

Resolute® AutoPak

Automated chromatography
columns for pilot and
process scale

Features and Benefits

The Resolute® AutoPak column range offers a unique combination of active multi-axis piston control, precision linear actuation and fully automated operation that delivers the following benefits to the end-user:

- Fully automated, reliable, efficient packing
- Reduced operator activity and human error
- Safe, clean, quiet operation
- Reduction of additional equipment and cleanroom size
- Configurable to suit a wide range of processes



Product Information

Resolute® AutoPak columns are designed for large scale pilot and production use. They are available from 350 mm to 2000 mm internal diameter (ID), in all common sizes. The columns utilize the proven Resolute® wetted flowpath providing low pressure drop and high-resolution chromatography over a wide range of normal operating flow rates. Typical flow rate ranges are from 30 to 800 cm/h.

Overview

Patented pack-in-place nozzles are used, with identical remote controlled three position nozzles at the top and bottom of the column. This technology allows packing and unpacking without opening the column.

Resolute® AutoPak include Resolute® AutoPak software enabling fully automated packing, unpacking, and cleaning-in-place (CIP) of the column at the touch of a button. This removes the need for a packing skid. The column valves and piston can also be controlled manually, meaning that traditional fixed or variable geometry pack in place methods can still be performed if required.

A range of material options and accessories is available to configure Resolute® AutoPak columns to your requirements. A standard Resolute® AutoPak is configured with the Resolute® AutoPak system, 20 µm polyethylene sinters, an acrylic tube, 3 barg operating pressure and 50 – 650 mm packed bed height capability.

Multi-Axis Control

Precision adjustment and dynamic piston leveling are delivered by three linear actuators. The software actively monitors the position of each actuator to ensure that the piston is kept level during adjustment. This provides a distinct advantage over centrally mounted single actuator designs, where the piston is held level solely by passive seal action and design stiffness.

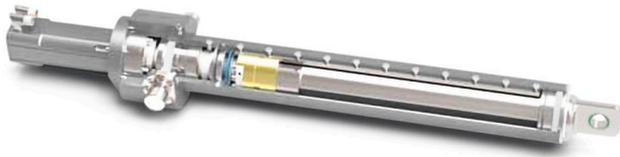


Figure 1: Cut Through of a Linear Actuator

Software and Control System

Resolute® AutoPak columns are controlled using a handheld touch screen remote control, from which the operator can initiate all functions including fully automated packing, unpacking, CIP, manual control, and hoist-free maintenance. The remote control can be used on several Resolute® AutoPak columns.

The software is purpose-coded for the remote control and is designed to be intuitive. All operator actions and commands are within four clicks of the home screen, making navigation and operation quick and simple.

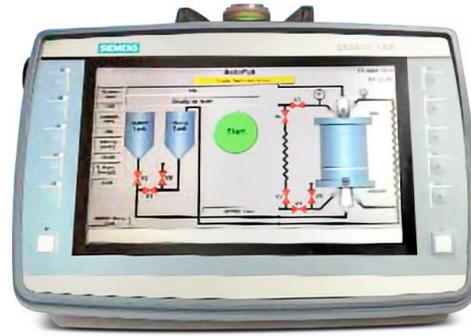


Figure 2: Resolute® AutoPak Remote Control

Resolute® AutoPak Features and Benefits

Feature	Benefit
Active multi-axis levelling control of piston, delivering class leading stability	Fully scalable column design, reduced risk of column damage over single axis designs
Electric control unit and linear actuators	Small footprint, no cooling liquid required, no risk of oil leakage
In-built maintenance, enabling consumable change out from ground level	Safe operator environment, small cleanroom footprint, no need for lifting equipment
Intuitive software	Easier operator training, reduced risk of operator error

**Resolute® AutoPak Software:
Let the Column Do the Packing**

The Resolute® AutoPak system was developed in direct response to an industry need for fully automated operations. Often key column preparation operations, particularly packing, are regarded as high risk clean room events.

These risks include human error, packing failure, and absence of experienced operators; they can result in plant downtime, loss of product or sorbent and inefficient use of resources. By adopting a fully automated approach, the Resolute® AutoPak system greatly simplifies operation, effectively eliminates operator error and reduces the burden on key operators. The automated sequences assure that reproducible and consistent operation is the norm.

