## **Product Bulletin**



#### Waters Automated Valve Station

Waters Automated Valve Station increases the versatility and output of your HPLC by enabling it to do unattended, on-line sample cleanup and other techniques based on automated switching of columns and solvents. Waters Automated Valve Station (WAVS) automates many of the repetitive pre- and postchromatographic sample preparation operations that are often too tedious or unreliable when done manually. WAVS can be used to automate the following procedures: on-line sample cleanup trace enrichment methods switching column flushout and equilibration sequential analytical separations small-scale staged preparative separations

## WAVS is easy to set up and operate

WAVS eliminates the complexity and inconvenience often associated with valve switching. WAVS is selfcontained, lightweight, compact, and easy-to-install. It occupies very little bench space. All internal plumbing and electrical circuitry is factory-installed. WAVS can be easily set up and produce results the day it arrives. Handy reference cards make it easy to operate in a variety of useful and productive configurations.

## Sample cleanup is necessary - manual sample cleanup is not

WAVS makes it much faster to prepare and clean samples by solid phase extraction. WAVS column and solvent switching valves automate the sample loading and selective elution of samples. By eliminating the errors inherent with manual handling and transferring of samples, WAVS improves the reliability and reproducibility of your HPLC results.

## WAVS cuts combined sample preparation and analysis time

WAVS is capable of automatically loading and fractionating a sample on a precolumn while simultaneously analyzing the preceding sample on the HPLC analytical column. Analysis time stays the same, and you save time involved in preparing samples by hand.



## A versatile convenient module

## One setup - multiple capabilities

By incorporating a Waters Automated Valve Station (WAVS) in a standard HPLC system and adding an auxiliary pump, it is possible to automate three different procedures with the same high pressure tubing connections. The differences between procedures are in the type of precolumn used and in the way samples are introduced into the system.

WAVS consists of two six-port, high-pressure column switching valves, three three-way solvent select valves, an internal 12-volt power supply for valve switching actuation, and a switched AC outlet. All valves and the external AC outlet can be controlled by any Waters HPLC controller\* or any commercially available controller with the equivalent of six switch closures. Waters 590 Programmable Solvent Delivery Module will also control WAVS. Together, the 590 and WAVS are a powerful combination. For example the 590 can control an auxiliary pump and WAVS column switching and solvent select valves while it delivers analytical solvent through the analytical column.

WAVS can also be operated manually from the front panel. Front panel switches allow you to manually switch valve positions at timed intervals to verify the sequence of

#### Figure 1 One setup - multiple capabilities

timed events before going to automatic control. The front panel indicator lights show exactly what step in the procedure is being performed.

For maximum productivity, a two pump setup is recommended. The auxiliary pump loads the sample onto the precolumn while the analytical pump simultaneously analyzes the preceding sample on the analytical column. In this setup, the auxiliary pump does not need to provide the same flow precision as the analytical pump since it is only loading the sample on the precolumn.

If your analytical workload is light, a single pump can be used with WAVS to alternately load the sample onto the precolumn and then elute it onto the analytical column to perform the analysis.

\*including Waters 680, 720, 721 and 840 controllers



Procedure	Function	Typical use	Precolumn	Sample source
On-line cleanup	Remove interferences	Metabolism and pharmacokinetic studies	Guard-PAK <sup>**</sup> Cartridges or Precolumns	Autoinjector, e.g. WISP™
Trace enrichment	Concentrate trace amounts	Environmental monitoring - organics in water	Guard-PAK Cartridges or Precolumns	WAVS Solvent Valve Switching/Direct feed of large volumes via auxiliary pump - bypass or omit autoinjector
Sequential analysis	Size separation followed by a second LC mode to further resolve a specific size cut	Determining additives in polymers or pesticide residues in crops	GPC column	Autoinjector, e.g. WISP

### **On-line cleanup**

Beginning with the column and solvent valve connections in Figure 2.1, it is possible to follow a typical on-line cleanup sequence. Actual flow rates, times, and solvent (mobile phase) compositions will be specific for each application.

<b>Stage</b> Figure 2.1 Equilibrate Figure 2.1 Load	<b>Operation</b> Bring precolumn and analytical column to steady state. They are in separate flow paths and are not connected. Inject sample and collect on precolumn
Figure 2.2 Purge (Optional) Figure 2.3 Elute	Wash interferences to waste - retain sample on precolumn Connect precolumn to analytical column and pass sample from precolumn to analytical column.
Figure 2.4 Analysis Figure 2.4 Wash (Optional)	Sample is separated on the HPLC column. Precolumn is recon- nected to auxiliary pump circuit. Flushing of system and re-equlibration of pre- column can be done while analysis is in progress.



Auxilia Pump

Auto

Injecto

Solve

Analytical

Solve

Analytic: Pump





Figure 2.3 Elute











### Automatic trace enrichment

For measuring trace amounts of compounds found in water, chromatographers employ a technique in which large quantities of the water (typically two to 50 ml or more) containing the compound are pumped through a precolumn chosen for its ability to retain these trace organics. After a detectable amount is concentrated on the precolumn, WAVS switches to a stronger solvent which elutes the trace material off the precolumn in a concentrated band onto the analytical column for analysis.

