

FREEZE DRYER OPERATOR'S MANUAL



VIRTIS ADVANTAGE PRO LABORATORY BENCHTOP FREEZE DRYER

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Original Instructions

The U.S. English version of this document is the original instructions.
All other languages are a translation of the original instructions.

SP Scientific

3538 Main Street Stone Ridge, NY 12484 USA	935 Mearns Road Warminster, PA 18974 USA	815 State Route 208 Gardiner, NY 12525 USA	The Sovereign Centre, Farthing Road, Ipswich IP1 5AP UK
(800) 251-1531 (845) 687-0071	(800) 523-2327 (215) 672-7800	(800) 431-8232 (845) 255-5000	+44 (0)1473 240000

SP Service (800) 548-4666
SP Service Fax (845) 687-0024

Website <http://www.spscientific.com>

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Important Symbols



WARNING! INJURY OR EVEN DEATH MAY RESULT IF A RECOMMENDATION MARKED WITH THIS SYMBOL IS NOT HEEDED.



CRUSH HAZARD. KEEP HANDS CLEAR WHEN OPERATING DOOR.



ELECTRIC SHOCK DANGER! USE APPROPRIATE CAUTION TO AVOID INJURY OR DEATH.



CORROSIVE CHEMICAL. WEAR SUITABLE GLOVES, SAFETY GLASSES, AND PROTECTIVE CLOTHING.



BURN DANGER! POTENTIALLY HOT SURFACE. USE APPROPRIATE CAUTION.



PROPERTY CAUTION! TO PREVENT DAMAGE TO CHAMBER EQUIPMENT AND/OR LOAD, ADHERE TO PROCEDURES MARKED BY THIS SYMBOL.



DO NOT STORE FLAMMABLE MATERIALS IN CHAMBER.



PRACTICAL OPERATING TIP. THESE RECOMMENDATIONS STREAMLINE UNIT OPERATION AND PREVENT COMMON OPERATOR ERRORS.



ALWAYS WEAR APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT (PPE) SUITED FOR THE TASK YOU ARE PERFORMING.



EXPLOSIVE MATERIALS HAZARD! KEEP OBJECTS AWAY FROM HEAT.

Freeze Dryer Safety Warnings

- ✓ Do not freeze-dry explosive or highly flammable substances.
- ✓ Always assume that shelf, condenser and internal parts may be very cold or very hot. Wear protective equipment to avoid burns.
- ✓ Always ensure that only an authorized technician services the refrigeration, heat transfer, vacuum and electrical systems.
- ✓ Always ensure that refrigeration air intake is clear and clean.
- ✓ Always ensure vacuum pump exhaust is properly ventilated and/or contained.
- ✓ Always practice team lifting when moving heavy equipment.
- ✓ Always use a maximum one pound regulator if backfilling from an inert gas source.
- ✓ Always wear safety glasses when using glass flasks.
- ✓ Always wear appropriate personal protective equipment (PPE) suited for the task you are performing.
- ✓ Be sure to carefully read the entire instruction manual before attempting to operate the freeze dryer.
- ✓ Be sure to verify that the electric service and other utilities match the unit's requirements before connecting to power.
- ✓ Never allow hand or body contact with open vacuum ports.
- ✓ Never clean with solvents. Use mild detergent and water only.
- ✓ Never operate the unit without all covers in place.
- ✓ Never pressurize a freeze-drying chamber unless it has been specially designed and coded as a pressure vessel (e.g., displays an ASME-coded certificate).
- ✓ Never use acrylic closures if they are cracked or crazed.
- ✓ Never use with toxic, corrosive, flammable or organic materials unless special precautions are in place to prevent injury to personnel or damage to equipment.

Warranty Information

VirTis AdVantage Pro Lyophilizers are warranted by SP Scientific to be free of defects in material and workmanship when operated under normal conditions as specified in the instructions provided in this manual. Please take this opportunity to locate the serial tag on your new VirTis AdVantage Pro and record the information below for future reference. SP Scientific also recommends that you complete and return your unit's warranty registration card.

Model Number _____

Serial Number _____

Part Number _____

Limited Warranty

SP Scientific (the "Company") shall warrant each of its products against defects in material or workmanship for a period of 12 months from the date of installation or 15 months from the date of shipment (whichever comes first) provided that the product is used in a reasonable manner under appropriate conditions and consistent with the applicable operating instructions. In addition, the Company shall warrant the refrigeration system for a period of 24 months provided the system is used in a reasonable manner under appropriate conditions and consistent with the applicable operating instructions.

The obligation of the Company shall be, at its option, to repair or replace, without charge any parts that prove to be defective within the warranty period, if the purchaser notifies the Company promptly in writing of such defect. No product shall be returned to the Company without prior approval of the Company.

This limited warranty shall cover the costs of parts and labor to repair or replace all defective product(s) at the Seller's factory. For all products installed by the Company and located within the Company service travel areas, this warranty shall cover transportation charges to ship the product to and from the Company's factory and/or the costs of travel, room and board if the Company's employees conduct repair at the Buyer's location. In lieu of repair or replacement at the Company's factory, the Company may, in its discretion, authorize a third party to perform the repair or replacement at the Buyer's location, and at the Company's sole expense.

The Company shall not be responsible for labor charges payable with respect to persons other than Company employees. Replacement or repair of parts pursuant to this warranty shall not in any way extend the original warranty period. The Company shall not be responsible for any unauthorized repairs, replacements or product modifications, nor will it be responsible for any product failures resulting from such unauthorized repairs, replacements or product modifications negligently or otherwise made by persons other than Company employees or authorized representatives of the Company. The buyer shall assume transportation charges to ship the product to and from the Company's factory and the costs of travel, room and board if the Company's employees conduct repair at the Buyer's location within the warranty period if the product was not installed by the Company's and/or is not located within the Company's service travel areas.

THE COMPANY DOES NOT MAKE AND EXPRESSLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, WITH RESPECT TO THE SALE, INSTALLATION, DESIGN OR USE OF ITS PRODUCTS. ADDITIONALLY, THE COMPANY SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OF OR ANY DEFECTS IN ITS PRODUCTS.

The Company's employees are available to provide general advice to customers concerning the use of the Company's products; however, oral representations are not warranties with respect to particular products or their uses and may not be relied upon if they are inconsistent with the relevant product specifications for the items set forth herein.

Notwithstanding the above, the terms and conditions set forth in the Company's formal sales contracts shall be controlling and supersede any inconsistent terms contained herein, and any changes to such contracts must be made in writing and signed by an authorized executive of the Company.



WARNING! THE DISPOSAL AND/OR EMISSION OF SUBSTANCES USED IN CONNECTION WITH THIS EQUIPMENT MAY BE GOVERNED BY VARIOUS FEDERAL, STATE OR LOCAL REGULATIONS. ALL USERS OF THIS EQUIPMENT ARE URGED TO BECOME FAMILIAR WITH ANY REGULATIONS THAT APPLY IN THE USERS AREA CONCERNING THE DUMPING OF WASTE MATERIALS IN OR UPON WATER, LAND OR AIR AND TO COMPLY WITH SUCH REGULATIONS.

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Protective Cover for Intellitronics™ Controller66

Introduction



THIS IS THE EQUIPMENT OPERATOR'S MANUAL FOR THE VIRTIS ADVANTAGE PRO LYOPHILIZER. FOR ADDITIONAL INFORMATION, REFER TO YOUR CONTROL SYSTEM OPERATOR'S MANUAL.

Overview

The VirTis AdVantage Pro lyophilizer incorporates proven technology in an efficient freeze dryer with a convenient benchtop footprint. User-friendly yet technically sophisticated, the AdVantage Pro utilizes the versatile Intellitronics™ control system, which includes a detailed full-color, touch-screen display for monitoring and controlling all aspects of the freeze-dry cycle.

The AdVantage Pro freeze dryer offers an optional pneumatic stoppering system for stoppering vials and is available with up to three (3) usable product drying shelves. The AdVantage Pro also includes a choice of refrigeration systems and a variety of additional options and accessories to meet a vast amount of application requirements.

Notes: Refer to Chapter 5: Additional Options for further information on AdVantage Pro options and accessories.

Key Features

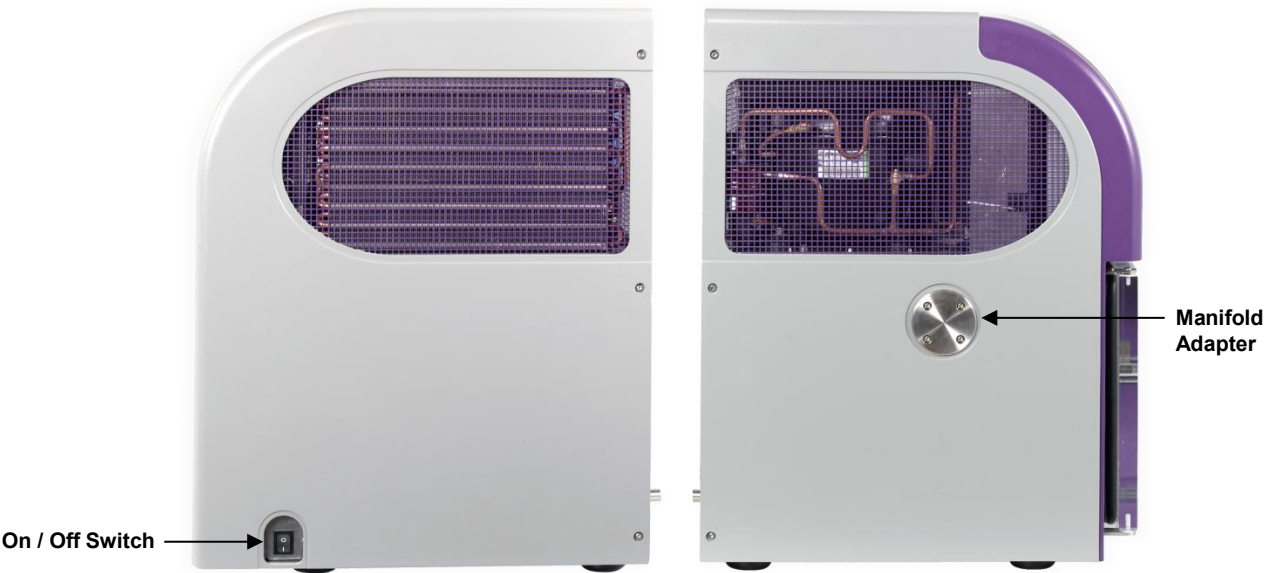
- Convenience of a tray dryer in a benchtop unit.
- Intellitronics™ controller with a full-color, touch-screen display.
- Available with up to three (3) usable product drying shelves.
- Optional pneumatic stoppering system available for stopper vials.
- Six-liter ice condensing capacity.

AdVantage Pro Series Freeze Dryer

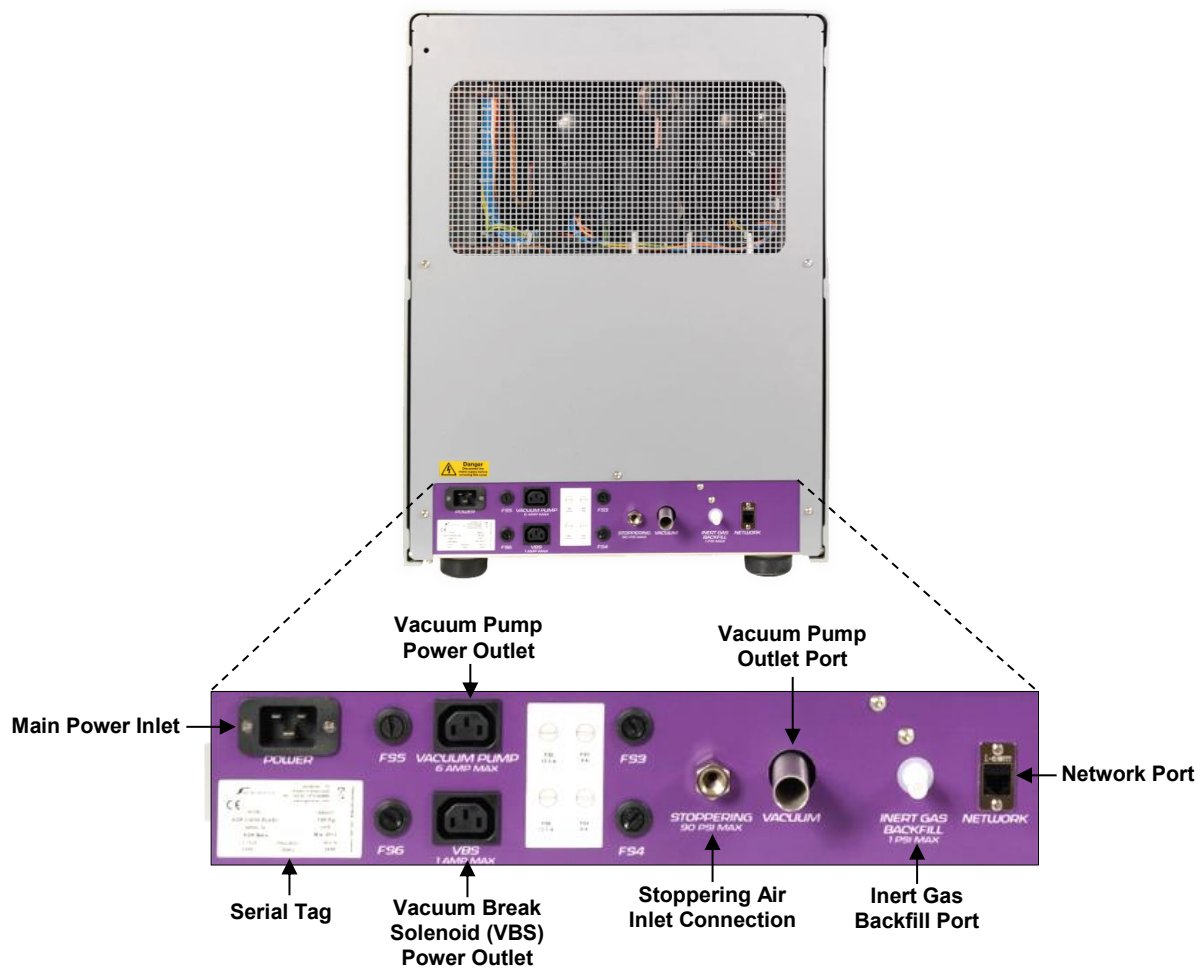
AdVantage Pro (Front View)



AdVantage Pro (Side Views)



AdVantage Pro (Rear View)



Getting Started



PRACTICAL OPERATING TIP. YOUR LYOPHILIZER IS SUPPLIED WITH A SOPHISTICATED CONTROLLER. REVIEW YOUR CONTROLLER OPERATOR'S MANUAL BEFORE OPERATING YOUR FREEZE DRYER.