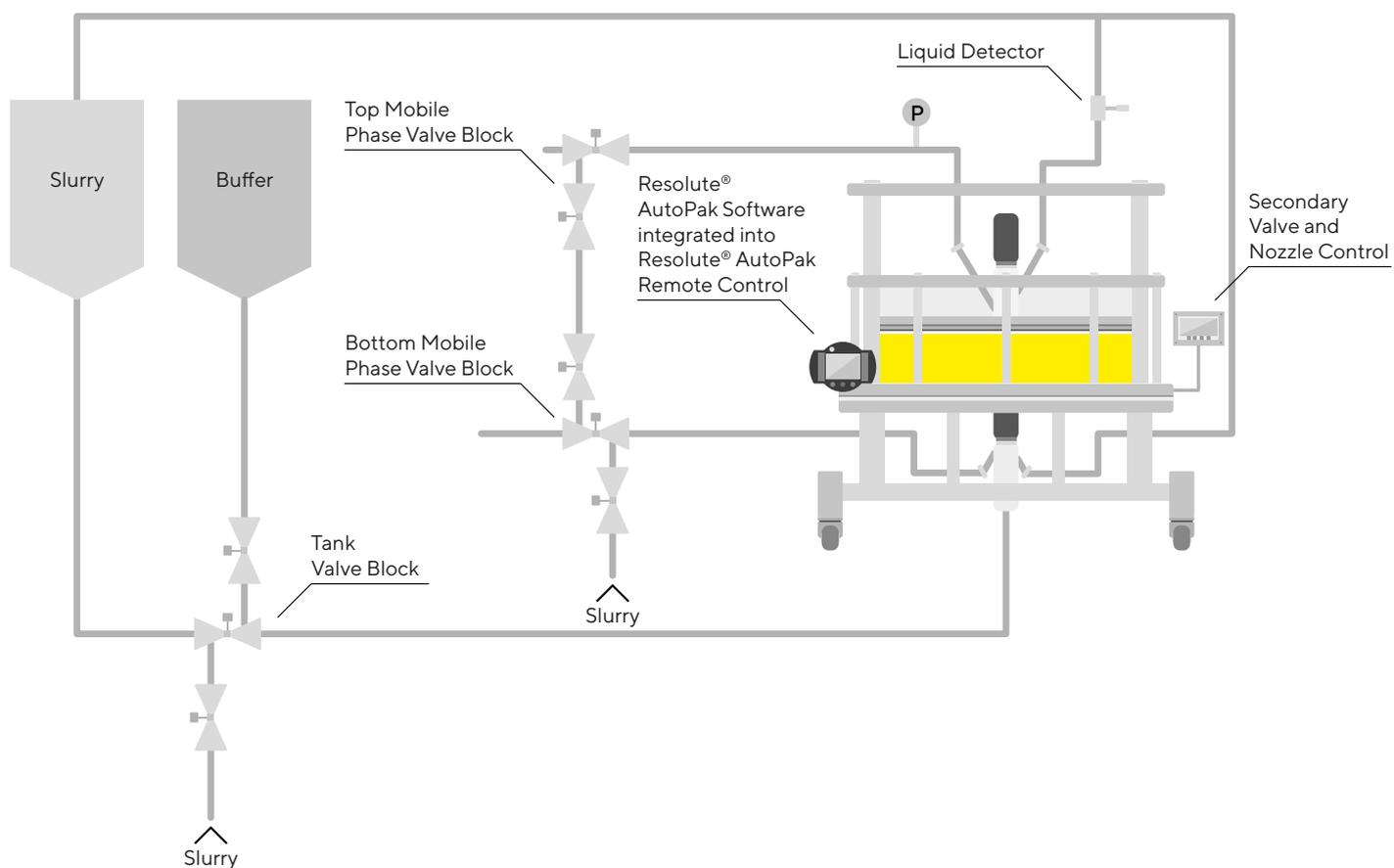


Figure 3: Typical Configuration of a Resolute® AutoPak Column With Integrated Resolute® AutoPak Software

The schematic above shows the scope of the Resolute® AutoPak system. The top and bottom mobile phase blocks are dual-function; they are used for Resolute® AutoPak sequences and for running the chromatography process.

