump head securely at all times when installing and tightening the screws.*

21. Align the pump head carefully over the plunger and indicator rod, and then slide the head onto the head support.
22. Insert the two 5/32-inch hex screws, and alternately tighten them with a T-handle wrench.
23. Ensure the gap between the pump head and the head support is uniformly spaced all around.

24. Pull out and release the indicator rod.
    - If the rod does not snap back easily, the head is misaligned. Loosen the pump head, and then repeat steps 19 and 20.
    - If the rod snaps back easily, continue with step 23.
25. Reconnect the inlet and outlet tubing assemblies to the pump head. Use the 1/2-inch open-end wrench to hold the check valve housings in place while tightening the tubings with the 5/16-inch open-end wrench.
26. Repeat the process for the remaining pump head supports, then complete the steps in Section 2.1.6, Installing the Solenoid.

2.1.4 Installing Head Support Components (1525EF Model)

Perform these steps only if you have the 1525EF model.

Note: *Waters recommends replacing the high pressure seal while the head is disassembled. See the* Waters 1525µ and 1525EF HPLC Pump Installation and Maintenance Guide *for more information.*

1. Lay the head support on a hard surface, back side up.

   Note: *The back side of the pump head support is identified by the larger wash seal cavity. Figure 2-6 shows the back side of the pump head support.*