WHEN IN OPERATION, ALWAYS ASSUME THE LYOPHILIZER CHAMBERS ARE UNDER VACUUM. ALL GLASSWARE UNDER VACUUM REPRESENTS A SIGNIFICANT IMPLOSION HAZARD. INSPECT ALL GLASSWARE USED IN THE LYOPHILIZER FOR VISIBLE DEFECTS (CRACKS, CHIPS, OR SCRATCHES) PRIOR TO USE. DO NOT USE GLASSWARE THAT IS DEFECTIVE.



LIQUID NITROGEN IS A HAZARDOUS MATERIAL THAT BOILS AT -194°C . LIQUID NITROGEN PRESENTS A SEVERE FROSTBITE HAZARD. WHEN USING LIQUID NITROGEN, WEAR PROPER EYE PROTECTION AND PROTECTIVE GLOVES.



ALWAYS WEAR APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT (PPE) SUITED FOR THE TASK YOU ARE PERFORMING (E.G., EYE PROTECTION) AT ALL TIMES WHEN WORKING WITH OR ANYWHERE NEAR A LYOPHILIZER.

Initial Inspection

Your AdVantage Pro series lyophilizer was carefully packed and thoroughly inspected before leaving the factory. However, in the unlikely event that shipping damage has occurred, retain all packing material and contact your freight carrier immediately.



DO NOT ACCEPT DAMAGED SHIPMENTS FROM A CARRIER WITHOUT A SIGNED NOTIFICATION OF DAMAGES.

Upon receiving your shipment, inspect all contents of your equipment for damage. Check packing material for small accessory items. Remove all packing material carefully and inspect for concealed shipping damage. Inspect the inside of the machine for any visible damage. If concealed damage or loss is discovered, contact the freight carrier immediately.¹ Keep all contents, packing material and related paperwork intact until a written report is obtained.

Note: SP Scientific will cooperate in the matter of collecting your claim, but is not responsible for the collection or free replacement of the material. When possible, replacement parts will be shipped and invoiced to you, making them a part of your claim.

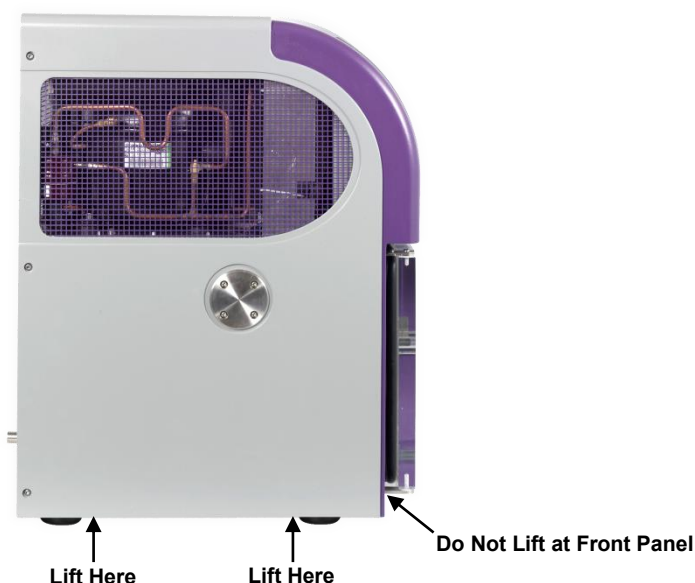
¹ "Concealed damage or loss" refers to damage or loss that does not become apparent until the merchandise has been unpacked and inspected. Should damage or loss be discovered, you may make a written request for inspection by the carrier's agent within 15 days of the delivery date. You may then file a claim with the freight carrier or SP Scientific, depending on the terms of your shipment. If your shipment was "FOB Destination" file your claim with SP Scientific and include the inspection report and any other supporting documents. If your shipment was "FOB Shipping Point" file your claim with the freight carrier and include the inspection report and any other supporting documents.

Lifting the AdVantage Pro Freeze Dryer

If no damage was discovered following the initial inspection of the AdVantage Pro, SP Scientific recommends using a moving assistance device (e.g., lift trolley) to safely lift the unit into place. Ensure that at least two (2) individuals are available to safely lift the unit on and off the moving assistance device. The AdVantage Pro should be lifted at the metal frame near the unit's four (4) feet, not at the front panel.



WARNING! THE ADVANTAGE PRO WEIGHS APPROXIMATELY 309 LBS (140 KG). ALWAYS PRACTICE TEAM LIFTING WHEN MOVING HEAVY EQUIPMENT.



AdVantage Pro Setup

Position your AdVantage Pro unit so it rests firmly and level on the desired location. Allow sufficient space so the unit may be easily connected and ensure that the area around the unit provides for adequate air circulation. The back of AdVantage Pro should be at least 4 inches (10.2 cm) away from the wall.

Note: For efficient operation, SP Scientific recommends an operating range of 15 - 25 °C (59 - 77 °F).

Service Connections

Ensure that the outlet you intend to use meets the service requirements listed on the AdVantage Pro's serial tag, which is located on the rear panel of your unit. Plug your unit into an appropriate outlet and switch on the On / Off Switch located at the lower left corner of the right side panel (when facing the unit). The Intellitronics™ touch-screen display will illuminate.

Note: The AdVantage Pro is configured with an IEC60320 C20 inlet on the back of the unit. This inlet allows country specific power leads to be supplied.

Vacuum Pump Installation

A remotely mounted vacuum pump (sold separately) is required for operation. The vacuum pump must be a two-stage, high-vacuum pump or a suitable dry pump and must meet the service requirements listed on the AdVantage Pro's serial tag, which is located on the rear panel of the unit. SP Scientific recommends using a vacuum pump with a minimum capacity of 60 liters per minute (Lpm).

If not venting the pump externally, SP Scientific recommends installing an Oil Mist Eliminator (OME) to reduce fumes from the vacuum pump.

Notes: Ensure that the pump is properly maintained prior to installation. For more information, refer to the Vacuum System section of Chapter 6: General Maintenance and/or the operator's manual for your specific vacuum pump.

A vacuum pump inlet port adapter and sufficient tubing are required for connection to the vacuum pump. If you need assistance, please contact SP Scientific.

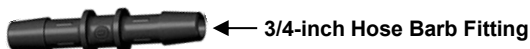
For more information on Oil Mist Eliminators, please contact SP Scientific.

Installing the Vacuum Pump

1. Disable power to your AdVantage Pro series freeze dryer.
2. Position the vacuum pump near the freeze dryer to ensure that the pump will be easily accessible during routine maintenance.
3. Locate the inlet port on your vacuum pump.
Note: For more information on the vacuum pump inlet port, refer to the operator's manual for your specific vacuum pump.
4. Remove all material with the exception of the inlet filter screen and gasket.
5. Place the vacuum pump inlet port adapter on the inlet port and secure it with a fitting.
6. Remove and retain all objects from the vacuum pump outlet port on the back of the unit (*i.e.*, VACUUM).
7. Place the vacuum pump outlet port adapter on the VACUUM port.



8. Place the 3/4-inch Hose Barb fitting into the open end of the vacuum pump outlet port adapter.



9. Connect vacuum tubing from the vacuum pump inlet port adapter to the 3/4-inch Hose Barb fitting. Secure both ends with a fitting.
10. Once vacuum tubing is securely connected, check the vacuum pump oil level. The oil level should read halfway up the sight glass. Add oil only if necessary.
Note: Vacuum pumps are typically shipped with oil in them. Do not overfill.
11. Plug the vacuum pump into the vacuum pump power outlet on the back of the unit (i.e., VACUUM PUMP).



Product Preparation: Shelf Drying

Notes: If you are processing samples using the Four Port Manifold or in flasks, refer to Quickseal Valves, Product Preparation: Flask / Manifold Drying section.

Product must remain below its critical formulation temperature throughout the drying process.

To process samples on the shelf (or shelves) within the product chamber:

1. Fill tray(s) or vials with your product.² Do not exceed half the container's total capacity.
2. If desired, insert product probes into the product. For accurate temperature readings, probe ends should make point contact with the bottom of the container at the bottom of the product.³
3. If your unit is equipped with the stoppering option and you are processing your product in vials, partially insert a split rubber stopper into each vial.
4. Load samples onto the shelf (or shelves) using removable bottom or bulk trays. If you are using product probes, connect the probes to the thermocouple jacks that are provided.
5. Close the product chamber door.

Note: Once product is loaded into the chamber, be sure to start a cycle after closing the product chamber door. Failure to do so may lead to explosive and/or flammable conditions.



WARNING! DO NOT USE THE VIRTIS ADVANTAGE PRO LYOPHILIZER IN AN EXPLOSIVE ATMOSPHERE OR IN THE PRESENCE OF FLAMMABLE GASES, VAPORS OR FUMES. DO NOT USE THE ADVANTAGE PRO TO MEASURE THE PRESSURE OF EXPLOSIVE OR COMBUSTIBLE GASES OR GAS MIXTURES.

² For a list of standard serum vial capacities, refer to [Appendix B: Serum Vial Capacities](#).

³ For precise positioning of probes in vials, contact SP Scientific about optional MVP Probe Holders.

Stoppering

Your AdVantage Pro lyophilizer may be equipped with an optional top-down stoppering system. Stoppering applies pressure to the stoppers of processed vials, forcing them fully into the vials while sealing the product under the current system vacuum. While in Recipe Mode, stoppering can be operated during the Product Storage phase, before or after backfilling the chamber with an inert gas.⁴ While in Manual Mode, stoppering may be operated at any time. All stoppering must be performed in full trays with vials of equal height to ensure uniform stoppering force distribution and prevent vial shifting.

The optional stoppering system requires a constant supply of compressed air or nitrogen regulated at 60 psig (90 psig maximum) to support the shelves and operate the stoppering piston. The Compressed Air Inlet connection is a 1/4-inch British Standard Pipe Thread (BSPT) bulkhead fitting located on the rear service panel of your unit.

Note: A BSPT to 1/4-inch NPT adapter shall be provided with the unit. This allows users to choose between a 1/4-inch BSPT fitting and a 1/4-inch NPT fitting.

Inert Gas Backfill

For a unit equipped with stoppering, inert gas may be admitted into the chamber through the inert gas backfill port (*i.e.*, 3/8-inch Hose Barb fitting) and the Vacuum Release Solenoid (VRS) valve, storing your product in an optimal, oxygen-free environment. Backfilling with inert gas is preferred for long-term storage of product samples that are unstable in the presence of oxygen.

Note: Products may also be stoppered under vacuum by skipping the inert gas backfill procedure.



WARNING! IF INERT GAS BACKFILL IS PERFORMED, ENSURE THAT ALL PRODUCT SAFETY RULES ARE OBSERVED IN REGARD TO THE MSDS (AND OTHER APPLICABLE CAUTIONS) FOR THE INERT BACKFILL GAS. DO NOT OVERFILL WITH BACKFILL GAS.

WARNING! NEVER CONNECT A GAS SOURCE WITHOUT A PRESSURE REGULATOR. THE PRESSURE REGULATOR MUST BE ABLE TO REDUCE SUPPLY PRESSURE TO 1 PSIG (70 MBAR, 7 KPA), OR LESS.

⁴ AdVantage series freeze dryers must be connected to a low-pressure (≤ 1 psig) inert gas source when backfilling with an inert gas.

To Backfill with Inert Gas:



BACKFILL IS ONLY AVAILABLE THROUGH THE RECIPE MODE SCREEN. AN ACTIVE RECIPE MUST BE IN THE PRODUCT STORAGE PHASE IN ORDER FOR BACKFILL TO BE ENABLED.

1. Connect the gas source to the INERT GAS BACKFILL port on the back of your AdVantage Pro series freeze dryer.



INERT GAS BACKFILL

2. Press the **Recipe** button to open the Recipe Mode screen.
3. Press the **Backfill Stoppering** button to open the Backfill & Stoppering screen.
4. Press the Vacuum Set Point numeric field. A numeric keypad will open.
Note: The Actual vacuum pressure is displayed next to the Vacuum Set Point.
5. Press the keypad buttons to enter the desired Vacuum pressure.
6. Press the **Esc** button to close the keypad without making changes or press the enter button (i.e., ) to accept the entered value.
7. Press the **Backfill** button to enable the Backfill function. Backfill will run until the Vacuum Set Point pressure is reached.
8. When the Vacuum Set Point pressure is reached, ensure that the backfill cycle has ended then remove the backfill container.
9. Once backfilling is complete, stoppering may begin.
Note: For instructions on stoppering, refer to the To Operate the Stoppering System section of this chapter.

Stoppering Operation



WARNING! FOLLOWING THE INITIAL SETUP AND INSTALLATION OF YOUR EQUIPMENT, OR CHANGES TO THE COMPRESSED AIR SUPPLY, ACTIVATE THE STOPPERING SYSTEM TO FULLY COLLAPSE AND RAISE UNLOADED PRODUCT SHELVES. THIS WILL ENSURE PROPER OPERATION OF THE STOPPERING MECHANISM.

Prior to operating the stoppering mechanism, ensure:

- The product chamber door is fully closed.
- The product is fully dried.
- The recipe is in the Product Storage phase (Recipe Mode only).
- The product chamber has been backfilled with an inert gas (if applicable).

Note: If the product chamber door is not fully closed, the Stoppering **Up** and **Down** buttons will be grayed out and unable to be pressed. For further information on stoppering, refer to control system operator's manual

The stoppering system requires a constant supply of compressed air or nitrogen regulated at 60 psig (90 psig maximum) to support the shelves and operate the stoppering piston. This pressure is used not only to lower and raise the shelves during stoppering, but also to support the shelves during the Drying phase. A manual valve may be installed to limit pressure drops and allow the air source to be shut off or otherwise removed. The Stoppering Air Inlet connection is located on the rear service panel of your unit (i.e., STOPPERING).



STOPPERING

To Operate the Stoppering System:

1. Confirm that a constant supply of compressed air or nitrogen regulated at 60 psig (90 psig maximum) is connected to the Stoppering Air Inlet connection (i.e., STOPPERING).
2. If backfilling with an inert gas, perform steps 1-9 of the [To Backfill With Inert Gas](#) section of this chapter, then continue to the next step. If backfill is not desired, continue to the next step.
3. Stopper the vials:
 - a. If in Manual Mode, press the **Manual** button to open the Manual Mode screen. To stopper, press and hold the Stoppering **Down** button to begin compressing the shelves and fully inserting partially inserted stoppers into the product vials. Once the Stoppering **Down** button can no longer be pressed, press and hold the Stoppering **Up** button to raise the compressed shelves.

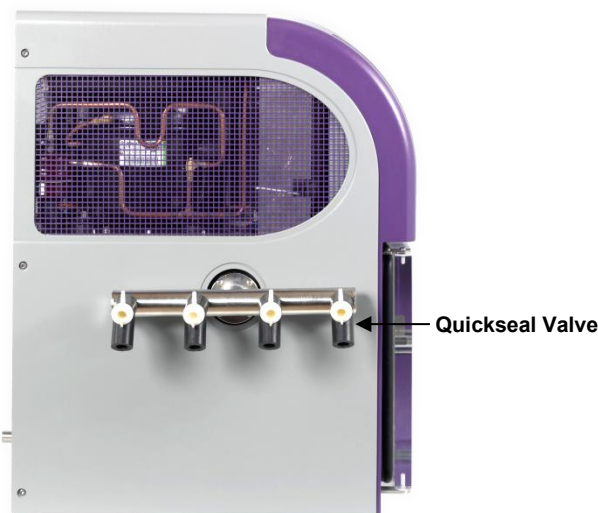
Note: While the stoppering system is active, either the Stoppering **Up** or **Down** button will be displayed in green.