Resolute® AutoPak System Features and Benefits

Feature	Benefit
Fully automated packing, unpacking, and CIP	Reproducible results. Reduced time for column packing. Less reliance on skilled operators.
Fully automated re-packing	No need to open the column or use slurry tank to re-pack. No recalculation of slurry concentration. Efficient use of buffers.
Greatly simplified operator interaction	Risk of operator error reduced. Fewer operators required.
Ability to use all the sorbent in the tank	Reduction in media costs. An empty slurry tank after packing enables faster slurry tank cleaning, storage, or re-use elsewhere.
Simplified pipework compared to pump pack methods	Quicker, error free set-up.
Multiple fully configurable packing methods	Easy to adjust to changing plant requirements. Ability to pack a wide range of sorbents.
Ability to save packing parameters as recipes	Easy to transfer recipes between columns on different sites. Faster, lower risk validation for new sites.
Column-mounted secondary valve & nozzle control	The system valves can be adjusted whilst the handheld remote control is being used on other columns.

Resolute® AutoPak System Sequences

The fully automated system includes four main sequences as standard. Each sequence has configurable parameters so that it can be adapted to a variety of requirements.

Sequence	Description
Auto Pack	At the touch of a button, valves, nozzles, and piston movement are coordinated to draw slurry into the column and achieve a robust packed bed.
Auto Re-Pack	At the touch of a button, a packed bed is re-agitated using process air, buffer is added, and the bed is re-packed without the need for an external slurry tank. Buffer consumption is minimal.
Auto Unpack	At the touch of a button, the bed is re-agitated and slurry is expelled back to the slurry tank. Media is fully rinsed from the column with the option of an additional rinse.
Auto CIP (empty column)	In the first automated step, cleaning liquid is drawn into the column using piston movement and routed through all possible flow paths before being drained. The operator then connects the Resolute® AutoPak system tank valve to a neutralizing tank. The second automated step rinses all of the wetted surfaces and neutralizes the column. An additional rinse is optional. Cleaning and neutralization can be accomplished in as little as 2 column volumes.

Maintenance Mode

All Resolute® AutoPak columns have a patented maintenance function inbuilt, allowing access to major consumable spare parts from ground level, without the need for an external crane or hoist.

The maintenance function provides:

- Assured operator safety
- A smaller footprint than side-swinging designs, improving cleanroom space-efficiency

Entry into maintenance mode is made through easily followed instructions on the handheld remote control. The column is disassembled using the linear actuators without increasing the column footprint.

Maintenance schedules are advised in the operating manuals. A list of key consumables is provided on page 9.



Figure 4: Resolute® AutoPak

Column Configuration Options

Resolute® AutoPak columns are configurable to suit your process. A range of options exists for columns and pipework kits to give flexibility in process design (options quoted on request).

Column Tube Options

Column tubes are offered in acrylic (PMMA) as standard. Stainless steel options are available upon request, see wetted pathway options below.

Wetted Pathway Options

Different grades of stainless steel can be applied to column tubes, bed supports, nozzle tubes and pipework kits. As standard, columns are supplied with stainless steel 1.4404 components*.

- Stainless Steel 1.4404, 316L
- Stainless Steel 1.4435, 316L (Not available for meshes)
- Stainless Steel 1.4539, 904L
- Stainless Steel C22, Hastelloy

Increasing chloride resistance

*Stainless Steel options quoted on request.

Bed Support Options

Bed supports are available in 10 µm and 20 µm pore sizes. The mesh should be selected based on the sorbent average particle size; generally, a bed support size <2 of the average particle size is sufficient to prevent particle flow through. For example, for a 90 µm sorbent, 20 µm bed supports would be specified, for a 34 µm media 10 µm bed supports would be specified.

Note that the difference between a 10 and 20 µm bed support pore size makes a negligible difference in overall column pressure drop.

