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A column-selection valve connects two or more HPLC columns to a liquid chromatograph. This article describes several ways to use HPLC column selection valves for the selection of 2, 4, 6, 8, or 12 HPLC columns.

## INTRODUCTION

The great versatility of HPLC and the high cost of liquid chromatographs have made it necessary to use a number of HPLC columns on the same liquid chromatograph. This means that each time an analytical chemist wants a different HPLC column on a particular liquid chromatograph, the instrument has to be shut down and one column exchanged for another. This takes instrument time, and the tubing fittings or columns often leak from repeated changing. We have found that an HPLC column selection valve can be used to give rapid access to several columns connected to a liquid chromatograph. Any column selection system adds extracolumn volume to the chromatographic system. Attention must be paid to keeping the extracolumn volume of the selector valve and the connecting tubing as small as possible. This extracolumn volume will cause HPLC peaks to be broadened, but not significantly if the system is carefully prepared. The column selection valves mentioned in this article are made of Nitronic 60 stainless steel with Valcon "H" fluorocarbon polymer blend rotors. For corrosive situations, valve bodies can be made of Hastelloy C or tantalum. All valves are available with electric/electronic actuators or air-driven actuators (Valco, Houston, Texas). These actuators can be easily interfaced to most laboratory data systems, and this combined system can be used for automated HPLC column selection.

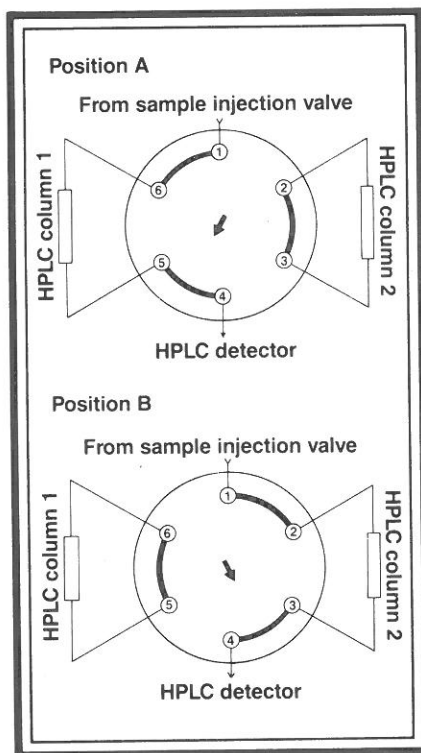


FIGURE 1: The selection of two HPLC columns using a 6-port valve.

## RESULTS AND DISCUSSION

**Column selection using two-position HPLC valves:** Two HPLC columns can be selected using a 6-port valve, as shown in Figure 1. The Valco C6W valve is the best 6-port valve for column selection because this valve has the smallest internal volume of any 6-port HPLC valve presently on the market. Each valve port has a volume of 0.15  $\mu$ l, and each slot has a 0.5- $\mu$ l volume. The C6W adds 1.6  $\mu$ l extracolumn volume to the chromatographic system in Figure 1

(this does not include the connecting tubing volume). When the valve is in position A, column 1 is connected to an external injection valve and the HPLC detector. Column 2 is dead-ended at the column selector valve. When the column selector valve is moved to position B, column 2 can be used for analysis.

By using the system shown in Figure 2, it is possible to lower the extracolumn volume of the 2-column selector to 0.9  $\mu$ l. This volume includes the valve and manifold but not the interconnecting tubing. Since the HPLC column exit lines go directly to the T manifold, the interconnecting tubing between the column and the column selection valve/manifold (Figure 2) can be much shorter in the valve/manifold system than in the selector valve system (Figure 1). This lowers the extracolumn volume of the entire system. The T used in Figure 2 has a 0.010-in. i.d. connecting port and contributes 0.1  $\mu$ l volume to the system.

Many liquid chromatographic separations (ion exchange and some gradient elution) require that the HPLC column be regenerated with a second mobile phase before the column can be used again for analysis. This can take a lot of instrument time. With the 10-port column selector shown in Figure 3, column 1 is being used for analysis when the valve is in position A. At the same time, column 2 can be regenerated with a second mobile phase (this requires a second pump). The second mobile phase can be pumped through the second column in either a forward or reversed flow direction. The Valco C10W valve has an internal volume of 1.5  $\mu$ l.