- b. If in Recipe Mode, press the **Recipe** button to open the Recipe Mode screen then press the **Backfill Stoppering** button to open the Backfill & Stoppering screen. To stopper, press and hold the Stoppering **Down** button to begin compressing the shelves and fully inserting partially inserted stoppers into the product vials. Once the Stoppering **Down** button can no longer be pressed, press and hold the Stoppering **Up** button to raise the compressed shelves.

***Note:** While the stoppering system is active, either the Stoppering **Up** or **Down** button will be displayed in green.*
4. Once stoppering is complete, refer to your control system operator's manual for further information on vacuum release and defrost.

Quickseal Valves

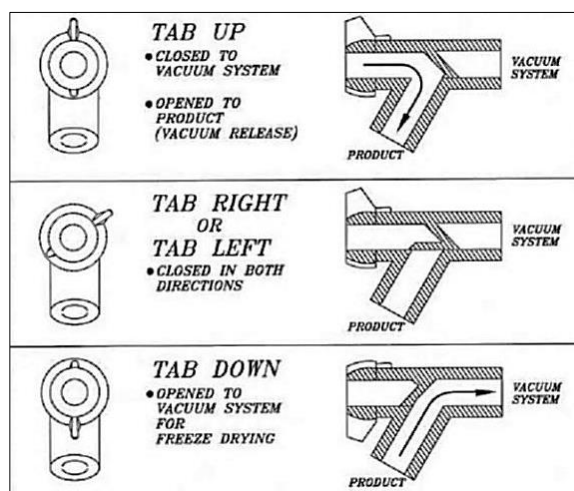
In order to use Quickseal valves, your AdVantage Pro lyophilizer must be equipped with the optional Four Port Manifold.



AdVantage Pro with Four Port Manifold

Quickseal Valves

Quickseal valves may be utilized in many methods of drying. They permit the attachment of flasks for in vitro freeze-drying, and are also used to break vacuum after a cycle completes. Quickseal valves operate as follows:



Note: Quickseal valves are an integral part of the freeze-drying process, and they must be maintained as such. For information regarding the service of Quickseal valves, refer to the Quickseal Valves section of Chapter 6: General Maintenance.

Product Preparation: Flask / Manifold Drying

Notes: If you are processing samples using a shelf (or shelves) within the product chamber, refer to the Product Preparation: Shelf Drying section of Chapter 2: Getting Started.

Product must remain below its critical formulation temperature throughout the drying process.

To prepare samples using glassware:



NEVER FILL A CONTAINER TO MORE THAN HALF ITS TOTAL CAPACITY.
TO MINIMIZE DRYING TIME, ALWAYS FREEZE PRODUCTS IN AS THIN A LAYER AS POSSIBLE.

1. Prepare flasks with your product. When using wide mouth flasks, ensure that the filter paper and O-ring are positioned correctly within the flask cover. Snap the cover securely onto the flask.⁵
2. Pre-freeze product samples in a laboratory freezer, dry ice bath or shell bath freezer. Freezing to -40 °C (-40 °F) is adequate for most products.⁶



Preventing Glassware Breakage

- Avoid cleaning glassware with a wire brush as a metal-to-glass abrasion creates microscopic scratches, which can cause breakage.
- Never fill a flask to more than half of its total capacity (e.g., a 600 mL flask has a working capacity of 300 mL).
- When pre-freezing samples in a storage freezer, tilt glassware at a 30 to 45 degree angle to increase surface area and reduce stress on the glass.
- To prevent metal-to-glass or glass-to-glass abrasions when placing flasks in glassware washers, do not allow contact with metal racks or other glassware.

⁵ Wide Mouth Flasks are the most popular glassware type, but other types of flasks, vials and ampoules are available. If you are not certain how to use glassware accessories, contact SP Scientific.

⁶ Dry ice methods can freeze a product to approximately -78 °C (-108.4 °F), while liquid nitrogen (N₂(liq)) methods can freeze a product to approximately -190 °C (-310 °F).

Using Quickseal Valves During a Freeze-Drying Cycle

1. Ensure that the Four Port Manifold is securely attached to the unit.
2. Begin a freeze-dry cycle in either Manual Mode or Recipe Mode.
***Note:** For further information on Manual Mode and/or Recipe Mode, refer to control system operator's manual.*
3. Once the condenser reaches the appropriate condenser pull-down temperature:
 - a. If in Manual Mode, press the **Vacuum** button to evacuate the product chamber to the Vacuum Setpoint.
 - b. If in Recipe Mode, vacuum will evacuate during the Evacuation phase based on the Condenser Temperature for Vacuum Start setpoint.
4. Secure the glassware adapter to the flask top.⁷
5. Attach a flask containing your pre-frozen sample to one (1) of the four (4) Quickseal valves. Additional flasks may be connected to the system if the condenser has sufficient total ice capacity.
***Note:** When adding a flask, the chamber vacuum will increase temporarily. Vacuum should recover within 20 minutes. The duration between adding flasks should be spaced accordingly to avoid possible condenser overload and/or periods of poor vacuum.*
6. Open the Quickseal valve by turning the white selector knob 180 degrees to the open (down) position.
7. Wait for the vacuum to recover sufficiently before attaching an additional flask.
8. Ensure that all critical system parameters remain within acceptable ranges (i.e., shelf temperature, condenser temperature and vacuum pressure).
9. Observe the product to determine when the drying process is complete. The drying process is typically complete when the exterior glassware reaches ambient temperature and the product appears dry (i.e., approximately 90 to 95% of the moisture has been removed). Lower moisture content may be achieved by allowing the product to continue to dry for several hours.
10. Close the Quickseal valve by turning the white selector knob 180 degrees to the closed (up) position and remove the glassware.
11. End the freeze-dry cycle in either Manual Mode or Recipe Mode.
***Note:** For further information on Manual Mode and/or Recipe Mode, refer to control system operator's manual.*

⁷ Glassware adapter must be capable of being attached to a Quickseal valve.

Meltback

Meltback is a process defect commonly associated with freeze-drying that describes the condition of a product when it melts or defrosts before subliming. Products that have low freezing points are more prone to meltback during the freeze-drying process.

The following suggestions may help to prevent meltback:

Note: *These guidelines only apply to drying product in flasks.*

- Decrease the volume and depth of the product or the number of samples connected.
- Insulate the product container to decrease the product temperature due to the ambient heat source.
- Verify that the equipment is functioning properly.
- If you are processing samples using flasks or other glassware, ensure that room temperature is approximately 20 °C.
- Consider reformulating the product or diluting it with water.
- Lower the shelf temperature and vacuum level to decrease the product temperature during drying.

Additional Options

VirTis AdVantage Pro lyophilizers offer a variety of optional components to match an assortment of product or process applications.

Bulk 316 Stainless Steel Trays

Bulk 316 stainless steel trays are available as an option for AdVantage Pro units that feature a shelf system designed for bulk tray processing.

The configuration of these trays are (W x D x H):

- 10 x 14 x 1.5 in (254 x 355.6 x 31.8 mm).

Removable Bottom Stainless Steel Trays

Removable bottom 316 stainless steel trays are available for AdVantage Pro units with the stoppering option. These trays are available in three (3) configurations that vary based on the height of the vials that are being used.

The configuration of these trays are (W x D x H):

- **Vials ≤ 1 in (25.4 mm).** 10 x 14 x .75 in (254 x 355.6 x 19.1 mm).
- **Vials 1 - 1.5 in (25.4 - 38.1 mm).** 10 x 14 x 1 in (254 x 355.6 x 25.4 mm)
- **Vials ≥ 1.5 in (38.1 mm).** 10 x 14 x 1.5 in (254 x 355.6 x 38.1 mm).

Stoppering Rod Extension

For AdVantage Pro units with the stoppering option, stoppering rod extensions are available. Stoppering rod extensions allow for stoppering when using low profile trays. These rod extensions add 1.5 inches (38.1 mm) to the stoppering rod.

Vacuum Break Solenoid (VBS) Valve

The AdVantage Pro may be equipped with an optional Vacuum Break Solenoid (VBS) valve. If purchased, the VBS valve shall be installed between the vacuum system and the condenser to prevent possible backflow into the condenser when the pump is de-energized.

Shelf Latching Kit

The AdVantage Pro may be equipped with an optional shelf latching kit. A shelf latching kit allows for the drying and stoppering (*i.e.*, if applicable) of vials that do not fit into the standard shelf clearance of the unit.

A shelf latching kit will allow for:

- 2 to 1 shelf latching on 2-shelf units.
- 3 to 2 shelf latching on 3-shelf units.

Notes: 3 to 1 shelf latching is unavailable for AdVantage Pro lyophilizers.

The use of a shelf latching kit will reduce the total number of usable shelves while increasing shelf clearance. For further information on shelf clearance, refer to your unit specifications.

For shelf latching instructions, refer to [Appendix C: Shelf Latching](#).

Solvent Resistant Door

The AdVantage Pro may be equipped with an optional solvent resistant door that is constructed of glass and aluminum and intended for applications using organic solvents. This solvent resistant door may be purchased prior to receiving your unit or after your unit is received. If purchased after receiving your unit, the solvent resistant door may be easily switched with the standard acrylic door in the field.



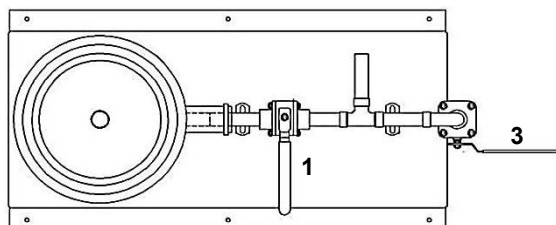
AdVantage Pro with Solvent Resistant Door

Liquid Nitrogen Trap

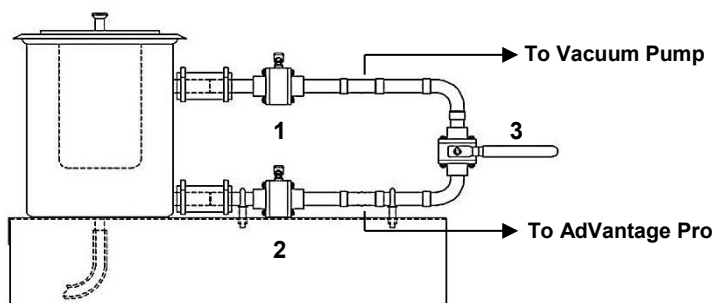
The optional Liquid Nitrogen ($N_2(\text{liq})$) Trap protects your vacuum pump from the corrosive properties of acid and alkaline vapors, as well as the low temperatures and organic solvents associated with the freeze-drying process. The trap is available in both 2.8 and 5-liter capacities.



WARNING! LIQUID NITROGEN CAN CAUSE SEVERE CRYOGENIC BURNS. EXERCISE CAUTION WHEN HANDLING. WEAR PROTECTIVE GLOVES AND AVOID SKIN CONTACT.



Top View



Side View

To Operate a Liquid Nitrogen Trap:

1. Enable the condenser and wait for the system to reach operating temperature.
2. Remove the plastic cover from the stainless steel vessel and add a small amount of liquid nitrogen to the center well. If adding liquid nitrogen from a tank, use adequate ventilation to protect from gaseous vapors.



WARNING! THE LIQUID NITROGEN WILL EXPAND AND BUBBLE WHEN IT MEETS THE WARM CENTER WELL. WEAR PROTECTIVE EYEWEAR AND GLOVES TO AVOID CONTACT WITH SKIN.

3. Replace the cover and wait one (1) minute.
4. Open the center well and slowly fill it with liquid nitrogen (2.8 or 5-liter, depending on capacity).
5. Open valves 1 and 2 and close valve 3 (see diagram above).
6. Enable the vacuum and wait until vacuum pressure reaches 100 mT.
7. The trap is now in operation. Liquid Nitrogen evaporates rapidly over time and the solvent is condensed. Check the center well often and refill it with liquid nitrogen as needed.

Filter Trap

SP Scientific filter traps protect your vacuum pump from damaging and corrosive vapors that are released during freeze-drying. If purchased, the filter trap is typically located between your freeze dryer and the vacuum pump.

Disposable Sodasorb®, activated charcoal, and molecular sieve trap drop-in wire mesh cartridges are available and must be purchased separately.

To install the filter trap:

1. Connect the vacuum pump to the port marked OUT.
2. Connect the rest of the system to the port marked IN.

Degassing Filter Trap Cartridges



WARNING! BE SURE TO PROPERLY HANDLE AND DISPOSE OF USED CARTRIDGES.

Filter trap cartridges are highly absorbent and may require degassing prior to freeze-drying. If you do not degas filter trap cartridges, vacuum pull-down may take significantly longer. Degassing is also necessary each time you change your filter trap cartridge. Most filters require an overnight degassing to achieve proper vacuum.

To degas the filter trap cartridge:

1. Unscrew the clear polypropylene housing from the white plastic top.
2. To begin degassing, enable the vacuum pump, open the gas ballast valve slightly and close all ports.
Note: For more information, refer to the [Gas Ballast Valve on the Vacuum Pump](#) section of Chapter 6: General Maintenance.
3. Degassing is complete when vacuum reaches 50 mT or less. Prior to turning off the pump, close the gas ballast.

Note: Degassing may take between 12 and 24 hours.

Filter trap cartridges are disposable. Their lifespan depends on frequency of use and the volume of contaminants they absorb. The Sodasorb® cartridges contain an Absorbent Exhaustion Indicator, which turns purple to signify the need for replacement. Full exhaustion is indicated by a deep purple color.

The activated charcoal cartridges contain no absorption limit indicator. Vacuum pump oil must be routinely checked for clarity to assess the charcoal's absorbing capacity. Depending on the usage and concentration, changing the charcoal cartridge every three (3) to six (6) months may suffice.

Lab Cart

An optional painted steel lab cart with casters is available for portability of the AdVantage Pro lyophilizer.

Note: A power-strip is not included with the lab cart.

Condenser Drain Tray

A condenser drain tray is available with your AdVantage Pro for easier removal of defrosted condensate.

Replacement Door Gasket

If needed, a replacement door gasket is available for your AdVantage Pro lyophilizer.

Note: For more information on any of the options available for the AdVantage Pro, contact SP Scientific.



General Maintenance

Overview

Proper routine maintenance is the key to an efficiently operating lyophilizer with minimal downtime, and will likely extend the life of your equipment, sub-systems and components.