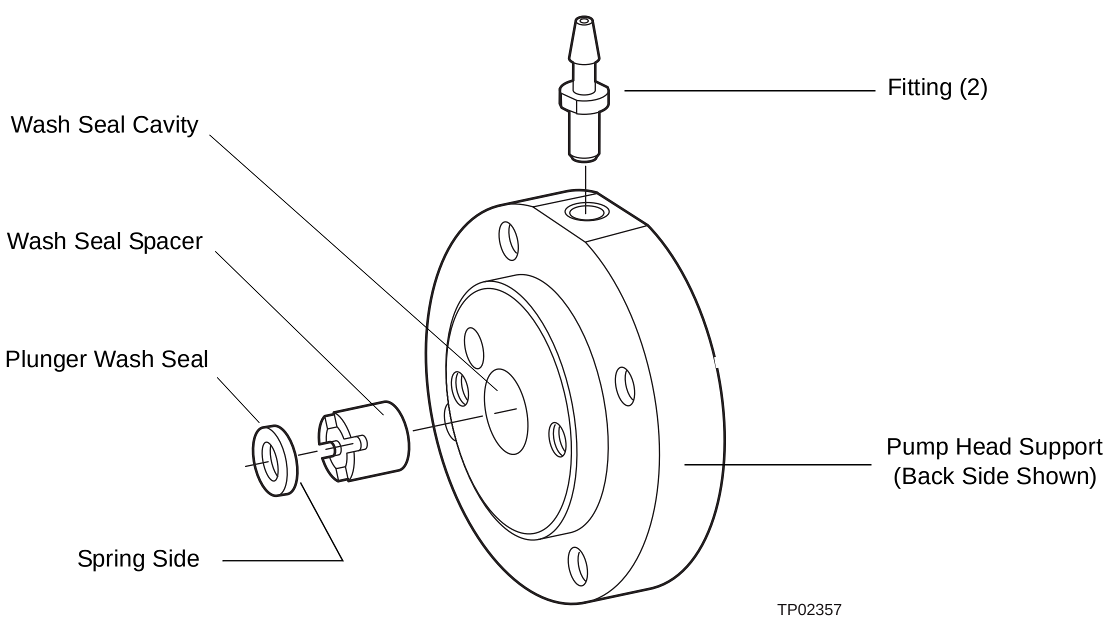

Figure 2-6 1525EF Head Support Components

2. Insert the wash seal spacer into the wash seal cavity at the center of the head support.
3. Using the wash seal installation tool, press the wash seal spacer until it bottoms in the wash seal cavity.
4. Rotate the wash seal spacer with a screwdriver until its slots line up with the holes in the edge of the head support. This creates a fluid path for the seal wash solvent.
5. Check the fluid path for obstructions by holding the head support up to a light source and looking through the holes in the edge of the head support. The fluid path should be unobstructed. If it is not, blow through the hole, or use a thin wire to clear any obstructions.
6. Lay the head support on a hard surface, back side up.
7. Insert the plunger wash seal (spring side down) into the wash seal cavity.
8. Use the wash seal installation tool (Figure 2-4) to bottom the plunger wash seal against the wash seal spacer.
9. Insert a tube fitting, barbed end out, into each hole on the edge of the head support. Slide the tubular end of the wash fitting installation tool over the fitting and press down until the fitting flange is firmly seated against the flat area on the head support edge (Figure 2-6).
10. Slide the stainless steel washer, spring, and plastic washer included in the kit carefully onto the pump plunger.

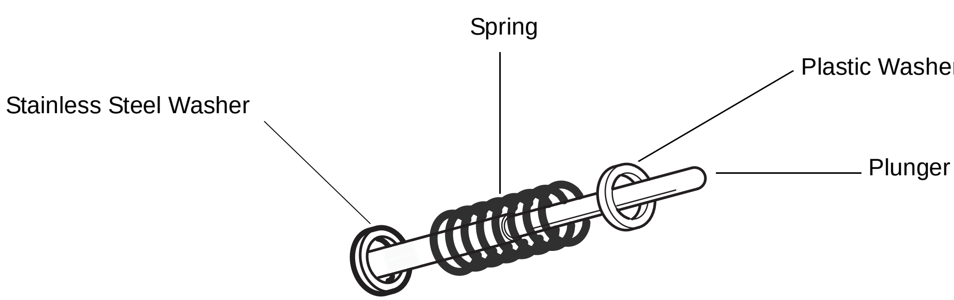

Figure 2-7 Installing the 1525EF Washers and Spring

11. Slide the plunger indicator rod from the back side of the head support through the hole in the head support.
12. Lubricate the plunger and seals with methanol.

13. Align the head support on the pump housing face. The back side of the head support should be against the pump housing face. When viewed from the front of the pump, the indicator rod should be oriented to the upper right of the head support.

STOP ***Attention:*** *Support the head support securely at all times when installing and tightening the screws.*

14. Insert the four 9/64-inch hex screws and alternately tighten them with a T-handle wrench.
15. Ensure the indicator rod slides freely.
16. Lubricate the pump head seal with methanol.

STOP ***Attention:*** *Support the pump head securely at all times while installing and tightening the screws.*

17. Align the pump head carefully over the plunger and indicator rod, and then slide the head onto the head support.
18. Insert the two 5/32-inch hex screws, and alternately tighten them with a T-handle wrench.
19. Ensure the gap between the pump head and the head support is uniformly spaced all around.
20. Pull out and release the indicator rod.
    - If the rod does not snap back easily, the head is misaligned. Loosen the pump head, and then repeat steps 17 and 18.
    - If the rod snaps back easily, continue with step 21.
21. Reconnect the inlet and outlet tubing assemblies to the pump head. Use the 1/2-inch open-end wrench to hold the check valve housings in place while tightening the tubings with the 5/16-inch open-end wrench.
22. Repeat the process for the remaining pump head supports, and then complete the steps in Section 2.1.6.

2.1.5 Installing Head Components (1525µ Model)

Perform these steps only if you have the 1525µ model.

Note: *Waters recommends replacing the high pressure seal while the head is disassembled. See the* Waters 1525µ and 1525EF HPLC Pump Installation and Maintenance Guide *for more information.*

