

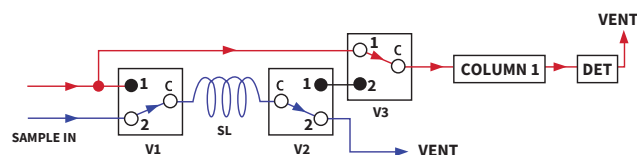
DV SERIES APPLICATIONS IDEAS

Rev. 2.0

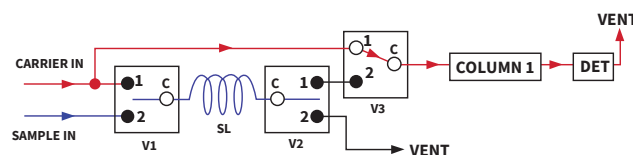
APP. #1

Sample loop injection

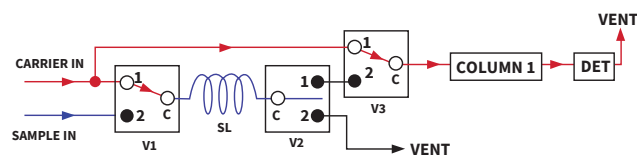
A - Step 1 SAMPLING (NO ACTUATING PRESSURE APPLIED)



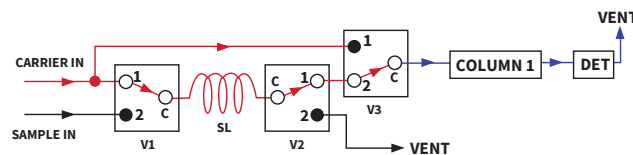
B - Step 2 SAMPLE ISOLATED



C - Step 3 SAMPLE INJECTION INTO A SIMPLE COLUMN CONFIGURATION WITH SAMPLE LOOP PRESSURIZATION TO CARRIER PRESSURE



D - Step 4 PRESSURIZED SAMPLE LOOP INJECTION



NOTE :

The above sample injection is done in 4 steps to avoid flow and pressure variation. This avoids baseline upset upon injection, see also App. #8. If traditional sample injection mode is desired, (i.e. without pressurized the sample loop before injection) only one three way solenoid valve is necessary. The solenoid valve would drive V1 to V3 at the same time.

LEGEND :

R: FLOW RESTRICTOR

C: INDICATE THE COMMON PORT

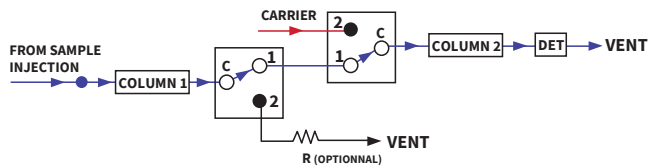
● PORT CLOSED

○ PORT OPEN

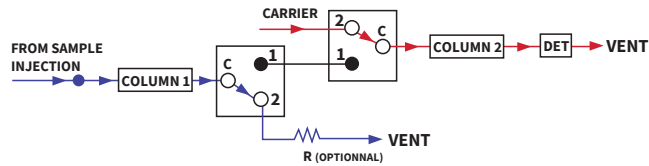
APP. #2

Frontcut, heartcut or endcut of column 1 to column 2 or vent

A - COLUMN 1 TO COLUMN 2 AND DETECTOR



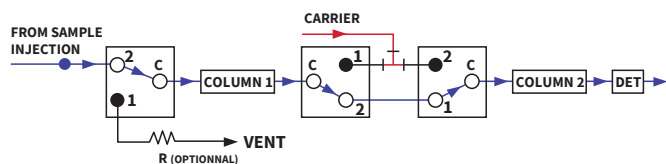
B - COLUMN 1 SENT TO VENT



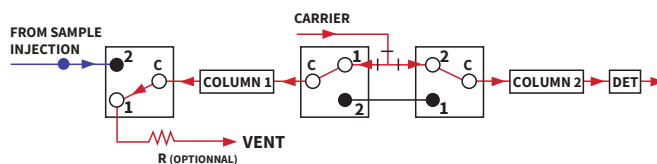
APP. #3

Backflush of column 1 to vent

A - FRONT OF COLUMN 1 TO COLUMN 2 AND DETECTOR



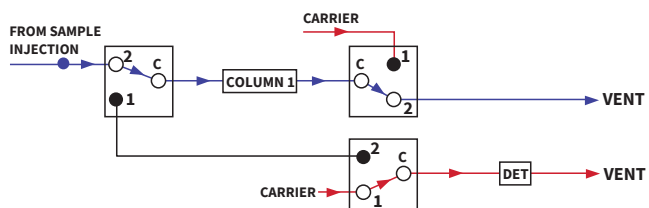
B - COLUMN 1 BACKFLUSHED TO VENT, COLUMN 2 TO THE DETECTOR