Maintenance should be performed a minimum of four (4) times a year. Since system use and application varies from one facility to another, system maintenance may need to be performed more frequently.

Vacuum System

Vacuum Pump

Note: AdVantage Pro series freeze dryers do not include a vacuum pump. However, SP Scientific recommends the following protocols for vacuum pump maintenance. For additional information, refer the operator's manual for your specific vacuum pump.

Clean oil is necessary for optimal vacuum and overall efficiency of the vacuum system. Checking and changing the oil on a regular basis will greatly extend the life of the vacuum pump. Check the vacuum pump oil after each freeze-dry cycle by draining a small amount (~100 mL) from the pump drain line. Use a clear container to capture the sample. Oil should be changed as needed.

When visually checking the oil, use the following guidelines:

- Pale yellow or clear vacuum pump oil indicates good condition.
- Dark vacuum pump oil indicates acid contamination.
- Cloudy gray vacuum pump oil indicates water contamination.

Changing Vacuum Pump Oil

Change the oil immediately after shutting down the pump while the oil is still hot.



PROPERTY CAUTION! IF YOUR PRODUCT CONTAINS CORROSIVE MATERIALS OR ORGANIC SOLVENTS, OIL MUST BE CHECKED AND CHANGED MORE FREQUENTLY. IN ADDITION, A FILTER TRAP MAY BE INSTALLED TO PROTECT THE VACUUM PUMP AND PUMP OIL.



PROTECT YOUR HANDS FROM THE HOT OIL BY WEARING THE APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT (PPE).

1. Ensure that vacuum is released from the system.
2. Remove the top fill plug and open the drain valve located at the bottom of the pump. Drain the contaminated oil into a suitable container.
3. When the oil has completely drained, close the valve and add new oil to the pump while visually checking the sight glass to ensure the proper level (near the MAX line). Reinstall the fill plug.
4. If pump oil was contaminated, operate the vacuum pump for 10 to 15 minutes to flush any residual oil from the system's interior components. Repeat steps 2 and 3 to complete the process.

Scheduling Oil Changes

After clean oil is loaded into the vacuum pump and all necessary connections have been made between the vacuum pump and the freeze dryer, perform a full capacity test cycle.

Have a qualified technician check the oil after the test cycle. If the oil appears dirty, you may need to change the oil after every use. If the oil appears clean, check the oil again after two uses or cycles. If the oil remains clean after two cycles, check the oil again after four cycles. Continue to monitor the vacuum pump oil after each cycle until a change of condition is noted or a period of one month elapses. If the oil remains clean after several cycles, changing the oil once per month may be sufficient.

Clearing the Vacuum Pump Maintenance Alarm

The Vacuum Pump Maintenance Alarm is used to draw attention to vacuum pump maintenance (e.g., oil changes). The alarm will generate after the Current Hours (i.e., the number of hours that the vacuum pump has operated) has exceeded the Vacuum Pump Maintenance Alarm Setpoint (i.e., the number of continuous hours the vacuum pump can operate before the alarm is generated). The Current Hours and the Vacuum Pump Maintenance Alarm Setpoint are both located on the Vacuum Pump Maintenance screen.

When the Vacuum Pump Maintenance Alarm is generated, check if any routine maintenance is needed for the vacuum pump and perform it if needed. Once the vacuum pump is checked and any necessary maintenance is completed, the Current Hours may be reset and the alarm may be cleared.

Note: To reset the Current Hours and clear the alarm Vacuum Pump Maintenance Alarm, refer to your control system operator's manual.

Optional Secondary Traps

Most water-based products will completely condense or trap on the condenser when an appropriate cycle has been completed. However, products that contain compounds with freezing points near or below the operational temperature of the condenser coil may bypass the condenser and enter the vacuum pump instead. The result can be severely reduced vacuum performance and/or vacuum failure.

Optional secondary traps are available for applications where acid or solvent vapors may bypass the condenser and extra protection is required for the vacuum pump. If your unit was ordered with a cartridge-type trap, the cartridges may need to be replaced periodically.

There are two (2) types of cartridges, a Sodasorb® cartridge for acid-based applications and an activated charcoal cartridge for solvent-based applications. The Sodasorb® cartridge has an indicator that will change to a purple color when replacement is required. The activated charcoal cartridge contains no indicator, so replacement at regular intervals is required. Depending on the usage and concentration, changing the charcoal cartridge every three (3) to six (6) months may suffice.

Gas Ballast Valve on the Vacuum Pump

The gas ballast valve removes some contaminants from the pump oil. During freeze-drying, vapors may bypass the condenser and end up in the vacuum pump. If this occurs, the vapors will degrade the oil, causing excessive wear and higher vacuum pressure.

When the ballast is open, it allows a controlled amount of air into the second stage pump cylinder. This reduces the partial pressure, increases the pump's operating temperature and releases the vapors.

Note: Refer to the operator's manual for your specific vacuum pump for the location of the gas ballast valve.

Vacuum Tubing and Gaskets

Inspect tubing and gaskets periodically for signs of wear (e.g., cracking or dried appearance).

Vacuum Tubing

To inspect vacuum tubing:

1. Remove the cover of the AdVantage Pro to access the vacuum tubing.
Note: For cover removal instructions refer to [Appendix B: Cover Removal](#).
2. Remove the tubing and inspect it for excessive wear (e.g., cracking or dried appearance).
3. If the tubing requires cleaning, it may be cleaned with a mild alcohol (e.g., ethanol).
Note: If the tubing needs to be replaced, contact SP Scientific. The required length of the vacuum tubing is approximately 4 feet (121.9 cm).
4. Reattach tubing to the unit.
5. Refit the cover.

Door Gasket

To inspect the door gasket:

1. Remove the door gasket.
2. Grasp the gasket in both hands and turn it inside out.
3. Inspect the inside of the gasket. This is where you are most likely to find a potential problem.
4. If any inconsistencies are found (e.g., cuts, cracks, dry rot, rippling) on the inside of the gasket, it should be replaced immediately.
Note: For information regarding a replacement door gasket, contact SP Scientific.
5. Always install door gaskets on a clean, grease-free metal rim. Remove excess grease from the metal using isopropyl alcohol on a fresh paper towel or cloth. The gasket may also be cleaned with isopropyl alcohol.
6. Once the new or cleaned gasket is installed, apply a very thin coating of high vacuum grease to the outer surface of the gasket only. The gasket should appear slightly moist.

Quickseal Valves

An optional Four Port Manifold equipped with four (4) Quickseal valves may be featured on your AdVantage Pro lyophilizer. Quickseal valves should be serviced at least per each year.

To service Quickseal valves:

1. Remove the valves from the Four Port Manifold.
2. Twist and pull the white selector until it is dislodged from the black rubber body. If the valve is difficult to turn and very sticky, the grease may have dried up. This increases the potential for leaks.
3. Clean the valves thoroughly with isopropyl alcohol to remove old grease and dirt.
4. Inspect each cleaned selector carefully.
Note: *The use of broken flask adaptors can damage the selector.*
5. If scratches or cracks are found, the selector part(s) should be replaced.
6. Apply a thin film of high vacuum grease to acceptable selector(s) and reassemble.
7. Repeat steps 1 - 6 for all remaining Quickseal valves.

Refrigeration System

Air-Cooled Condenser

It is very important to keep the air-cooled condenser clean. This is where high-pressure vapor from the compressor is converted to liquid refrigerant by rejecting the heat gained from the vapor condenser into the ambient air. Reduced airflow over the condenser can result in severely reduced performance and may shorten the life of the compressor.

To maintain the air-cooled condenser and compressor:

1. Remove the cover of the AdVantage Pro to access the vacuum tubing.
Note: *For cover removal instructions refer to [Appendix B: Cover Removal](#).*
2. Vacuum the fins.
3. Always maintain at least 6 inches (15.2 cm) of clearance in front of the air-cooled condenser grill, which is located on the right side of the unit (when facing).
4. Always maintain a room temperature approximately of 20 °C. Higher temperatures may result in reduced performance and shorten the life of the compressor.
5. Inspect the fan for proper operation.
6. Refit the cover.

Compressor(s)

Depending on the model of your freeze dryer, your unit may contain one (1) or two (2) compressors.

- XL models contain one (1) compressor.
- EL models contain two (2) compressors.

When a cooling system problem is suspected, have a qualified refrigeration service technician check the refrigerant charge, or contact SP Service directly. Each refrigeration system contains a specified charge, which is indicated on the unit's charge tag.

A qualified refrigeration technician may check the charge after the unit has been off after several hours at room temperature. This will allow internal pressures to equalize. The AdVantage Pro's cover will need to be removed to allow the high and low side access valves to be visible. If the actual system pressure matches the pressure specified on the charge tag ($\pm 5\%$), a refrigeration leak should be ruled out. If the actual system pressure is more or less than 5 % of the specified charge, it may be necessary to perform a leak check on the system and repair the leak.

Note: For cover removal instructions refer to [Appendix B: Cover Removal](#).

If a refrigeration problem is suspected, a qualified technician should check for frost on the suction line. If the line is warm or just slightly cool to the touch, it usually means that a loss of refrigerant has occurred, and that the condenser and shelf are experiencing cooling problems.

Note: For more information, contact SP Scientific.

Appendix A: Troubleshooting

Vacuum Problems

Optimal vacuum is only achievable with a clean, dry system. Initial vacuum will be affected by the amount of loaded product. For efficient freeze-drying, vacuum should be below 200 millitorr. If using optional Quickseal valves, product may need to be introduced in stages to keep the vacuum below acceptable levels.

The following list poses questions to help eliminate possible vacuum-related problems:

- Was the condenser defrosted and drained after the last run?
- Is the chamber dry?
- Are all accessory ports, valves or filters closed tightly?
- Is the door gasket clean and properly greased?
- Are all the Quickseal valves in the closed position (if applicable)?
- Are the Quickseal valves in good condition (if applicable)?
- Using the sight glass, is the vacuum pump oil clean and at the proper level?
- Is the condenser maintaining the proper temperature?

Note: *If the temperature rises due to refrigeration problems, moisture may be leaving the condenser walls and migrating to the vacuum pump, causing poor vacuum.*

If you get a vacuum reading below 500 millitorr (on the front panel or vacuum gauge) within 15 to 30 minutes, you can rule out any problem with the pump, vacuum probe and vacuum tubing connections. Recheck the chamber and gasket for joint separations and dirty or rough surfaces.

If you do not get a normal vacuum reading on the front panel display or vacuum gauge within 15 to 30 minutes, start checking components in the following order:

1. Change the vacuum pump oil.

Note: For instructions on changing vacuum pump oil, refer to the Changing Vacuum Pump Oil section of Chapter 6: General Maintenance and/or the operator's manual for your specific vacuum pump.

2. Inspect vacuum tubing for excessive wear (e.g., cracking or dried appearance).

Note: For instructions on inspecting vacuum tubing, refer to the Vacuum Tubing section of Chapter 6: General Maintenance.

3. Check all threaded and welded connections and seal with vacuum sealant.

If poor vacuum persists or testing vacuum with a second, calibrated gauge indicates a good vacuum reading, the problem is likely related to the vacuum probe. Replace the vacuum probe tube and retest.

Note: If the vacuum problem is not resolved after checking these components (i.e., 1 - 3), contact SP Scientific.

Product Melting

The most common reason for product melting is insufficiently low vacuum pressure. Adequate vacuum is required to keep products in a frozen state. Check for a vacuum leak or possible restrictions in the vacuum hose as described above.

If the unit is functioning properly, but the product is still melting, the product's freezing point (eutectic temperature) may be too low to remain in a frozen state. Re-test using a water sample to determine if a mechanical or product-related problem exists.

Appendix B: Cover Removal

The cover of the AdVantage Pro must be removed to perform various general maintenance tasks (e.g., inspecting the tubing and gaskets).

To remove the cover:

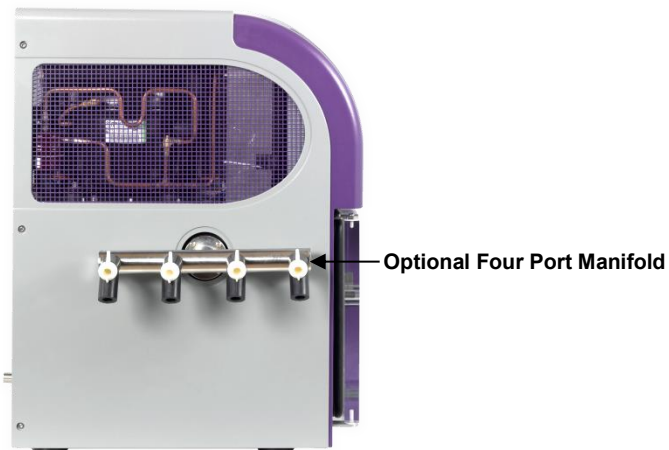


ENSURE THAT YOUR UNIT IS POWERED OFF AND UNPLUGGED PRIOR TO REMOVING THE COVER.

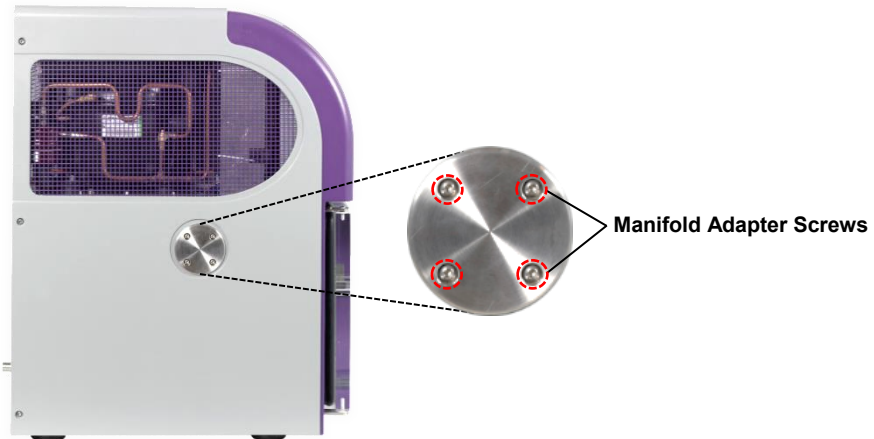
1. If a drain line is fitted to your unit's drain valve, disconnect the line from the valve. If not, proceed to step 2.



2. If your unit is equipped with the optional four port manifold, remove it from the manifold adapter. If not, proceed to step 3.



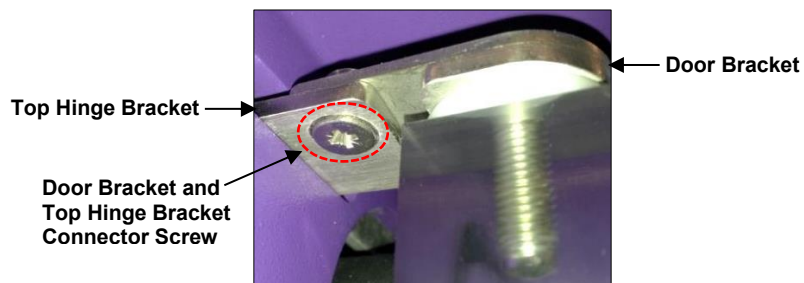
3. Remove the four (4) screws from the manifold adapter.