1. Use a piece of tape or tweezers to remove the metal seal retainer (Figure 2-8) from the head support.

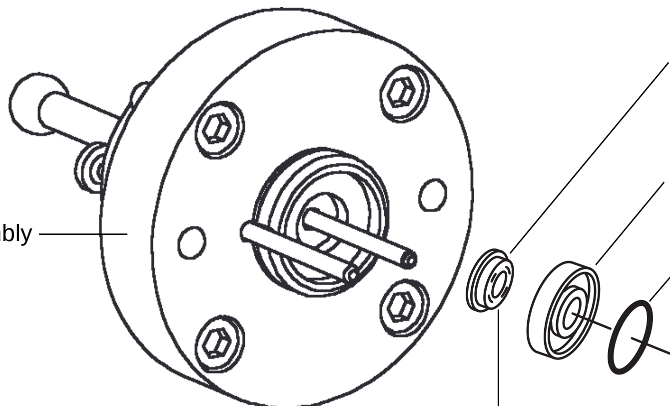

Figure 2-8 1525µ Head Support Components

2. Press the seal retainer O-ring into the front of the seal retainer.

   Note: *After starting the O-ring into the groove, turn over the retainer and O-ring, and press them onto a flat surface to seat the O-ring into the O-ring groove.*

3. Press the wash seal onto the opposite side of the seal retainer so that its spring faces the seal retainer (Figure 2-8).
4. Carefully slide the retainer assembly over the plunger and into the head support.
5. Ensure the indicator rod slides freely.
6. If the pump head has a plastic cap behind the top check valve housing, use the 5/16-inch open-end wrench to remove the cap.
7. Carefully start the barbed fittings into the threaded holes at the top and bottom of the pump head. Tighten the fittings so that they are finger tight.

8. Lubricate the plunger, plunger seal, and high-pressure seal with methanol.

Attention: *Support the pump head securely at all times when installing and tightening the screws.*

9. Align the pump head carefully over the plunger and indicator rod, and then slide the head onto the head support.
10. Insert the two 5/32-inch hex screws, and alternately tighten them with a T-handle wrench.
11. Ensure the gap between the pump head and the head support is uniformly spaced all around.
12. Reconnect the inlet and outlet tubing assemblies to the pump head. Use the 1/2-inch open-end wrench to hold the check valve housings in place while tightening the tubings with the 5/16-inch open-end wrench.
13. Repeat the process for the remaining pump heads, and then complete the steps in Section 2.1.6.

2.1.6 Installing the Solenoid

Perform these steps for all 1525 analytical, 1525EF, and 1525µ models.

1. Install the solenoid bracket on the pump chassis with the two Torx head screws provided with the kit. The solenoid bracket mounting holes are located slightly below and to the left of the upper-left pump head.
2. Align the solenoid so that the arrow on its base faces forward and points to the right (Figure 2-9). Push the metal body of the solenoid into the bracket until it snaps into position.
3. Ensure that the solenoid bracket does not contact the label on the solenoid. If it does, adjust the solenoid position.

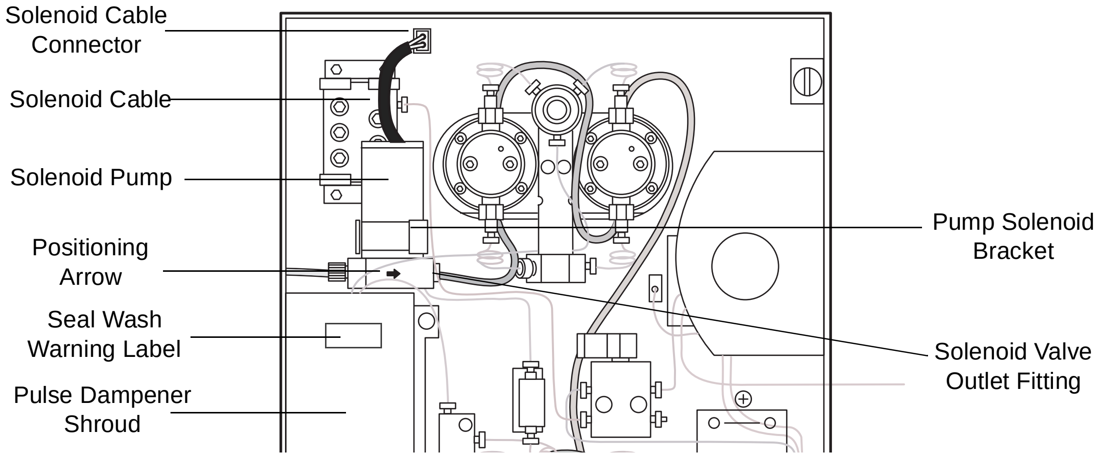

Figure 2-9 Correct Solenoid Positioning

4. Carefully start the barbed fitting into the threaded hole on the right side of the solenoid base. Tighten the fitting finger tight.
5. Plug the solenoid cable into the solenoid cable connector (Figure 2-9).