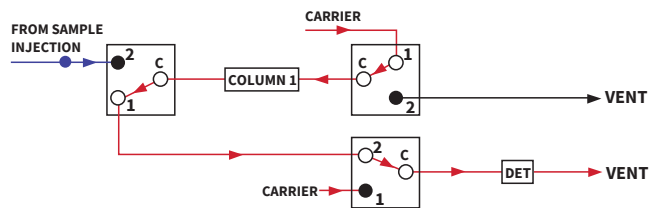
APP. #4

Backflush of column 1 to detector

A - COLUMN 1 TO VENT



B - BACKFLUSH OF COLUMN 1 TO THE DETECTOR



LEGEND :

R: FLOW RESTRICTOR

C: INDICATE THE COMMON PORT

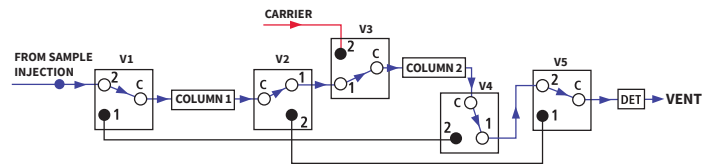
● PORT CLOSED

○ PORT OPEN

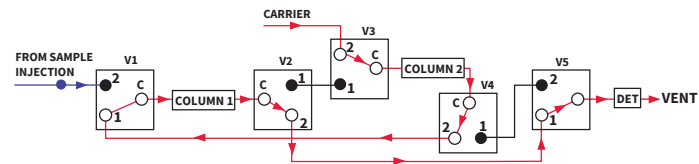
APP. #5

Two columns sequence reversal / foreflushing

A - COLUMN 1 TO COLUMN 2 AND DETECTOR



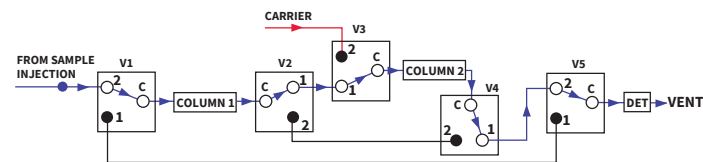
B - COLUMN 2 TO COLUMN 1 AND DETECTOR



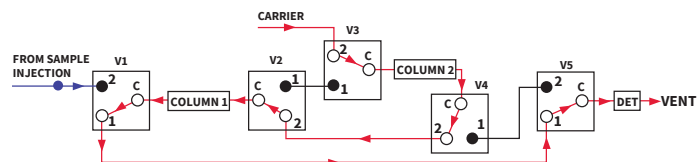
APP. #6

Two columns sequence reversal and backflush of column 1 to detector

A - COLUMN 1 TO COLUMN 2 AND DETECTOR



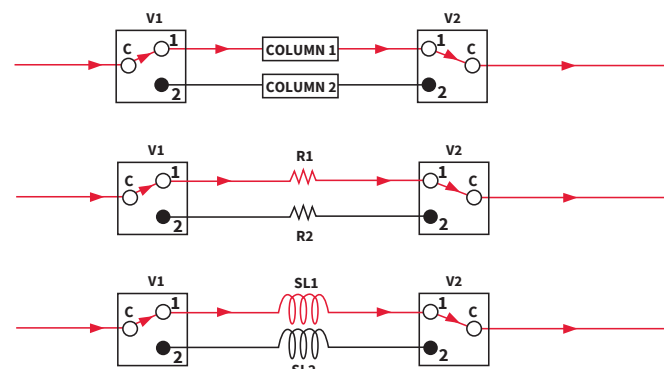
B - COLUMNS REVERSAL AND BACKFLUSH OF COLUMN 1 TO DETECTOR



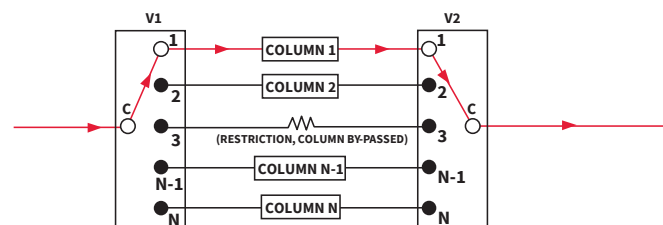
APP. #7

Isolation, selection or by-pass of columns and/or traps

A - WITH DV3 VALVES



B - WITH DVS SERIES SAMPLING VALVES



LEGEND :