4. Remove the manifold adapter and the centering ring.



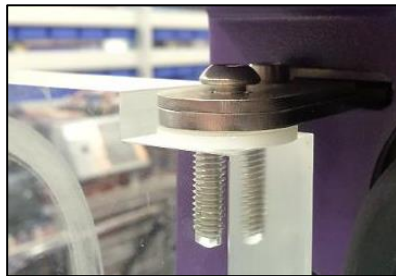
5. Remove the door bracket and top hinge bracket connector screw.



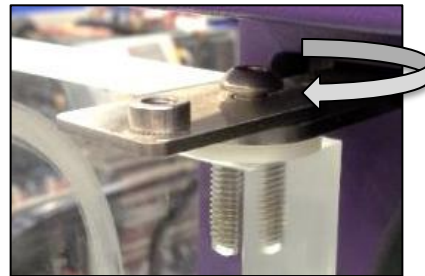
6. Using two hands, open the door to the fully open position.



7. Rotate the door bracket 180 degrees clockwise from the default position.

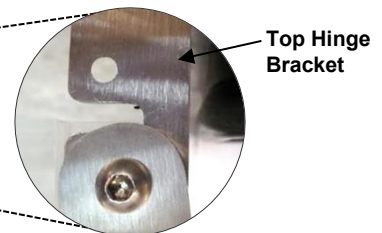
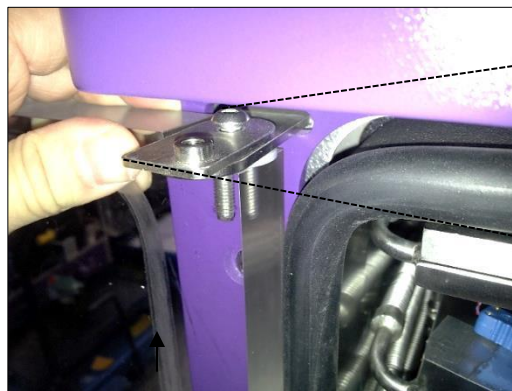


Door Bracket Default Position



Door Bracket Rotated 180° Clockwise

8. Push the top of the door towards the unit to separate the door from the top hinge bracket.



9. Tilt the door away from the unit then lift the door off the bottom hinge bracket pin.

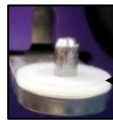


CAUTION! ONCE REMOVED, MISHANDLING OF THE PRODUCT CHAMBER DOOR MAY LEAD TO DAMAGE.



Bottom Hinge Bracket Pin

10. Remove the washer on the bottom hinge bracket.



Bottom Hinge Bracket Washer

11. Remove the chamber door seal.



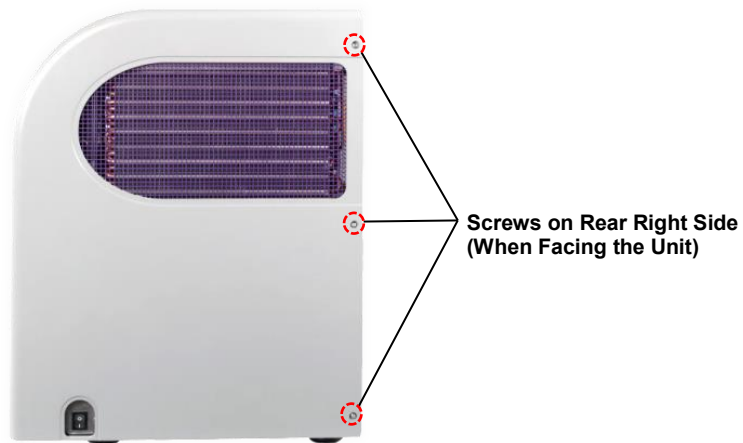
Chamber Door Seal

12. Remove the four (4) screws surrounding the product chamber.



Screws Surrounding the Product Chamber

13. Remove the six (6) screws on rear left and rear right sides of the unit (i.e., three (3) on each side).



14. Slide the cover forward off the unit.



CAUTION! TO PREVENT POSSIBLE DAMAGE TO THE DRAIN VALVE AND POWER SWITCH, DO NOT PULL THE COVER FROM JUST ONE SIDE WHEN REMOVING IT FROM THE UNIT.

CAUTION! ONCE REMOVED, MISHANDLING OF THE COVER MAY LEAD TO DAMAGE.



15. Once the necessary maintenance has been performed, replace the cover, door seal, door and manifold adapter.

Note: Ensure that all of the screws that were removed during the cover removal process have been replaced and tightened.

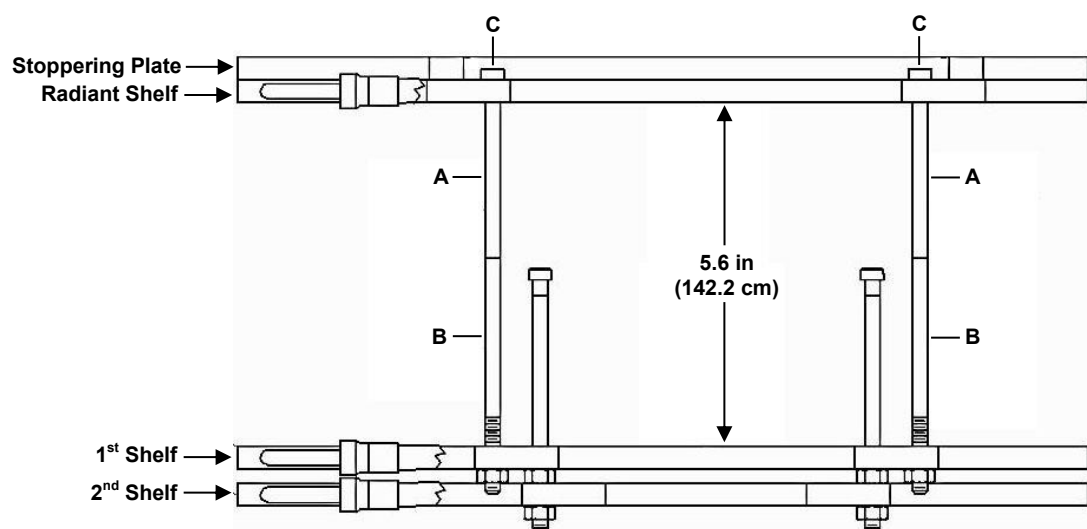
Appendix C: Shelf Latching

Shelf Latching Instructions

To latch shelves together on an AdVantage Pro using the optional shelf latching kit:

Configuration A: 2 to1 Shelf Latching

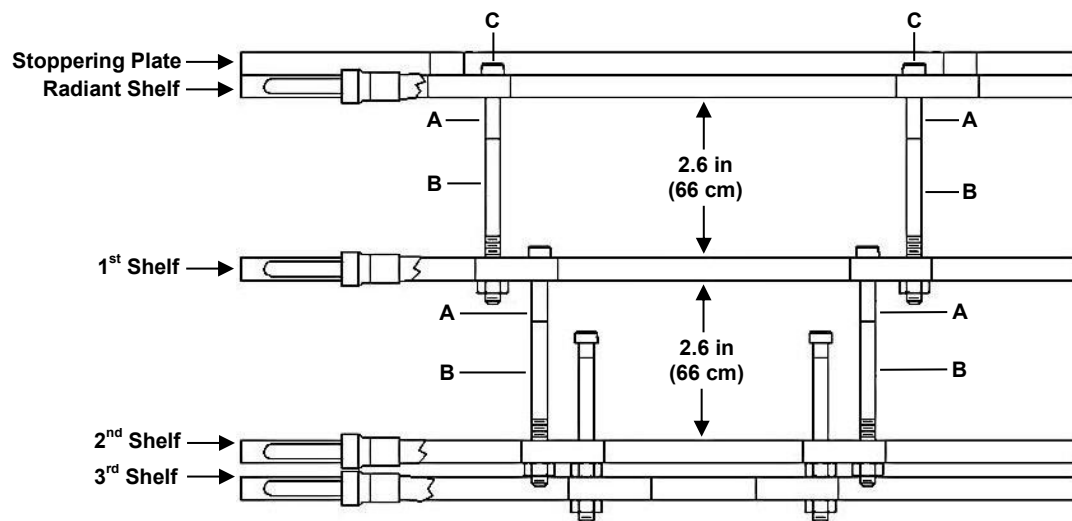
Item	Quantity	Description
A	4	Latching Rod Extension
B	8	Latching Rod
C	8	Shoulder Screw



1. Ensure that all shelves are empty.
2. Ensure that the Pneumatic Cylinder Rod is fully extended.
3. Remove the four (4) upper shoulder screws (Item C) and install the latching rod extensions (Item A). Remove only the upper shoulder screws installed in the four (4) corners of the top shelf.
4. Replace and secure the four (4) upper shoulder screws (Item C).
5. Raise the shelves to the Up position.
6. To return to a 2-shelf arrangement, repeat the process and remove the latching rod extensions (Item A). Ensure that the shoulder screws are secured before raising the shelf stack.

Configuration B: 3 to 2 Shelf Latching

Item	Quantity	Description
A	8	Latching Rod Extension
B	12	Latching Rod
C	12	Shoulder Screw



1. Ensure that all shelves are empty.
2. Ensure that the Pneumatic Cylinder Rod is fully extended.
3. Remove the eight (8) upper shoulder screws (Item C) and install latching rod extensions (Item A). Remove only the upper shoulder screws installed in the four (4) corners of the top two (2) shelves.
4. Replace and secure the eight (8) upper shoulder screws (Item C).
5. Raise the shelves to the Up position.
6. To return to a 3-shelf arrangement, repeat the process and remove the latching rod extensions (Item A). Ensure that the shoulder screws are secured before raising the shelf stack.

Appendix D: Serum Vial Capacities

Serum Vial Capacities Chart

Part number	Height (mm) ⁸	Body OD (mm)	Capacity (ml)	Quantity Per Tray
179077 ⁹	35	18	2	285
179275 ¹⁰	85	12	2	560
179101 ⁹	40	22	6	202
179085	47	23	5	174
179143 ⁹	50	23	10	174
179135	54	26	10	143
178855 ⁹	62	28	20	120
178830	58	33	20	80
178897	63	37	30	63
178921	73	43	50	45
178954	95	52	100	30
178988	107	54	125	30

⁸ Add 8 mm for partially inserted stopper.

⁹ Thin Wall.

¹⁰ Special Stoppering Ampoule (add 10 mm for partially inserted stopper).

Appendix E: Stainless Steel Cleaners

The following table lists possibly problematic situations and suggests corrective actions. For additional information, contact SP Scientific.

Cleaning Required	Cleaning Agent ¹¹	Application Method ¹²	Effect on Finish
HEAT TINT OR HEAVY DISCOLORATION	Penny-Brite or Copper-Brite	Use in direction of polish lines on No. 4 (polished) finish. Wipe with dry cloth.	May scratch No. 2 (mil) and Nos. 7 and 8 (polished) finishes.
	Paste Nu-Steel, DuBois Temp, Tarnite, or Kelox	Rub with dry cloth or stainless steel wool.	Use in direction of polish lines on No. 4 (polished) finish. May scratch No. 2 (mil) and No. 7 and 8 (polished) finishes.
	Revere Stainless Steel Cleaner, Take-Off, or AC-60	Apply with damp sponge or cloth.	Use in direction of polish lines on No. 4 (polished) finish. May scratch No. 2
	Allen Polish, Steel Bright, Wyandotte, Bob-O, Zud, Dubrite, or Prepare Dex	Rub with a damp cloth.	Use in direction of polish lines on No. 4 (polished) finish. May scratch No. 2 (mil) and Nos. 7 and 8 (polished) finishes.
TENACIOUS DEPOSITS, RUSTY DISCOLORATIONS, INDUSTRIAL ATMOSPHERIC STAINS.	Oakite No. 33, Dilac, Texo 12, Texo N.Y., Flash-Klenz, Caddy Cleaner, Turco Scale 4368, or Permag 57	Swab and soak with clean cloth. Allow to stand 15 minutes or more, per directions on package. Then rinse and dry.	Satisfactory for use on all finishes.
HARD WATER SPOTS AND SCALE.	Vinegar	Swab or wipe with cloth. Rinse with water and dry.	Satisfactory for use on all finishes.
	Dilac, Oakite No 33, Texo 12, Texo N.Y.	Swab with cloth or soak. Let stand 10-15 minutes. Always follow with neutralizer rise, and dry.	Satisfactory for use on all finishes. Effective on tenacious deposits or where scale has built up.

¹¹ Use of proprietary names is only intended to indicate a type of cleaner, and does not constitute any endorsement (nor does omission of any proprietary name imply its inadequacy). All products should be used in strict accordance with instructions and warnings on the product package.

¹² In all applications, a stainless steel wool, sponge fibrous brush, or pad is recommended. Avoid use of ordinary steel wool or steel brushes for scouring stainless steel.

Appendix F: Chemical Resistance Charts

Acrylic Parts

Clean acrylic covers and manifolds with a mild detergent. Use a soft cloth or Kimwipes® to avoid scratching the acrylic. The following table may be used as a general guide to acrylic chemical resistances.



PROPERTY CAUTION! DO NOT USE ORGANIC SOLVENTS OR ABRASIVE CLEANERS.

Chemical	Code	Chemical	Code	Chemical	Code
Acetic Acid (5%)	R	Ethyl Acetate	NR	Nitric Acid (10%)	R
Acetic Acid (Glacial)	NR	Ethyl Alcohol (50%)	LR	Nitric Acid (40%)	LR
Acetic Anhydride	LR	Ethyl Alcohol (95%)	NR	Nitric Acid (Conc.)	NR
Acetone	NR	Ethylene Dichloride	NR	Oleic Acid	R
Acetonitrile	NR	Ethylene Glycol	R	Olive Oil	R
Ammonium Chloride (Saturated)	R	2-Ethylhexyl Sebacate	R	Phenol Solution (5%)	NR
Ammonium Hydroxide (10%)	R	Formaldehyde (40%)	R	Soap Solution (Ivory)	R
Ammonium Hydroxide (Conc.)	R	Gasoline (Regular, Leaded)	LR	Sodium Carbonate (2%)	R
Aniline	NR	Glycerine	R	Sodium Carbonate (20%)	R
Battery Acid	R	Heptane	R	Sodium Chloride (10%)	R
Benzene	NR	Hexane (Commercial Grade)	R	Sodium Hydroxide (1%)	R
Benzyl Alcohol	NR	Hydrochloric Acid	NR	Sodium Hydroxide (10%)	R
Butyl Acetate	NR	Hydrofluoric Acid (40%)	R	Sodium Hydroxide (60%)	R
Calcium Chloride (Sat.)	R	Hydrogen Peroxide (3%)	R	Sodium Hypochlorite (5%)	R
Calcium Hypochlorite	R	Hydrogen Peroxide (28%)	NR	Sulfuric Acid (3%)	R
Carbon Tetrachloride	NR	Isooctane	R	Sulfuric Acid (30%)	R
Chloroform	NR	Isopropyl Alcohol	LR	Sulfuric Acid (Conc.)	NR
Chromic Acid (40%)	NR	Kerosene	R	Toluene	NR
Citric Acid (10%)	R	Lacquer Thinner	NR	Transformer Oil	R
Cottonseed Oil (Edible)	R	Methyl Alcohol (50%)	LR	Trichloroethylene	NR
Detergent Solution (Heavy Duty)	R	Methyl Alcohol (100%)	NR	Turpentine	LR
Diesel Oil	R	Methyl Ethyl Ketone (MEK)	NR	Water (Distilled)	R
Diethyl Ether	NR	Methylene Chloride	NR	Xylene	NR
Dimethyl Formamide	NR	Mineral Oil	R	Trifluoroacetic Acid	NR
Diethyl Phthalate	NR	Naphtha (VM&P)	R		

CODES

R = Resistant (withstands long periods of exposure at temperatures up to 50 °C).