   Note: *The solenoid cable must be plugged in at all times. This ensures that the seal wash system is active whenever the instrument is operating.*

6. Affix the warning sticker to the pulse dampener shroud.
7. For all models, complete Section 2.1.7.

2.1.7 Installing Seal Wash Tubing

Perform these steps for all 1525 analytical, 1525EF, and 1525µ models.

1. Cut the PharMed® tubing provided with the kit into the following lengths:

Length	Number of Pieces
3 in. (7.6 cm)	2
7.75 in. (19.7 cm)	2
16 in. (40.6 cm)	1

2. Connect one end of a 3-inch piece of tubing to the solenoid valve outlet fitting (Figure 2-9). Connect the other end to the bottom fitting on the upper-left pump head.

3. Connect one end of a 7.75-inch piece of tubing to the top fitting on the upper-left pump head. Connect the other end of the tube to the bottom fitting on the upper-right pump head.
4. Connect one end of the 16-inch piece of tubing to the top fitting on the upper-right pump head. Connect the other end of the tube to the bottom fitting on the lower-right pump head.
5. Connect one end of the remaining 7.75-inch piece of tubing to the top fitting on the lower-right pump head. Connect the other end of the tube to the bottom fitting on the lower-left pump head.
6. Connect one end of the remaining 3-inch piece of tubing to the top fitting on the lower-left pump head. Slide the other end over the 1/8-inch OD ETFE (clear plastic) tubing from the kit. The ETFE tubing should extend at least 3/16 inches inside the PharMed tubing.