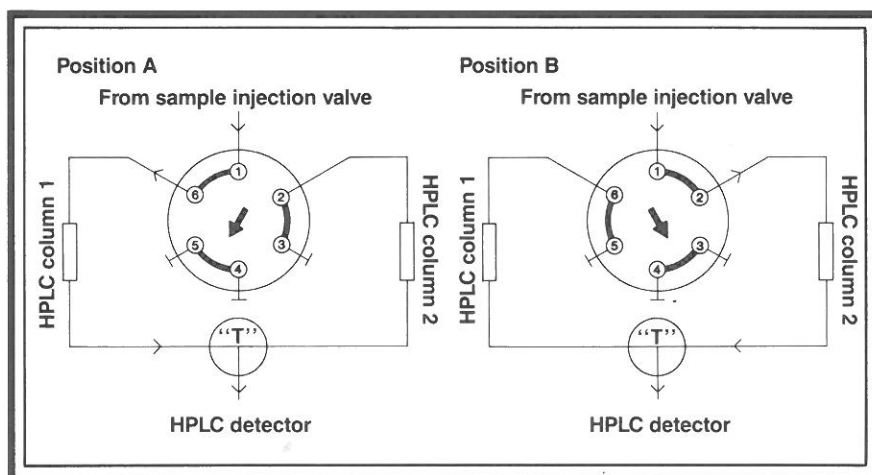


FIGURE 2: The selection of two HPLC columns using a 6-port valve and a T.

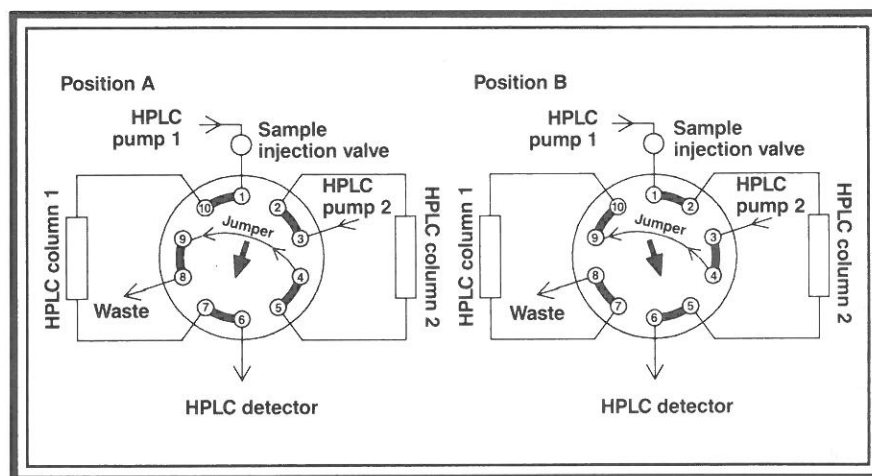


FIGURE 3: The selection and regeneration of two HPLC columns using a 10-port valve.

Figure 4 illustrates a system that provides automated 4-column selection with the ability to regenerate one column with another mobile phase during analysis. A 6-port valve is used to select either of the two 10-port column selection valves and also to direct the second mobile phase to the unused column on the selected 10-port valve. The two W valves and the T contribute 2.5  $\mu$ l extracolumn volume to the system (this does not include the connecting tubing volume). The order of events for 4-column selection and regeneration follows:

- The 6-port valve is put into the A position (Figure 4). The injected sample goes from the external injection valve to the 6-port valve to the 10-port valve B (which is in its A position as shown in Figure 4). The B valve directs the injected sample to HPLC column 1. HPLC column 1 is connected to the T and the HPLC detector. During the analysis, pump 2 sends mobile phase 2 to the 6-port valve. The 6-port valve directs mobile phase 2 to HPLC column 2 mounted on B valve. Mobile phase 2 regenerates column 2 and goes to waste.
- The 10-port B valve is switched to the B position. The 6-port valve stays in the A position. The sample is injected onto column 2, and column 1 is regenerated.
- The 6-port valve is switched to its B position. This directs the injected sample to the 10-port column selection valve C. Valve C is placed in its B position. For analysis, the sample is injected onto column 4. At the same time, column 3 is regenerated.
- The C valve is switched to its A position. The sample is injected onto column 3, and column 4 is regenerated.

#### Column selection using multiposition

**HPLC valves:** Valco Instruments makes four multiposition 5000 psi HPLC valves that can be used for HPLC column selection. The multiposition valve is best moved with an electric or air actuator. Also, since the multiposition valve has several positions, the valve actuator indicates the valve's position. Because of their internal geometry, the multiposition valves have more internal volume ( $\approx 10 \mu\text{l}$ ) than the 6- and 10-port two position column-selector valves mentioned above.

Four columns can be selected using the multiposition valve (CST4U) shown in Figure 5. This multiposition valve has 10 ports. A 6-column selector valve (CST6U) with similar geometry is also available; it has 14 ports.

Figure 6 shows an 8-column multiposition selector/manifold system. The 8-column selector valve (CSD8U) has 9 ports and the manifold (Z8M1) has 9 ports. The HPLC column exits are connected to 8 ports around the circumference of the manifold. These ports have 0.008-in. i.d. holes. The exit port is in the top of the manifold, and it has a 0.029-in. i.d. hole. The advantages of the selector valve/manifold system (Figure 6) over the selector valve system (Figure 5) are: the extracolumn volume is lower because the connecting tubing is shorter; the system is more compact; and a larger number of columns can be selected.