R: FLOW RESTRICTOR

C: INDICATE THE COMMON PORT

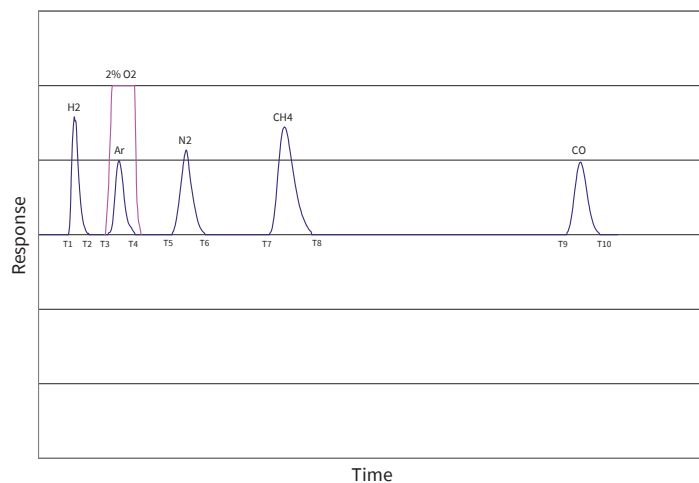
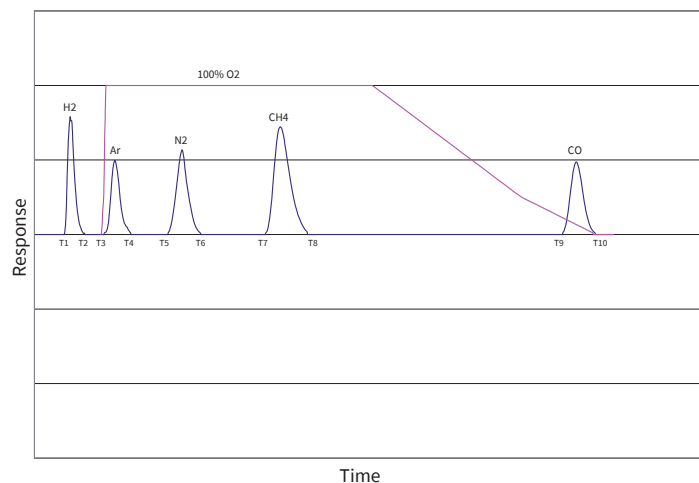
● PORT CLOSED