The tubing connections of the low pressure solvent select valves, desinated SSV1, SSV2, and SSV3, are indicated in Figure 3. In this case,

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three samples are shown along with a solvent. If required, the solvent flushes out the lines between sample runs. Otherwise a fourth sample can be substituted for the solvent. When the sample has been sufficiently enriched on the precolumn, WAVS automatically connects the precolumn to the analytical column. The analytical pump elutes the sample from the precolumn onto the analytical column.

# Basic approach to WAVS method set up

Waters Automated Valve Station is a tool designed to expedite your work. It is used by following a sound systematic chromatographic approach. As with any chromatographic procedure, the chemistry and system characteristics should be kept in mind. Any information already known about the sample, such as manual SEP-PAK<sup>TM</sup> cleanup procedures, can be used profitably.

#### The basic steps include: developing the analytical separation, Figure 4.1

□ developing the precolumn (Guard-PAK<sup>™</sup> cartridge or guard column) procedure for retention and elution of the components, Figures 4.2a and b

□ determining the timing of events to combine the two procedures, see Figure 4.3 and setup time line

The following chromatograms illustrate the procedure for isolating tricyclic anti-depressants from serum.



## Setup time line

Preco	blumn	1. Load and purge	2. Elute	3. Wash 100% CH3CN	5. Re-equilibrate	100% H <sub>2</sub> O	Next Sample - 1. load and purge
Anal colur	ytical nn	Complete prior sample	Elute	4. Analysis		-;	6. Ready
Elaps time,	sed ( minutes	) 2.0	3	9.2 9	.2	15	.2 17.
1. 2. 3.	Sample loc umn for two At two mini- switched in (acetonitrile mobile pho onto analy At 3.2 minu- switched or	ided onto precol- o minutes in water. utes precolumn to analytical flow e/triethylamine use) to elute sample tical column. utes, precolumn is ut of analytical flow.	4. 5.	Analytical separation beg while solvent flow to prece lumn is switched to 100% acetonitrile. After six minutes, the solve flow to the precolumn is switched back to water for equilibration of precolumn flow programming may be	ins 6. D- nt re-	Regenerc and load onto prec as analyt ishes: And ready for	ation of precolumn ling of next sample column is completed ical separation fin- alytical column is next sample.

useful for washing and re-equilibration.

# Transfer from manual to automated sample cleanup

Analysts have long recognized that sample preparation is often essential for reliable results. SEP-PAK cartridges have become a valued tool for:

- □ removing interferences
- D prolonging column life
- □ increasing detectability of trace level components

The sequence of operations done manually with SEP-PAK cartridges can be conveniently automated with WAVS, Figure 5.1 through 5.3. In addition, consolidating the final elution and injection steps improves reliability by eliminating the possibility of a transfer loss.

#### Figure 5.1



#### Figure 5.2 SEP-PAK Procedure WAVS On-Line Procedure Intermediate $\bigcirc$ Solveni INTERMEDIATE Selective Pump SOLVENT Elution Pump and Autoinjector Sep-PAK Cartridge Pre-000 Column Waste Analytical Column Figure 5.3 **SEP-PAK Procedure** WAVS On-Line Procedure Elute and $\odot$ Inject Sample Pump ELUTE Pump and Strong Solvent Autoiniector SEP-PAK Cartridge Pre-Colum Waste

# Add cleanup capability to your HPLC - maintain output

There are a number of approaches to increasing total system output when the WAVS is used with two solvent delivery systems. As shown in Figure 6, one pump can elute the sample from the precolumn onto the analytical column while the other pump is loading the next sam-

### Figure 6 WAVS two pump set up



ple onto the precolumn and selectively eluting off interferences to waste.

INJECT

Establish Volume and Inject

By using the two pump setup, online cleanup is accomplished automatically with no increase in time between analysis or actual analysis times when sample loading and cleanup times are comparable to the HPLC analysis cycle. Since WAVS contains two six-port column switching valves, it is also possible to use a dual pre-column setup. This doubles the number of samples which can be processed prior to precolumn maintenance or replacement.

Analytical

Column

### Figure 7 WAVS dual column set up



Operating	specifications
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Power requirements	100/120/220/240 VAC +/- 10%, 47-63 HZ	· · · · · · · · · · · · · · · · · · ·
Utilities	Air or nitrogen, 35-100 psi (2.5 to 6.5 atm)	Rdd
Dimensions	Width 11 in. (28 cm) Height 9 in. (23 cm) Depth 13 in. (33 cm)	
Weight	18.7 lbs (8.5 kg)	
Operating temperatur	e 10° to 40°C	
Low pressure valves	All Teflon® fluid path 60 µl internal volume 8 ms response	
High pressure valves	316 s.s. and inert polymer fluid path 5000 psi (350 atm) operation. Can be adjusted to 7000 psi (475 atm)	
Order information	Waters Automated Valve Station	35000
	Interconnect cables for: Waters 590 Programmable Solvent Delivery System Waters 680 Controller Waters 720 Controller Waters 721 Controller Waters 840 Data Station	35029 35029 35029 35029 35029 35028/ 36029
	Waters Guard-PAK Pre- column Module	80040
	Package of 10 Guard-PAK Si Inserts	85824
	Package of 10 Guard-PAK CN Inserts.	85825
	Package of 10	85826

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