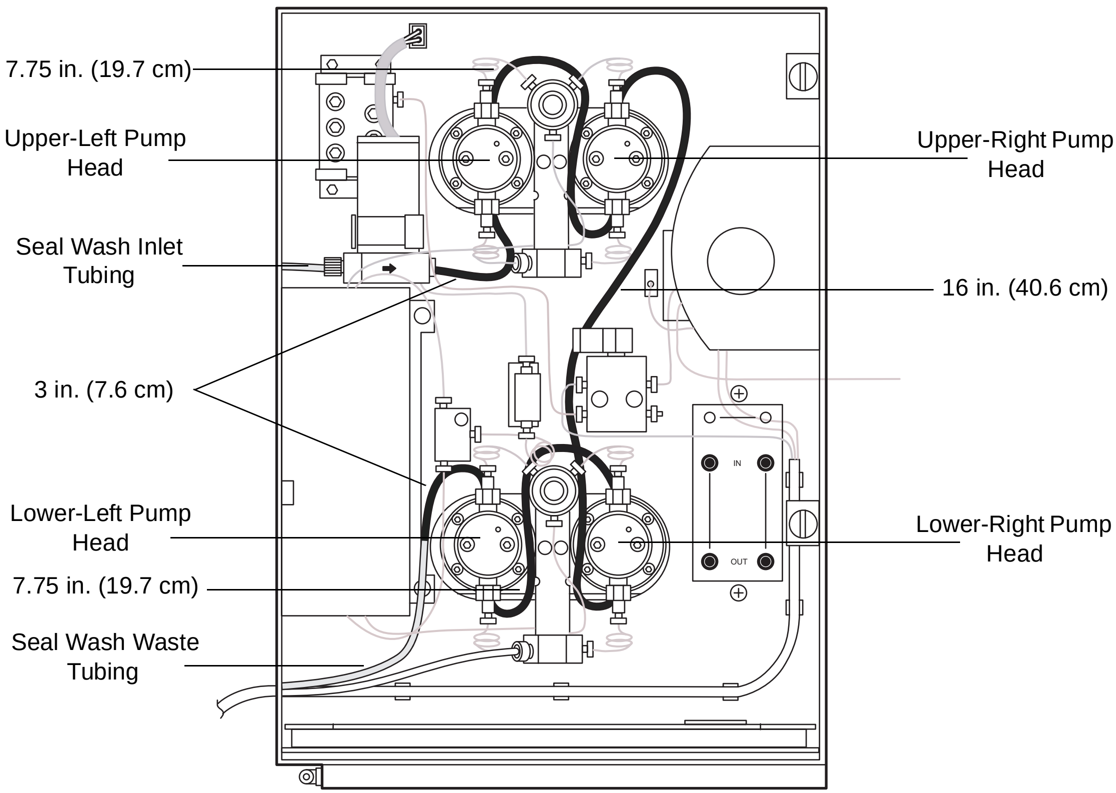

Figure 2-10 Seal Wash Tubing Routing

7. Route the ETFE tubing to a suitable waste receptacle, and cut the tubing to length.
8. Slide one end of the remaining portion of the ETFE tubing into the inlet slot on the left side of the instrument.
9. Slide a compression screw over the end of the tubing, followed by a ferrule with its tapered end facing away from the tubing end, and its wide end flush with the tubing end, as shown in Figure 2-11.

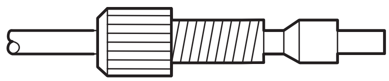

Figure 2-11 Reverse Ferrule and Compression Screw Assembly

10. Firmly seat the tubing end into the inlet on the left side of the solenoid pump, and then hold the tubing in place while finger-tightening the compression screw.

STOP ***Attention:*** *To avoid damaging the ferrule, do not overtighten the compression screw.*

11. Attach a sinker to the free end of the inlet tubing, and then insert the tubing into the seal wash solvent reservoir.
12. Prime the pump and check for leaks.

2.2 Using the Seal Wash System

The seal wash solvent lubricates the plunger. It also flushes away solvent or precipitated salts forced past the plunger seal from the high-pressure side of the solvent piston chamber.

STOP ***Attention:*** *Once the seal wash option has been installed, it must be used at all times when operating the instrument. Failure to do so may damage the plungers and seals.*

For reversed-phase HPLC applications, use an aqueous plunger seal wash solution with enough organic content to inhibit bacterial growth. For example, use a 4:1 water-methanol or water-acetonitrile solution, depending on your application. For all GPC separations, use a 1:1 water-methanol seal wash solution. If required, use an intermediate solution to prevent immiscibility or precipitation problems when you switch between GPC and reversed-phase analytical solvents.

Attention: *Never recycle seal wash.*

2.2.1 Priming the Plunger Seal Wash Pump

You must prime the plunger seal wash pump for first-time use or when the entire line is dry.

Note: *Ensure the plunger seal wash supply line (labeled “Seal Wash In”) is in the plunger seal wash solvent bottle and that the plunger seal wash waste line (clear) is in an appropriate waste container. Never recycle seal wash.*

1. Fill the plunger seal wash solvent bottle with an appropriate solvent.
2. Place the plunger seal wash supply line in the plunger seal wash solvent bottle.
3. Connect the tubing adapter to the syringe provided with the kit.
4. Disconnect the seal wash outlet tube from the waste tubing.
5. Attach the syringe to the seal wash outlet tube, and pull out the syringe plunger to create vacuum in the system.
6. Turn the instrument on. The seal wash solenoid will make a rapid clicking sound as it lets you draw solvent through the seal wash system.
7. When solvent begins to flow into the syringe, remove the syringe from the seal wash outlet tube.
8. Reconnect the seal wash outlet tube to the waste tubing.

If the seal wash system runs dry during operation, shut down and restart the instrument to return the seal wash pump to the priming mode. Perform the above procedure to prime the pump.