○ PORT OPEN

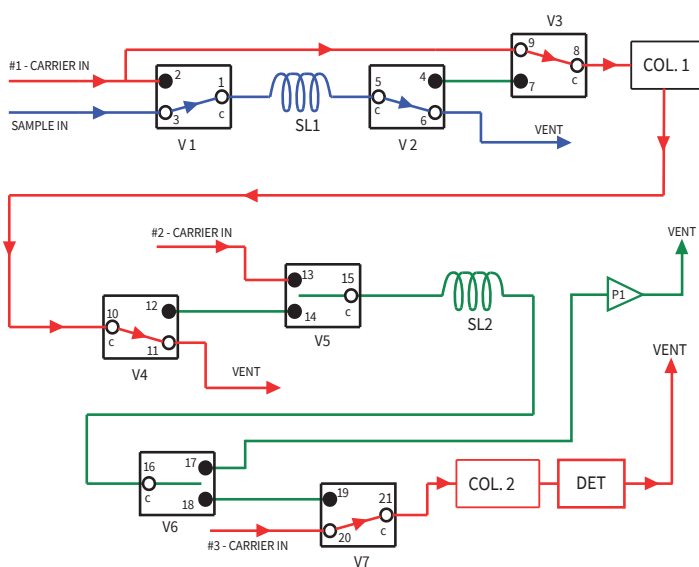
APP. #8

Peak transfer method

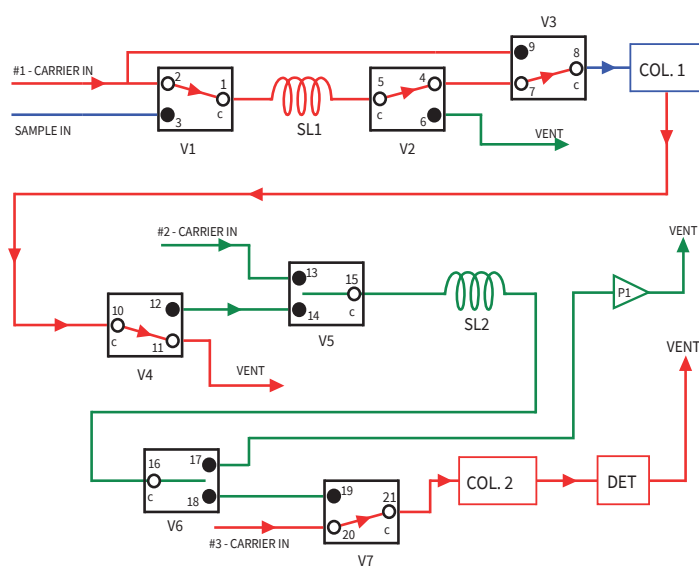
This method is a proprietary of Servomex Ltd. For more information, please contact them at www.servomex.com. There is a patent pending on this method. Complete system is available through Servomex Group.



A - SAMPLING, SL1 FILLED WITH THE SAMPLE GAS, SL2 IS ISOLATED



B - SL1 INJECTED INTO FIRST COLUMN 1 VENTED OUTSIDE THE SYSTEM



LEGEND :

R: FLOW RESTRICTOR

C: INDICATE THE COMMON PORT

● PORT CLOSED

○ PORT OPEN

Peak transfer method (cont'd)

The diagram illustrates a 3-component gas chromatograph system with the following components and flow paths:

- Carrier Gas Inlets:** #1 - CARRIER IN, #2 - CARRIER IN, and #3 - CARRIER IN.
- Sample Inlets:** SAMPLE IN and VENT.
- Valves:** V1, V2, V3, V4, V5, V6, and V7.
- Solenoid Valves:** SL1 and SL2.
- Pressure Indicators:** P1 and P2.
- Columns:** COL. 1 and COL. 2.
- Detector:** DET.

The flow paths are color-coded: red for carrier gases, blue for sample flow, and green for vent flow. The diagram shows the complex interconnections between these components, including the use of solenoid valves to direct flow between different paths.

The diagram illustrates a three-carrier system for a 2000-ton chiller. It features three parallel carrier loops, each with its own carrier inlet and vent. The loops are interconnected by a common return line that includes a pressure switch (P1) and a vent. The system also includes two control valves (COL.1 and COL.2) and a detector (DET).