LR = Limited Resistance (withstands short periods of exposure at room temperature).

NR = Not Resistant (immediate damage may occur upon exposure).

AdVantage Pro Bezel

The following table may be used as a general guide to ABS chemical resistances.

Chemical	Concentration	Resistance Level (20 °C / 68 °F)
Acetaldehyde	-	SE
Acetic Acid	10%	EX
Acetic Acid	glac./anh.	SE
Acetic Anhydride	-	SE
Aceto-Acetic Ester	-	SE
Acetone	-	SE
Other Ketones	-	SE
Acetonitrile	-	ND
Acetylene	-	ND
Acetyl Salicylic Acid	-	SE
Acid Fumes	-	SE
Alcohols	-	SE
Aliphatic Esters	-	SE
Alkyl Chlorides	-	SE
Alum	-	EX
Aluminium Chloride	-	EX
Aluminium Sulphate	-	EX
Ammonia, Anhydrous	-	EX
Ammonia, Aqueous	-	EX
Ammonium Chloride	-	EX
Amyl Acetate	-	SE
Aniline	-	SE
Antimony Trichloride	-	EX
Aqua Regia	-	SE
Aromatic Solvents	-	SE
Ascorbic Acid	-	SE
Beer	-	EX
Benzaldehyde	-	EX
Benzene	-	SE
Benzoic Acid	-	EX
Benzoyl Peroxide	-	EX
Boric Acid	-	EX
Brines, Saturated	-	EX
Bromide (K) Solution	-	EX
Bromine	-	SE
Bromine Liquid, Tech.	-	SE
Bromine water, Saturated Aqueous	-	SE
Butyl Acetate	-	ND
Calcium Chloride	-	EX
Carbon Disulphide	-	SE
Carbonic Acid	-	EX
CarbonTetrachloride	-	SE

Chemical	Concentration	Resistance Level (20 °C / 68 °F)
Caustic Soda & Potash	-	EX
Cellulose Paint	-	ND
Chlorates of Na, K, Ba	-	EX
Chlorine, dry	-	EX
Chlorine, wet	-	EX
Chlorides of Na, K, Ba	-	EX
Chloroacetic Acid	-	SE
Chlorobenzene	-	SE
Chloroform	-	SE
Chlorosulphonic Acid	-	SE
Chromic Acid	80%	EX
Citric Acid	-	EX
Copper Salts	most	EX
Cresylic Acids	50%	SE
Cyclohexane	-	SE
Detergents, Synthetic	-	EX
Emulsifiers, Concentrated	-	ND
Esters	-	SE
Ether	-	SE
Fatty Acids	>C6	EX
Ferric Chloride	-	EX
Ferrous Sulphate	-	EX
Fluorinated Refrigerants	-	SE
Fluorine, dry	-	SE
Fluorine, wet	-	SE
Fluorosilic Acid	-	SE
Formaldehyde	40%	EX
Formic Acid	-	EX
Fruit Juices	-	EX
Gelatine	-	EX
Glycerine	-	EX
Glycols	-	SE
Glycol, Ethylene	-	EX
Glycolic Acid	-	SE
Hexamethylene Diamine	-	ND
Hexamine	-	SE
Hydrazine	-	ND
Hydrobromic Acid	50%	EX
Hydrochloric Acid	10%	EX
Hydrochloric Acid	conc.	EX
Hydrocyanic Acid	-	EX
Hydrofluoric Acid	40%	EX
Hydrofluoric Acid	75%	SE
Hydrogen Peroxide	30%	EX
Hydrogen Peroxide	30 - 90%	SE

Chemical	Concentration	Resistance Level (20 °C / 68 °F)
Hydrogen Sulphide	-	ND
Hypochlorites	-	EX
Hypochlorites	Na 12-14%	EX
Iso-Butyl-Acetate	-	ND
Lactic Acid	90%	EX
Lead Acetate	-	EX
Lead Perchlorate	-	ND
Lime (CaO)	-	EX
Maleic Acid	-	EX
Manganate, Potassium (K)	-	EX
Meat Juices	-	EX
Mercuric Chloride	-	EX
Mercury	-	EX
Methanol	-	SE
Methylene Chloride	-	SE
Milk Products	-	EX
Moist Air	-	EX
Molasses	-	EX
Monoethanolamine	-	SE
Naptha	-	EX
Napthalene	-	SE
Nickel Salts	-	EX
Nitrates of Na	K and NH3	EX
Nitric Acid	<25%	SE
Nitric Acid	50%	SE
Nitric Acid	90%	SE
Nitric Acid (fuming)	-	SE
Nitrite	Na	EX
Nitrobenzene	-	SE
Oils, Diesel	-	ND
Oils, Essential	-	EX
Oils, Lubricating + Aromatic Additives	-	SE
Oils, Mineral	-	EX
Oils, Vegetable and Animal	-	EX
Oxalic Acid	-	EX
Ozone	-	SE
Paraffin Wax	-	EX
Perchloric Acid	-	ND
Petroleum Spirits	-	SE
Phenol	-	SE
Phosphoric Acid	20%	EX
Phosphoric Acid	50%	EX
Phosphoric Acid	95%	EX
Phosphorous Chlorides	-	ND
Phosphorous Pentoxide	-	ND

Chemical	Concentration	Resistance Level (20 °C / 68 °F)
Phthalic Acid	-	ND
Picric Acid	-	ND
Pyridine	-	SE
Salicyl Aldehyde	-	EX
Sea Water	-	EX
Silicic Acid	-	EX
Silicone Fluids	-	ND
Silver Nitrate	-	EX
Sodium Carbonate	-	EX
Sodium Peroxide	-	EX
Sodium Silicate	-	EX
Sodium Sulphide	-	EX
Stannic Chloride	-	SE
Starch	-	EX
Sugar, Syrups & Jams	-	EX
Sulphamic Acid	-	ND
Sulphates (Na, K, Mg, Ca)	-	EX
Sulphites	-	EX
Sulphonic Acids	-	ND
Sulphur	-	EX
Sulphur Dioxide, dry	-	EX
Sulphur Dioxide, wet	-	EX
Sulphur Dioxide	96%	SE
Sulphur Trioxide	-	EX
Sulphuric Acid	<50%	SE
Sulphuric Acid	70%	SE
Sulphuric Acid	95%	SE
Sulphuric Acid, Fuming	-	SE
Sulphur Chlorides	-	ND
Tallow	-	EX
Tannic Acid	10%	ND
Tartaric Acid	-	EX
Trichlorethylene	-	SE
Urea	30%	EX
Vinegar	-	EX
Water, Distilled.	-	EX
Water, Soft	-	EX
Water, Hard	-	EX
Wetting Agents	<5%	EX
Yeast	-	EX
Zinc Chloride	-	SE

CODES

EX = Excellent Resistance

SE = Severe Effect

ND = No Data

AdVantage Pro Front Panel

The following table may be used as a general guide to chemical resistances.

Chemical or Substance	Resistance	Chemical or Substance	Resistance
30% Hydrofluoric Acid	No Change	10% Sodium Chloride	No Change
63% Pechloric Acid	No Change	3% Hydrogen Peroxide	No Change
50% Pechloric Acid	No Change	95% Ethyl Alcohol	No Change
10% Hydrochloric Acid	No Change	50% Ethyl Alcohol	No Change
30% Sulfuric Acid	No Change	Acetone	Attacked
3% Sulfuric Acid	No Change	Ethyl Acetate	Attacked
70% Nitric Acid	No Change	Ethylene Dichloride	Attacked
50% Nitric Acid	No Change	Carbon Tetrachloride	Very Slightly Whitened
30% Nitric Acid	No Change	Toluene	Attacked
10% Nitric Acid	No Change	Heptane	No Change
10% Citric Acid	No Change	Tichloroethylene	Attacked
5% Acetic Acid	No Change	Lube Oil MIL-0-5606	No Change
10% Citric Acid	No Change	Lube Oil MIL-L-7808	No Change
Oleic Acid	No Change	Lube Oil MIL-L-23699	No Change
10% Sodium Hydroxide	No Change	ASTM Oil No. 3	No Change
1% Sodium Hydroxide	No Change	Jet Fuel JP-4	No Change
10% Ammonium Hydroxide	No Change	Jet Fuel JP-5	No Change
2% Sodium Carbonate	No Change	Water	No Change
100% Potassium Hydroxide	No Change	Propylene Glycol	No Change
Skydrol Hydraulic Fluid	Attacked	Perchloroethylene	Attacked
Motor Oil	No Change	Transmission Fluid	No Change
Brake Fluid	No Change	Ammonia	No Change
Coffee	No Change	Lestoil	No Change
Gasoline	No Change	Isopropyl Alcohol	No Change
10% Hydrochloric Acid	No Change		

The following table may be used as a general guide to chemical and stain resistance to potable liquids, cleaners, polishes, detergents, etc. after 30 days of contact.

Material	Chemical Resistance (23 °C / 73 °F)	Staining Tendency (23 °C / 73 °F)
Wesson Oil	No Change	None
Mazola Corn Oil	No Change	None
Coppertone Suntan Oil	No Change	None
Skol Suntan Oil	No Change	None
Lestoil	No Change	None
Simoniz Wax	No Change	Very Slight
Household Ammonia	No Change	None
All® Detergent	No Change	None
Exxon Gasoline	No Change	Very Slight
Mennen Skin Bracer	No Change	None
Tomato Juice	No Change	Very Slight
Prune Juice	No Change	Very Slight
Orange Juice Concentrate	No Change	Very Slight
Coffee	No Change	Very Slight
Bright Sail Bluing	No Change	Medium
Johnson's Pride	No Change	None
Isopropyl Alcohol	No Change	None
Cold Cream, Pond's	No Change	None
Butter	No Change	None
Mayonnaise	No Change	None
Mustard	No Change	Slight
Grape Juice	No Change	Slight
Clorox	No Change	None
Rinso Blue	No Change	None
Easy Monday Bluing	No Change	Medium
Pepsi-Cola	No Change	None
Water	No Change	None

AdVantage Pro: Miscellaneous Parts

The following table may be used as a general guide to chemical resistances at a resistance level of 20 °C / 68 °F.

Chemical	Drain Gasket	Condenser Gasket	Overlay Label	Drain Valve
Acetaldehyde	R	LR	NR	LR
Acetic Acid (50%)	ND	ND	ND	R
Acetates	ND	ND	ND	R
Acetic Acid (10%)	ND	ND	R	R
Acetic Acid (5%)	ND	ND	R	R
Acetic Acid (80%)	ND	ND	ND	R
Acetic Acid (conc.)	ND	ND	NR	ND
Aceto-Acetic Ester	ND	ND	ND	ND
Acetone	R	LR	NR	R
Acetonitrile	ND	ND	NR	NR
Acetophenone	R	NR	ND	LR
Acetyl Bromide	ND	ND	ND	ND
Acetyl Chloride (dry)	NR	NR	ND	ND
Acetyl Salicylic Acid	ND	ND	ND	ND
Acetylene	R	R	ND	R
Adipic Acid	R	R	R	R
Alcohols	ND	ND	ND	ND
Aliphatic Esters	ND	ND	ND	ND
Alkyl Chlorides	ND	ND	ND	ND
Allyl Alcohol	ND	ND	R	LR
Alum	ND	ND	ND	R
Aluminium Chloride	R	R	R	R
Aluminium Chloride (20%)	ND	ND	ND	R
Aluminium Sulphate	R	R	R	R
Aluminum Fluoride	R	R	ND	R
Aluminum Hydroxide	ND	ND	NR	R
Aluminum Nitrate	R	R	ND	R
Aluminum Oxalate	ND	ND	ND	ND
Aluminum Potassium Sulfate (10%)	ND	ND	ND	R
Aluminum Potassium Sulfate (100%)	ND	ND	ND	R
Amines	ND	ND	ND	ND
Ammonia (10%)	ND	ND	NR	R
Ammonia Nitrate	ND	ND	ND	ND
Ammonia, Anhydrous	R	R	ND	R
Ammonia, Aqueous	ND	ND	ND	R
Ammonium Acetate	ND	ND	R	R
Ammonium Bifluoride	ND	ND	ND	R
Ammonium Carbonate	ND	R	NR	R
Ammonium Caseinate	ND	ND	ND	ND
Ammonium Chloride	R	R	LR	R
Ammonium Fluoride (20%)	ND	ND	ND	ND

Chemical	Drain Gasket	Condenser Gasket	Overlay Label	Drain Valve
Ammonium Hydroxide	R	R	LR	R
Ammonium Metaphosphate	ND	ND	ND	R
Ammonium Nitrate	R	R	ND	R
Ammonium Oxalate	ND	ND	R	R
Ammonium Persulfate	R	R	ND	R
Ammonium Phosphate	R	R	ND	R
Ammonium Sulfate	R	R	ND	R
Ammonium Sulfide	ND	ND	ND	R
Ammonium Sulfite	ND	ND	ND	ND
Ammonium Thiosulfate	ND	ND	ND	ND
Amyl Acetate	LR	NR	ND	NR
Amyl Alcohol	R	R	ND	R
Amyl Chloride	ND	ND	NR	NR
Aniline	R	NR	NR	R
Aniline Hydrochloride	R	NR	ND	NR
Anise Oil	ND	ND	ND	ND
Anitfreeze	ND	ND	ND	R
Antimony Trichloride	ND	ND	ND	R
Aqua Regia	LR	NR	ND	LR
Aromatic solvents	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND
Arsenic Acid	ND	R	ND	R
Ascorbic Acid	ND	ND	ND	ND
Benzaldehyde	ND	ND	ND	NR
Barium Carbonate	ND	ND	ND	R
Barium Chloride	R	R	ND	R
Barium Cyanide	ND	ND	ND	ND
Barium Hydroxide	R	R	ND	R
Barium Nitrate	ND	ND	ND	ND
Barium Sulfate	R	R	ND	LR
Barium Sulfide	R	R	ND	R
Battery Acid	ND	ND	ND	ND
Bay Oil	ND	ND	ND	ND
Benzaldehyde	R	NR	NR	R
Benzene	NR	NR	NR	NR
Benzene Sulfonic Acid	LR	R	ND	LR
Benzoic Acid	LR	NR	R	R
Benzonitrile	ND	ND	ND	ND
Benzoyl Peroxide	ND	ND	ND	R
Benzyl Alcohol	R	R	R	NR
Benzyl Chloride	NR	NR	ND	R
Bismuth Carbonate	ND	ND	ND	R
Bitumen	ND	ND	ND	ND
Bleach	R	NR	ND	NR
Bone Oil	ND	ND	ND	ND