Bed supports can be made from stainless steel mesh (1.4404 or 1.4539) or polyethylene sinter.

Pressure Vessel Codes

Resolute® AutoPak columns are designed to PD5500 and are CE-marked as standard. Other design codes such as ASME or AD Merkblätter can be quoted on request.

Engineered Solutions

Sartorius offers engineered solutions such as columns with different pressure vessel design codes, components made from novel materials, jacketed column tubes, and integration with Distributed Control Systems (DCS). Your sales representative will work with you to specify an engineered solution and provide a quotation.

Core Accessories

In order to enable fully automated packing, unpacking, and CIP, an additional set of accessories is required. The remote control, tank valve block, and drive station are transferable between columns, meaning that only one of each needs to be purchased for a suite of columns.

If more than one column needs to be packed, unpacked or cleaned at the same time, then additional core accessories should be purchased.

Remote Control

The remote control is the master controller for Resolute® AutoPak columns and allows the full scope of operations to be initiated and monitored.

Integrated into the remote control is an operator presence switch, disabling automated sequences unless the operator is present and holding the remote control. If required, this function can be bypassed using an automation key.

At least one remote control must be purchased for each set of columns. If packing, unpacking or CIP is to take place simultaneously on more than one column, then additional remote control(s) should be purchased as required.



Figure 5: The Resolute® AutoPak Remote Control Showing Automation Key

Resolute® AutoPak System Tank Valve

The Resolute® AutoPak system tank valve provides the ability to switch between buffer and slurry while controlling the agitation in the tank. Included with the column is the valve, mounting, hoses to connect to the column tanks and associated clamps and EPDM gaskets. As standard, pipework and GEMU block valve are included in stainless steel (1.4404, 316L). If an alternative stainless steel is selected then the material change must be stated at the point of order.

At least one Resolute® AutoPak system tank valve must be purchased for each set of Resolute® AutoPak columns. If packing, unpacking or CIP is to take place simultaneously on more than one column, then additional valves should be purchased as necessary.



Figure 6: *Resolute® Autopak System Tank Valve Showing Electro-Pneumatic Actuators With Position Feedback*

Resolute® Linear Drive Station

The Resolute® linear drive station supplies the power and drive control for the three linear actuators.

One drive station can operate all columns sizes, therefore, only one drive station is required for each set of columns. If packing, unpacking or CIP is to take place simultaneously on more than one column, then additional drive stations are required as necessary. The drive station is not required when the column is in process mode.

The drive station enclosure is stainless steel, suitable for wipe-down, and for use in a cleanroom. The cabinet is rated to the requirements IP65.

The drive station is a discrete unit that occupies minimal floor space and requires only an electrical supply to operate. The drive station is supplied CE-marked, and UL listed certification.



Figure 7: *Resolute® Linear Drive Station*

Core Accessories Ordering Information

Part Number	Description	Columns Applicable
LD-HMI	Resolute® AutoPak remote control	All columns
TVB-1	Resolute® AutoPak tank valve	<800 mm ID
TVB-2	Resolute® AutoPak tank valve	≥800 mm ID
EPU	Resolute® Linear drive station	All columns

Other Accessories

Several other accessories are available to augment the Resolute® AutoPak column range and enable further safe, reliable working practices. To request the full range of additional equipment please contact your local representative, or visit our website for more information.

Column Handling

A range of column handling products are available to facilitate movement of complete columns and components. The MasterMover®* electric tug can move columns on castors or custom skates. For larger columns, an air-cushion-pallet transporter can be supplied which uses a hovercraft-like action to safely move heavy equipment. We also supply a bed support transporter which aids the transport and cleaning of large diameter bed supports which can be difficult to handle safely.

* MasterMover is a registered trademark of M-Mover Holdings Ltd.

Column Mounted Valve Control

The touch screen device is fitted permanently to the column, and allows the process valving and nozzles to be controlled when the remote control unit is not connected. This permits the remote control unit to be used with other columns.

This option should be obtained when multiple columns are purchased and only one column is packed at a time.