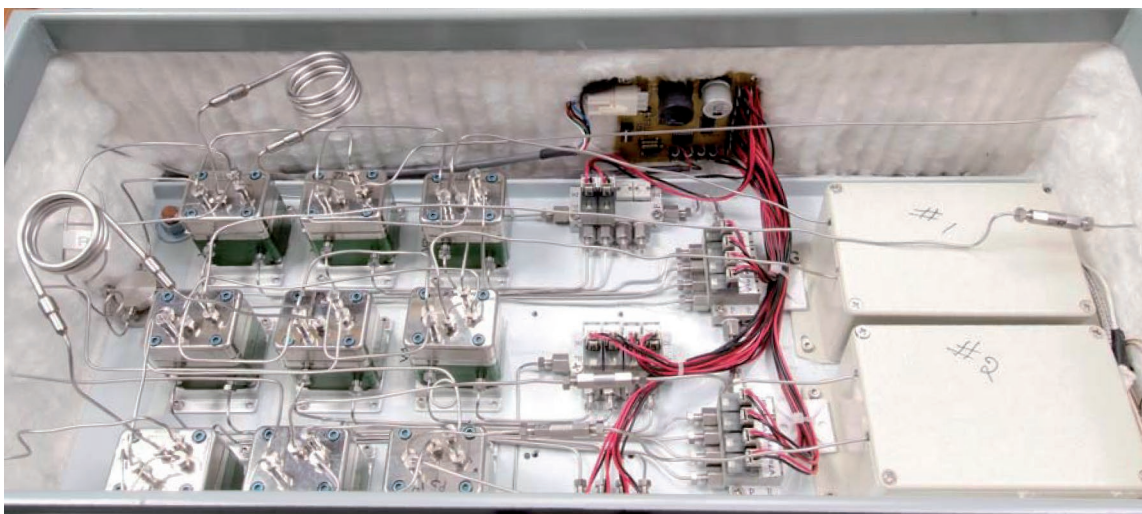
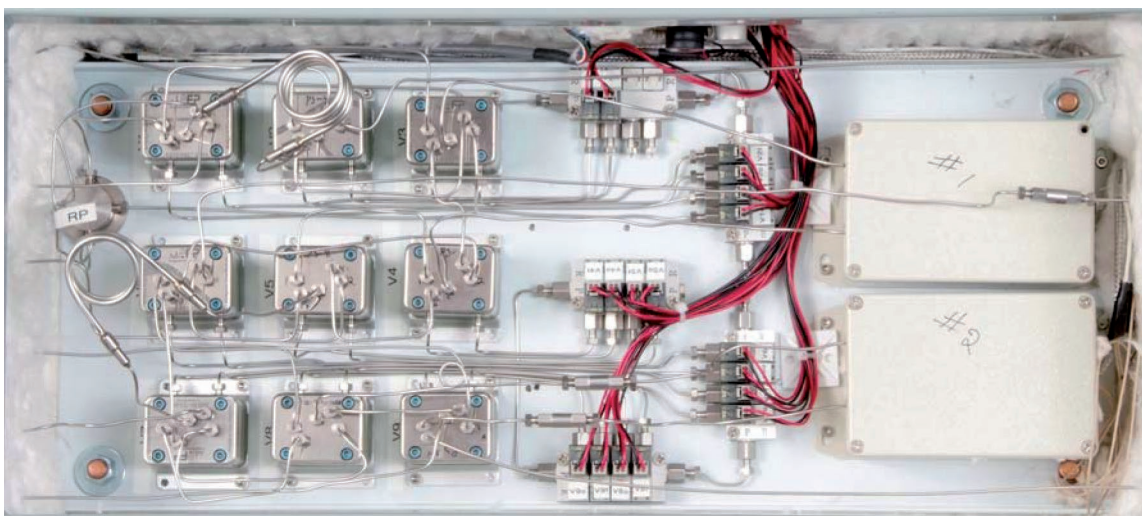
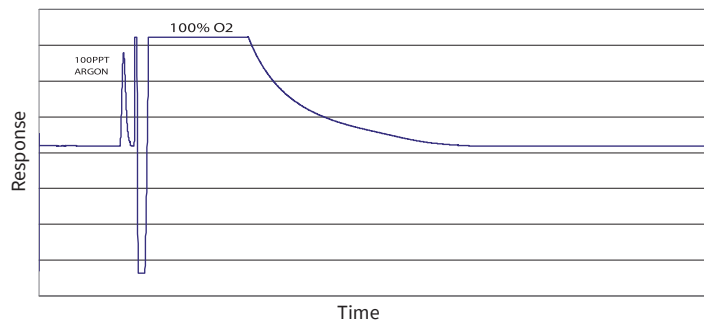
- Carrier Inlets:** #1 - CARRIER IN, #2 - CARRIER IN, #3 - CARRIER IN.
- Valves:** V1, V2, V3, V4, V5, V6, V7.
- Solenoids:** SL1, SL2.
- Control Valves:** COL.1, COL.2.
- Detector:** DET.
- Vents:** VENT (multiple locations).
- Pressure Switch:** P1.

☐ PORT OPEN

APP. #8

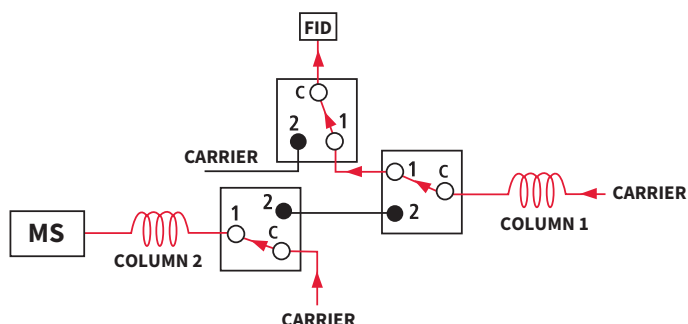
Peak transfer method (cont'd)

The peak transfer is system shown in a heat controlled enclosure, to avoid change in system equilibrium. Here is also shown the I/O driver board with its microcontroller.