Chemical	Drain Gasket	Condenser Gasket	Overlay Label	Drain Valve
Borax (Sodium Borate)	R	R	ND	R
Boric Acid (10%)	ND	ND	NR	R
Brines, Saturated	R	R	ND	ND
Bromic Acid (10%)	ND	ND	ND	ND
Bromide (K) Solution	ND	ND	ND	ND
Bromine	ND	R	NR	NR
Butadiene	LR	NR	NR	NR
Butane	NR	R	ND	R
Butanediol	ND	ND	ND	ND
Butanol	ND	ND	ND	ND
Butraldehyde	ND	ND	ND	ND
Butyl Acetate	LR	NR	NR	LR
Butyl Alcohol	R	R	R	R
Butyl Amine	R	NR	ND	NR
Butyl Lactate	ND	ND	ND	ND
Butyl Stereate	LR	NR	ND	ND
Butylene Glycol	ND	ND	R	ND
Butyric Acid	ND	ND	NR	NR
Calcium Bisulfide	ND	ND	ND	R
Calcium Bisulfite	NR	R	ND	R
Calcium Carbonate	ND	ND	ND	R
Calcium Chlorate	ND	ND	ND	R
Calcium Chloride (10%)	ND	ND	R	R
Calcium Disulphide	ND	ND	ND	NR
Calcium Hydroxide	R	R	NR	R
Calcium Hypochlorite	R	LR	NR	R
Calcium Nitrate	R	R	ND	R
Calcium Oxide	ND	ND	ND	ND
Calcium Sulfate	ND	ND	ND	R
Carbolic Acid (Phenol)	R	LR	ND	R
Carbon Bisulfide	NR	NR	ND	NR
Carbon Dioxide	R	R	ND	R
Carbon Disulphide	ND	ND	NR	NR
Carbon Monoxide	R	R	ND	R
Carbon Tetrachloride	NR	NR	NR	LR
Carbonic Acid	R	R	ND	R
Castor Oil	R	R	ND	R
Caustic Soda & Potash	ND	ND	ND	R
Cellosolve	R	NR	NR	LR
Chlorates of Na, K, Ba	ND	ND	ND	ND
Chloric Acid	ND	ND	ND	NR
Chlorides of Na, K, Ba	ND	ND	ND	ND
Chlorine	ND	ND	R	R
Chloroacetic Acid	ND	NR	NR	R
Chlorobenzene	NR	NR	NR	NR

Chemical	Drain Gasket	Condenser Gasket	Overlay Label	Drain Valve
Chloroethyl Acetate	ND	ND	ND	ND
Chloroform	NR	NR	NR	NR
Chlorophnol	ND	ND	ND	ND
Chlorosulphonic Acid	NR	NR	ND	NR
Chromic Acid (80%)	ND	ND	LR	R
Citric Acid (10%)	ND	ND	R	R
Citric Oils	ND	ND	ND	R
Clophen A 60 (50%)	ND	ND	ND	ND
Cod Liver Oil	R	R	ND	R
Copper Chloride	R	R	ND	R
Copper Cyanide	R	R	ND	R
Copper Fluoride	ND	ND	ND	R
Copper Nitrate	ND	ND	ND	R
Copper Sulphate	R	R	R	R
Corn Oil	LR	LR	ND	ND
Creosote Oil	NR	ND	ND	ND
Cresol	NR	LR	NR	NR
Cresylic Acids (50%)	ND	ND	ND	NR
Cupric Acid	ND	ND	ND	ND
Cyanic Acid	ND	ND	ND	ND
Cyclohexanol	LR	R	ND	NR
Cyclohexane	NR	LR	R	NR
Cyclohexanone	GR	NR	ND	NR
Cyclohexene	ND	ND	ND	ND
Decahydronaphthalene	ND	ND	R	ND
Detergents, Synthetic	R	R	ND	R
Dextrin	ND	ND	ND	R
Dextrose	ND	ND	ND	R
Diacetone Alcohol	ND	R	ND	NR
Diamyl Phthalate	ND	NR	ND	ND
Dibutyl Sebecate	R	NR	ND	ND
Dibutylphthalate	R	ND	ND	R
Dichlorobenzene	ND	ND	ND	NR
Diesel	ND	ND	ND	LR
Diethyl Ether	NR	LR	NR	NR
Diethylamine	R	R	ND	LR
Diethylene Glycol	ND	R	R	R
Diglycolic Acid	ND	ND	ND	R
Dimethyl Aniline	R	LR	ND	ND
Dimethylamine	ND	ND	ND	R
Dimethylformamide	R	LR	NR	R
Diethyl Sebacate	R	NR	ND	ND
Diethylphthalate	R	NR	ND	NR
Dioxane	R	NR	NR	R
Diphenyl	ND	ND	ND	NR

Chemical	Drain Gasket	Condenser Gasket	Overlay Label	Drain Valve
Diphenyl Oxide	NR	NR	ND	ND
Disodium Phosphate	ND	ND	ND	ND
Edible Oil, Edible Fat	ND	ND	R	ND
Emulsifiers, Concentrated	ND	ND	ND	ND
Esters	ND	ND	ND	ND
Ethane	NR	R	ND	NR
Ethanol (96%)	ND	ND	ND	ND
Ether	ND	ND	NR	NR
Ethyl Acetate	R	LR	NR	R
Ethyl Alcohol	R	R	R	R
Ethyl Alcohol (<15%)	ND	ND	ND	ND
Ethyl Alcohol (>30%)	ND	ND	ND	ND
Ethyl Alcohol (15 - 30%)	ND	ND	ND	ND
Ethyl Bromide	ND	ND	ND	ND
Ethyl Butyrate	ND	ND	NR	LR
Ethyl Chloride	LR	NR	NR	NR
Ethyl Ether	LR	LR	NR	NR
Ethyl Sulfate	ND	ND	ND	ND
Ethylene Chloride	LR	NR	NR	NR
Ethylene Chlorohydrin	R	R	ND	NR
Ethylene Diamine	R	R	ND	R
Ethylene Dibromide	ND	ND	ND	LR
Ethylene Dichloride	LR	NR	ND	NR
Ethylene Glycol	R	R	LR	R
Ethylene Oxide	LR	NR	NR	LR
Ethylene Sulfate	ND	ND	ND	ND
Ferric Chloride	R	R	ND	R
Ferric Nitrate	R	R	ND	R
Ferric Sulfate	R	R	ND	R
Ferrous Chloride	ND	ND	ND	R
Ferrous Sulphate	ND	ND	ND	R
Fluoboric Acid	R	R	ND	R
Fluorinated Refrigerants	ND	ND	ND	ND
Fluorine	NR	NR	R	NR
Fluorosilic Acid	ND	ND	ND	R
Formaldehyde (40%)	ND	ND	R	R
Formamide	ND	ND	ND	ND
Formic Acid (1%)	ND	ND	R	R
Formic Acid (40%)	ND	ND	ND	R
Freon	NR	LR	R	R
Frigen, Freon	ND	ND	NR	ND
Fruit Juices	ND	ND	R	R
Fuel Oil	NR	R	R	R
Gallic Acid	R	R	ND	R
Gasoline	NR	LR	NR	NR

Chemical	Drain Gasket	Condenser Gasket	Overlay Label	Drain Valve
Gelatine	R	R	ND	R
Ginger Oil	ND	ND	ND	ND
Glucose	R	R	ND	R
Glycerine	R	R	R	R
Glycerol	ND	ND	ND	ND
Glycol	R	R	R	R
Glystantin (40%)	ND	ND	R	ND
Grease	ND	ND	ND	ND
Heptane	ND	ND	LR	LR
Hexamethylene Diamine	ND	ND	ND	ND
Hexamine	ND	ND	ND	ND
Hexane	NR	R	R	LR
Hexyl Alcohol	LR	R	ND	ND
Hydraulic Oil	NR	R	ND	NR
Hydrazine	R	R	ND	NR
Hydrobromic Acid (50%)	ND	ND	ND	R
Hydrochloric Acid (10%)	ND	ND	ND	LR
Hydrochloric Acid (conc.)	ND	ND	ND	R
Hydrochloric Acid (2%)	ND	ND	R	ND
Hydrochloric Acid (36%)	ND	ND	R	ND
Hydrocyanic Acid	ND	R	ND	R
Hydrocyanic Acid (75%)	ND	ND	ND	R
Hydrocyanic Acid (30%)	ND	ND	LR	R
Hydrogen Bromide (10%)	ND	ND	ND	ND
Hydrogen Peroxide (>40%)	ND	ND	ND	R
Hydrogen Peroxide (0.5%)	ND	ND	R	R
Hydrogen Peroxide (30%)	ND	ND	R	R
Hydrogen Phosphide	ND	ND	ND	ND
Hydrogen Sulphide	ND	ND	R	R
Hydroquinone	R	NR	ND	R
Hypochlorites	ND	ND	ND	ND
Ink	ND	ND	R	ND
Iodine	ND	ND	ND	R
Isobutyl Acetate	ND	ND	ND	ND
Isobutyl Alcohol	R	R	ND	R
Isooctane	NR	R	ND	R
Isopropanol	ND	ND	LR	ND
Isopropyl Acetate	R	NR	ND	LR
Isopropyl Alcohol	R	R	ND	R
Isopropyl Ether	NR	LR	ND	NR
Jet Fuel	ND	ND	ND	NR
Kerosene	NR	R	R	NR
Ketones	ND	ND	ND	NR
Lacquers	NR	NR	ND	NR
Lactic Acid (10%)	ND	ND	R	R

Chemical	Drain Gasket	Condenser Gasket	Overlay Label	Drain Valve
Lactic Acid (90%)	ND	ND	R	R
Lead Acetate	R	R	ND	R
Lead Perchlorate	ND	ND	ND	ND
Lead Sulfamate	R	R	ND	R
Lemon Oil	ND	ND	ND	NR
Ligroin	ND	ND	ND	NR
Lime (CaO)	ND	ND	ND	R
Linoleic Acid	NR	NR	ND	LR
Linseed Oil	LR	R	R	R
Lubricants	NR	ND	R	LR
Lugal Solution	ND	ND	ND	ND
Magnesium Carbonate	ND	ND	ND	R
Magnesium Chloride	R	R	R	R
Magnesium Hydroxide	R	R	ND	R
Magnesium Nitrate	ND	ND	ND	R
Magnesium Oxide	ND	ND	ND	ND
Magnesium Sulfate	R	R	ND	R
Maleic Acid	R	LR	ND	R
Maleic Anhydride	R	LR	ND	ND
Malic Acid	R	LR	ND	R
Manganate, Potassium (K)	ND	ND	ND	ND
Manganese Sulphate	ND	ND	ND	LR
Melamine	ND	ND	ND	ND
Mercuric Chloride	R	R	ND	R
Mercuric Cyanide	ND	ND	ND	R
Mercuric Nitrate	ND	ND	ND	R
Mercury	R	R	ND	LR
Methane	NR	R	ND	R
Methanol	ND	ND	NR	R
Methyl Acetate	R	R	ND	R
Methyl Acetone	ND	ND	ND	ND
Methyl Acrylate	R	R	ND	ND
Methyl Alcohol	R	R	R	R
Methyl Benzoate	ND	ND	ND	ND
Methyl Bromide	NR	NR	ND	LR
Methyl Butyl Ketone	ND	ND	ND	ND
Methyl Cellosolve	R	LR	ND	LR
Methyl Chloride	LR	NR	NR	NR
Methyl Cyclohexanol	ND	ND	ND	ND
Methyl Dichloride	ND	ND	ND	ND
Methyl Ethyl Ketone	R	LR	NR	NR
Methyl Methacrylate	LR	NR	ND	ND
Methyl Naphthalene	ND	ND	ND	ND
Methyl Salicylate	R	NR	ND	R
Methylamine	ND	ND	ND	ND

Chemical	Drain Gasket	Condenser Gasket	Overlay Label	Drain Valve
Methylene Chloride	LR	NR	NR	LR
Methylene DiChloride	ND	ND	ND	ND
Methylsulfuric Acid	ND	ND	ND	ND
Milk	ND	ND	R	R
Mineral Oil	LR	R	LR	LR
Mineral Spirits	ND	ND	ND	ND
Molasses	ND	ND	ND	R
Monobromonaphthalene	ND	ND	ND	ND
Monochloroacetic Acid	ND	ND	ND	R
Monoethanolamine	R	NR	ND	R
Monoethanolamine	ND	ND	ND	ND
Motor Oil/Engine Oil	ND	ND	ND	NR
Naptha	NR	LR	ND	NR
Napthalene	NR	NR	ND	LR
Nickel Chloride	R	R	ND	R
Nickel Nitrate	ND	ND	ND	R
Nickel Salts	ND	ND	ND	ND
Nickel Sulfate	R	R	R	R
Nitrates of Na, K and NH3	ND	ND	ND	ND
Nitric Acid (<25%)	ND	ND	R	R
Nitric Acid (50%)	ND	ND	R	NR
Nitric Acid (90%)	ND	ND	LR	NR
Nitric Acid (2%)	ND	ND	R	R
Nitric Oxide	ND	ND	ND	ND
Nitrite (Na)	ND	ND	R	ND
Nitrobenzene	R	NR	NR	NR
Nitrocellulose	ND	ND	ND	ND
Nitromethane	R	R	ND	ND
Nitrous Acid	ND	ND	ND	ND
Octyl Alcohol	ND	R	ND	ND
Oils Lubricating	ND	ND	ND	ND
Oleic Acid	NR	LR	LR	LR
Oleum (100%)	ND	ND	ND	NR
Oleum (25%)	ND	ND	ND	NR
Olive Oil	R	R	ND	R
Oxalic Acid (10%)	ND	ND	R	R
Ozone	R	LR	NR	NR
P3-Solution, Aqueous	ND	ND	NR	ND
Paint Thinner	NR	NR	ND	ND
Palmitic Acid	R	R	ND	LR
Paraffin Oil	ND	ND	R	R
Peanut Oil	LR	LR	ND	NR
Pentane	ND	ND	ND	ND
Perchlorethylene	NR	NR	LR	NR
Perchloric Acid	R	R	NR	NR