Figure 7: Resolute® Linear Drive Station

Resolute® Slurry Tanks

Resolute® slurry tanks enable the agitation required to enable reliable automated packing. Tanks have a range of features including a conical bottom, mechanical stirrer, sight glass, manual access port, and associated air filtration and valves required to maintain a closed system during operation. Tanks can be stainless steel or polypropylene and are available upon request with features to suit your process.

Technical Data

Weights and Dimensions

The table below provides indicative dimensions and weights for the standard range. For additional diameters and bed heights, please contact your representative for an engineered solution.

Description	Weight Empty	Footprint Smallest Dimension Not Including Valves		Heights (mm)		
		Length	Depth	At Minimum Height	At Maximum Bed Height	Maximum Height During Maintenance
Resolute® Linear Drive Station	90 kg	510 mm	600 mm	850 mm	–	–
Resolute® AutoPak Column Size						
400 mm	700 kg	840 mm	1050 mm	2000 mm	2750 mm	2550 mm
600 mm	1030 kg	1010 mm	1060 mm	2000 mm	2750 mm	2510 mm
800 mm	2010 kg	1360 mm	1450 mm	2140 mm	2890 mm	2700 mm
1000 mm	2730 kg	1510 mm	1510 mm	2160 mm	2910 mm	2700 mm
1200 mm	4250 kg	1800 mm	1780 mm	2410 mm	3160 mm	2960 mm

Materials of Construction

The table below lists typical materials of construction. If a material is not compatible with your process, please contact Sartorius for an engineered solution.

Process Wetted Fixed Components	Material
Column tube	Acrylic (PMMA) as standard stainless steel* on request
Distribution cell	Polypropylene
Nozzle body	400 – 1000 mm ID column: PVDF 1200 mm ID column: polypropylene (PP)
Mobile phase termination	400 – 1000 mm ID column: PEEK 1200 mm ID column: stainless steel 316L
Slurry nozzle tip	PEEK
Slurry inlet port	Stainless steel 316L*
Main seals	EPDM (peroxide cured) FEP
Nozzle tip seals	FEP encapsulated silicone
Wiper ring	PTFE

All non-wetted materials are suitable for wipe down and clean room use.

* Different grades of stainless steel are available. See wetted pathway options on page 5.

Abbreviations: PMMA = Polymethyl methacrylate, PVDF = Polyvinylidene fluoride, PEEK = Polyetheretherketone, EPDM = Ethylene-propylene-diene monomer (elastomer), FEP = Fluorinated ethylene propylene, PTFE = Polytetrafluoroethylene

Standard Surface Finishes

Stainless steel*	Non-wetted	1.5 µm Ra
	Wetted	0.5 µm Ra
Plastics	Acrylic (PMMA)	Polished smooth
	All others	Not applicable

* Finer surface finishes quoted on request

Operating Temperature

Operating temperature static*	2 to 30 °C
Operating temperature dynamic**	15 to 25 °C

* The static temperature range refers to when the column is in process mode and no piston movement will take place

** The dynamic temperature range indicates the acceptable temperature range when the column piston is moving

Recommended Spare Parts

The following spare parts are recommended to support the column during its lifetime. For additional information, please contact your representative.

Recommended Spare Part	Description
Major seal kit	Replacement adjuster seals and fixed end pressure retaining seal
Snap ring	Replacement ring for attaching adjuster bed support
Wiper ring	Replacement adjuster wiper ring
Adjuster end bed support	Spare bed support for adjuster end (PE sinter or steel mesh)
Fixed end bed support	Spare bed support for fixed end (PE sinter or steel mesh)
Intermediate fixing screw kit	Set of screws for bed support security (larger columns only)
Nozzle tip kit	Spare nozzle tip compatible with either top or bottom nozzle
Nozzle valve seal kit	Replacement seals for pack-in-place nozzle valves

Certification and Technical Construction File

Resolute® AutoPak columns are designed to meet CE marking requirements using PD5500 design code. Other certifications and standards can be quoted on request, including ASME, AD Merkblätter, and UL listing.

All columns and accessories come with a full technical documentation file. Examples are available on request. Additional documentation requirements can be quoted on request. The hard copy of the Resolute AutoPak software validation documentation is available to review on Sartorius premises if required.

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