A 150 mm  $\times$  4.6 mm i.d. 5- $\mu\text{m}$  ODSII column was connected to a 2- $\mu\text{l}$  injection valve (EQ4CIW 2) and a Spectra-Physics 8300 fixed wavelength (254 nm) UV detector. Using 65:35 methanol/water as the mobile phase at a 1 ml/min flow rate, a naphthalene HPLC peak ( $k' = 7$ ) had 71,000 plates/meter efficiency. When the same column was connected to column selector position 1 (Figure 6) with a 2.5-in. (0.010 in. i.d.) tube, the naphthalene peak had 71,000 plates/meter. When the column was moved to column position 8, the naphthalene peak had 67,000 plates/meter. If one does not want to use all of the column positions, a bypass line can be used to go from the selector valve to the manifold, and the selector valve and the manifold can be purged with a solvent. A 12-column selector valve/manifold is also available. This system consists of a 13-port, 12-position 5000 psig HPLC valve (CSD12U) and a 13-port, 12-column manifold (Z12M1). ■

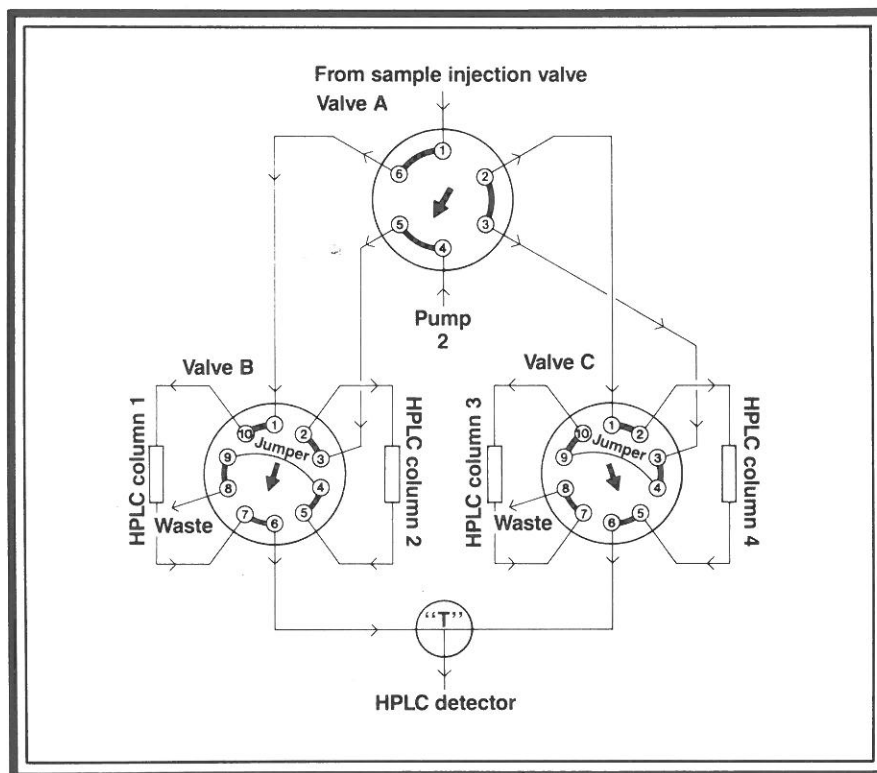


FIGURE 4: The selection and regeneration of four HPLC columns using a 6-port and two 10-port valves.

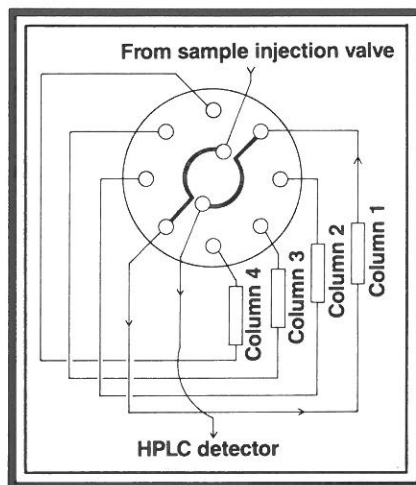


FIGURE 5: The selection of four HPLC columns using a multiposition valve.

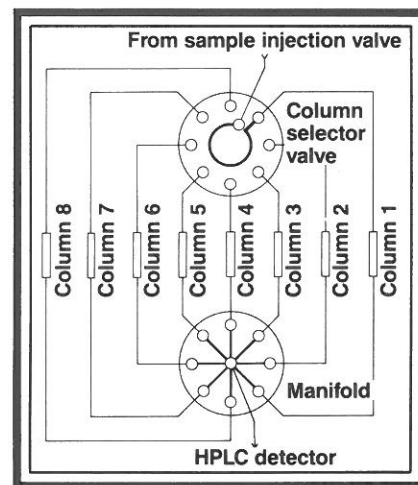


FIGURE 6: The selection of eight HPLC columns using a multiposition valve and a manifold.