Chemical	Drain Gasket	Condenser Gasket	Overlay Label	Drain Valve
Petrolatum	ND	ND	ND	ND
Petroleum	ND	R	LR	LR
Petroleum White Spirit	ND	ND	NR	ND
Phenol, Aqueous	R	LR	NR	R
Phosphoric Acid (10%)	ND	ND	R	LR
Phosphoric Acid (20%)	R	R	R	R
Phosphoric Acid (20%)	ND	ND	R	R
Phosphoric Acid (95%)	ND	ND	R	R
Phosphorous Chlorides	ND	ND	ND	ND
Phosphorous Pentoxide	ND	ND	ND	ND
Phthalates	ND	ND	ND	ND
Phthalic Acid	ND	ND	ND	LR
Phthalic Anhydride	ND	ND	ND	ND
Picric Acid	R	R	ND	ND
Pine Oil	NR	NR	ND	ND
Potash (Potassium Carbonate)	ND	ND	ND	R
Potassium Bicarbonate	ND	ND	ND	R
Potassium Bromide	ND	ND	ND	R
Potassium Carbonate	ND	ND	ND	R
Potassium Chlorate	ND	ND	ND	R
Potassium Chloride	R	R	R	R
Potassium Chromate	ND	ND	ND	R
Potassium Cyanide Solutions	R	R	ND	R
Potassium Dichromate (10%)	ND	ND	R	R
Potassium Ferricyanide	ND	ND	ND	R
Potassium Fluoride	ND	ND	ND	ND
Potassium Hydroxide Solution (10%)	ND	ND	NR	R
Potassium Hydroxide Solution (50%)	ND	ND	NR	R
Potassium Nitrate	R	R	ND	R
Potassium Oxalate	ND	ND	ND	ND
Potassium Perborate	ND	ND	ND	ND
Potassium Perchlorate (10%)	ND	ND	ND	ND
Potassium Permanganate (1%)	ND	ND	R	R
Potassium Persulfate	ND	ND	ND	R
Potassium Sulfate	R	R	ND	R
Potassium Sulfite	ND	ND	ND	R
Propane	NR	R	LR	LR
Propanol	ND	ND	R	ND
Propargyl Alcohol	ND	ND	ND	ND
Propyl Alcohol	R	R	ND	R
Propylene Glycol	ND	ND	LR	R
Pyridene	R	ND	NR	R
Pyridine	ND	NR	ND	R
Pyrogalllic Acid	ND	ND	ND	R
Rosins	ND	ND	ND	R

Chemical	Drain Gasket	Condenser Gasket	Overlay Label	Drain Valve
Salicylic Acid	R	R	ND	R
Sea Water	R	R	ND	R
Selenic Acid	ND	ND	ND	ND
Shellac	ND	ND	ND	R
Silicic Acid	ND	ND	ND	ND
Silicone	ND	ND	ND	R
Silicone Oil	ND	ND	R	R
Silver Bromide	ND	ND	ND	ND
Silver Nitrate	R	R	R	R
Soap Solution	R	R	R	R
Soda Solution (10%)	ND	ND	R	ND
Sodium Acetate	R	R	ND	R
Sodium Aluminate	ND	ND	ND	ND
Sodium Benzoate	ND	ND	ND	R
Sodium Biocarbonate	ND	ND	R	R
Sodium Bisulfate	ND	ND	ND	R
Sodium Bisulphite	R	R	R	R
Sodium Borate	R	R	ND	R
Sodium Bromide	ND	ND	ND	R
Sodium Carbonate (10%)	ND	ND	R	R
Sodium Chlorate	ND	ND	ND	R
Sodium Chloride (10%)	ND	ND	R	R
Sodium Chromate	ND	ND	ND	R
Sodium Cyanide	R	R	ND	R
Sodium Dichromate	ND	ND	ND	R
Sodium Ferrocyanide	ND	ND	ND	R
Sodium Fluoride	ND	ND	ND	R
Sodium Hydroxide Solution (5%)	ND	ND	NR	R
Sodium Hydroxide Solution (50%)	ND	ND	NR	R
Sodium Hydroxide Solution (80%)	ND	ND	ND	R
Sodium Hypochlorite (<20%)	ND	ND	R	R
Sodium Hypochlorite (100%)	R	NR	ND	R
Sodium Acetate	ND	ND	ND	ND
Sodium Metaphosphate	R	R	ND	NR
Sodium Metasilicate	ND	ND	ND	ND
Sodium Nitrate (10%)	ND	ND	ND	R
Sodium Perborate	R	R	ND	R
Sodium Peroxide	R	R	ND	LR
Sodium Phosphate	R	R	ND	R
Sodium Polyphosphate	ND	ND	ND	ND
Sodium Silicate	R	R	ND	R
Sodium Sulfate	R	R	ND	R
Sodium Sulphide	ND	ND	ND	R
Sodium Tetraborate	ND	ND	ND	R
Sodium Thiosulphate	R	R	ND	R

Chemical	Drain Gasket	Condenser Gasket	Overlay Label	Drain Valve
Sorghum	ND	ND	ND	ND
Soybean Oil	LR	R	ND	R
Stannic Chloride	R	R	ND	R
Stannic Fluoborate	ND	ND	ND	ND
Starch	ND	ND	ND	R
Stearic Acid	ND	ND	ND	ND
Stearic Acid	R	R	ND	R
Stoddard Solvent	NR	R	ND	NR
Styrene	NR	NR	NR	ND
Sulphamic Acid	ND	ND	ND	ND
Sulphates (Na, K, Mg, Ca)	ND	ND	ND	ND
Sulphites	ND	ND	ND	ND
Sulphonic Acids	ND	ND	ND	ND
Sulphur	ND	ND	ND	ND
Sulphuric Acid (98%)	ND	ND	NR	R
Sulphuric Acid (2%)	ND	ND	R	R
Sulphur Dioxide (96%)	ND	ND	ND	ND
Sulphur Dioxide, dry	R	NR	ND	R
Sulphur Chlorides	NR	LR	ND	NR
Sulphur Dioxide, wet	R	R	ND	NR
Sulphur Trioxide	R	NR	ND	NR
Tallow	ND	ND	ND	ND
Tannic Acid (10%)	ND	ND	ND	R
Tanning Oil	ND	ND	ND	ND
Tartaric Acid	ND	ND	ND	R
Tar	ND	ND	ND	ND
Tartaric Acid	R	R	R	R
Tetrachloroethane	ND	ND	ND	R
Tetrachloroethylene	NR	NR	ND	NR
Tetrahydrofuran	LR	NR	NR	NR
Tetrahydronaphthalene	ND	ND	NR	NR
Thionyl Chloride	LR	NR	NR	NR
Tincture of Iodine (alc.)	ND	ND	LR	ND
Toluene	NR	NR	NR	NR
Tomato Juice	ND	ND	ND	R
Trichloroethane	NR	NR	ND	NR
Trichloroethylene	NR	NR	NR	NR
Trichloropropane	ND	ND	ND	ND
Tricresylphosphate	NR	LR	ND	LR
Trichloroacetic Acid	ND	ND	LR	LR
Triethanolamine	R	R	NR	NR
Triethylamine	ND	ND	ND	NR
Trilon B (10%)	ND	ND	ND	ND
Trisodium Phosphate	ND	ND	ND	R
Turbine Oil	NR	NR	ND	R

Chemical	Drain Gasket	Condenser Gasket	Overlay Label	Drain Valve
Turpentine	NR	NR	NR	NR
Urea Aqueous	ND	ND	R	R
Urine	ND	ND	ND	R
Varnish	NR	NR	ND	R
Vaseline	ND	ND	R	ND
Vegetable Oil	LR	LR	ND	R
Vinegar	ND	R	ND	R
Wax, Molten	ND	ND	R	ND
Whey	ND	ND	ND	ND
Wine, Brandy	ND	ND	R	ND
Xylene	NR	NR	NR	NR
Yeast	ND	ND	ND	ND
Zinc Chloride (10%)	ND	ND	LR	R
Zinc Hydrosulfite	ND	ND	ND	ND
Zinc Sulfate	R	R	ND	R

CODES

R = Resistant

LR = Limited Resistant

NR = Not Recommended

ND = No Data

AdVantage Pro Top

The following table may be used as a general guide to HDPE chemical resistances.

Chemical	Concentration	Resistance Level (20 °C / 68 °F)
Acetaldehyde	-	R
Acetic Acid	10%	R
Acetic Acid	glac./anh.	R
Acetic Anhydride	-	R
Acetone	-	R
Other Ketones	-	R
Acetonitrile	-	R
Acetylene	-	R
Acid Fumes	-	R
Alcohols	-	R
Aliphatic Esters	-	R
Alkyl Chlorides	-	R
Alum	-	R
Aluminium Chloride	-	R
Aluminium Sulphate	-	R
Ammonia, Anhydrous	-	R
Ammonia, Aqueous	-	R
Ammonium Chloride	-	R
Amyl Acetate	-	R
Aniline	-	R
Aromatic Solvents	-	R
Ascorbic Acid	-	R
Beer	-	R
Benzaldehyde	-	R
Benzoic Acid	-	R
Boric Acid	-	R
Brines, Saturated	-	R
Bromide (K) Solution	-	R
Butyl Acetate	-	R
Calcium Chloride	-	R
Carbon Disulphide	-	R
Carbonic Acid	-	R
Carbon Tetrachloride	-	NR
Caustic Soda & Potash	-	R
Cellulose Paint	-	R
Chlorates of Na, K, Ba	-	R
Chlorine, dry	-	LR
Chlorine, wet	-	LR
Chlorides of Na, K, Ba	-	R
Chloroacetic Acid	-	R
Chlorobenzene	-	NR
Chloroform	-	NR

Chemical	Concentration	Resistance Level (20 °C / 68 °F)
Chlorosulphonic Acid	-	NR
Chromic Acid	80%	R
Citric Acid	-	R
Copper Salts	most	R
Cresylic Acids	50%	R
Cyclohexane	-	NR
Detergents, Synthetic	-	R
Emulsifiers, Concentrated	-	R
Esters	-	ND
Ether	-	R
Fatty Acids	>C6	R
Ferric Chloride	-	R
Ferrous Sulphate	-	R
Fluorinated Refrigerants	-	R
Fluorine, dry	-	NR
Fluorine, wet	-	NR
Fluorosilic Acid	-	R
Formaldehyde	40%	R
Formic Acid	-	R
Fruit Juices	-	R
Gelatine	-	R
Glycerine	-	R
Glycols	-	R
Glycol, Ethylene	-	R
Glycolic Acid	-	R
Hexamethylene Diamine	-	R
Hexamine	-	R
Hydrazine	-	R
Hydrobromic Acid	50%	R
Hydrochloric Acid	10%	R
Hydrochloric Acid	conc.	R
Hydrocyanic Acid	-	R
Hydrofluoric Acid	40%	R
Hydrofluoric Acid	75%	R
Hydrogen Peroxide	30%	R
Hydrogen Peroxide	30 - 90%	R
Hydrogen Sulphide	-	R
Hypochlorites	-	R
Hypochlorites	Na 12 - 14%	R
Iso-Butyl-Acetate	-	ND
Lactic Acid	90%	R
Lead Acetate	-	R
Lead Perchlorate	-	ND
Lime (CaO)	-	R
Maleic Acid	-	R

Chemical	Concentration	Resistance Level (20 °C / 68 °F)
Manganate, Potassium (K)	-	R
Meat juices	-	R
Mercuric Chloride	-	R
Mercury	-	R
Methanol	-	R
Methylene Chloride	-	LR
Milk Products	-	R
Moist Air	-	R
Molasses	-	R
Monoethanolamine	-	ND
Naptha	-	NR
Napthalene	-	R
Nickel salts	-	R
Nitrates of Na, K and NH3	-	R
Nitric Acid	<25%	R
Nitric Acid	50%	R
Nitric Acid	90%	NR
Nitric Acid (fuming)	-	NR
Nitrite	Na	R
Nitrobenzene	-	NR
Oils, Diesel	-	R
Oils, Essential	-	R
Oils, Lubricating + Aromatic Additives	-	R
Oils, Mineral	-	R
Oils, Vegetable and Animal	-	R
Oxalic Acid	-	R
Ozone	-	R
Paraffin Wax	-	R
Perchloric Acid	-	R
Petroleum Spirits	-	R
Phenol	-	R
Phosphoric Acid	20%	R
Phosphoric Acid	50%	R
Phosphoric Acid	95%	R
Phosphorous Chlorides	-	NR
Phosphorous Pentoxide	-	R
Phthalic Acid	-	R
Picric Acid	-	R
Pyridine	-	R
Salicyl Aldehyde	-	R
Sea Water	-	R
Silicic Acid	-	R
Silicone Fluids	-	R
Silver Nitrate	-	R
Sodium Carbonate	-	R

Chemical	Concentration	Resistance Level (20 °C / 68 °F)
Sodium Peroxide	-	R
Sodium Silicate	-	R
Sodium Sulphide	-	R
Stannic Chloride	-	R
Starch	-	R
Sugar, Syrups & Jams	-	R
Sulphamic acid	-	ND
Sulphates (Na, K, Mg, Ca)	-	R
Sulphites	-	R
Sulphonic Acids	-	ND
Sulphur	-	R
Sulphur Dioxide, dry	-	R
Sulphur Dioxide, wet	-	R
Sulphur Dioxide	96%	R
Sulphur Trioxide	-	NR
Sulphuric Acid	<50%	R
Sulphuric Acid	70%	R
Sulphuric Acid	95%	R
Sulphuric Acid, Fuming	-	R
Sulphur Chlorides	-	ND
Tallow	-	R
Tannic Acid	10%	R
Tartaric Acid	-	R
Trichlorethylene	-	R
Urea	30%	R
Vinegar	-	R
Water, Distilled.	-	R
Water, Soft	-	R
Water, Hard	-	R
Wetting Agents	<5%	R
Yeast	-	R
Zinc Chloride	-	R

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Protective Cover for Intellitronics™ Controller

The following table may be used as a general guide to chemical resistances.

Chemical	Chemical	Chemical	Chemical
Acetone	40% NaOH	Top Job1	Ketchup
MEK	Concentrated HCl	Fantastik2	Tea
Toluene	Gasoline (Regular)	Formula 4093	Tomato Juice
Methylene Chloride	Gasoline (Unleaded)	Windex w/Ammonia D4	Lemon Juice
Isopropyl Alcohol	Butyl Cellosolve	Wisk5	Grape Juice
Cyclohexanone	Mustard	Downy1	Vinegar
Ethyl Acetate	Coffee	Spray 'N Wash2	Milk
Xylene	Mr. Clean1	Clorox3	Vinegar

SP Scientific

3538 Main Street
Stone Ridge, NY 12484 USA

(800) 251-1531
(845) 687-0071

935 Mearns Road
Warminster, PA 18974 USA

(800) 523-2327
(215) 672-7800

815 State Route 208
Gardiner, NY 12525 USA

(800) 431-8232
(845) 255-5000

The Sovereign Centre,
Farthing Road,
Ipswich IP1 5AP UK

+44 (0)1473 240000

www.SPScientific.com