APP. #9

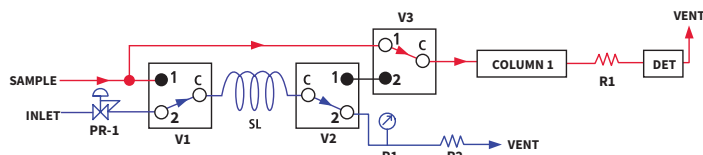
Multi-dimensional GC/GCMS



- A MULTI-DIMENSIONAL GC SYSTEM PERFORMS SEPARATION USING TWO COLUMNS THAT HAVE DIFFERENT CHARACTERISTICS
- ADVANTAGEOUSLY REPLACE THE “DEANS” TYPE SWITCHING MEANS
- NO SHIFT IN RETENTION TIME
- PETROLEUM ANALYSIS (OXYGENATED COMPONENTS IN GASOLINE)
 - * COL. 1: RTX-1, COL.2: DB-1701
 - * 5 SWITCHING SEQUENCE
- FRAGRANCE ANALYSIS
- ESSENTIAL OIL ANALYSIS

APP. #10

MPGC (Medium Pressure Gas Chromatography)



It is a well known fact that the adsorption in a GC column packing material behaves differently, based on local pressure conditions. This is true for gas solid chromatography (GSC) system, where the separation mechanism is mainly governed by surface adsorption. However, great care is taken to avoid this effect in gas-liquid chromatography (GLC). This can be seen in various manufacturer's adsorption isotherm curve. To simplify this phenomenon, applying a vacuum releases the “trapped” molecules from its structure; inversely pressurizing it increases adsorption. Furthermore, in presence of many impurities, the relative adsorption will change based on operating pressure.

The common 1/8” O.D. pack columns are still widely in use today, for gas solid chromatography. The reason for this, is the large sample volume that can be injected resulting in a much greater sensitivity, than achievable with capillary and plot column. However, 1/8” pack column have a poor resolution and extremely low HETP. The proposed method will improve the separation performance for such columns. It is also possible to improve sensitivity as it will be demonstrated below.

Most of the time in gas chromatography, the outlet of the column is at or close to the atmospheric pressure, depending on particular system chromatographic configuration. This means that carrier gas velocity increases when approaching the column's end. Accordingly, the carrier gas pressure is decreasing and also adsorption.

Operating the column outlet at a higher pressure will increase the relative adsorption of various components, resulting in enhanced selectivity or peak separation.

This is what MPGC is all about, i.e. operating the system at higher pressure. This is realized by simply adding a restriction between the column outlet and the detector, in order to increase outlet column pressure. Obviously, this also increases the inlet pressure.

At the same time, if the sample pressure is high enough, a restriction could also be added on sample vent, in order to increase the pressure in the sample loop. Doing so, allows a reduction of the length of the sample loop, while keeping the impurities level high enough for the target system detection limit. This helps to eliminate a difficult to separate background, improve heartcut or backflush and increase lifetime of various catalyst of palladium base H₂ membrane separation that could be used in such systems.

Many chromatographers have tried to increase sample pressure, to improve the detection limit (LDL) of their detector (Ex. for a TCD). However, due to existing chromatographic valve leak rates (diaphragm or rotary), the result they got was the opposite of what they expected.

This is due to the fact that when sample pressure was increased, the sample gas was leaked into carrier gas, killing detector sensitivity and/or separation. So, the only solution was to keep carrier pressure higher than the sample pressure. This resulted in another drawback, since carrier began to leak into sample, resulting in a detrimental effect on repeatability.

One way or the other, most of GCs are configured this way. System performance is dramatically limited by the valve. In order to use our proposed method, GC valves must have a high sealing integrity. The AFP™ valve family allows for such an operation for an extended period of time without system performance degradation. **Increasing the column and sample pressure will improve the overall system performance, at the expense of the only two flow restrictors.**

LEGEND :

R: FLOW RESTRICTOR

C: INDICATE THE COMMON PORT

● PORT CLOSED

○ PORT OPEN

APP. #10

MPGC (Medium Pressure Gas Chromatography) (cont'd)

Which pressure will be the best for my system ?

This is a good question and is something that one may calculate based on manufacturer thermodynamics adsorption data. There is good text book information on this. However, the use of a simple needle valve acting as variable orifice during system configuration will save a lot of precious time. When proper needle valve setting has been found, it may easily be replaced by a flow restrictor made of a small piece of 1/16" OD, SS tubing.

The GC valve may be from the MDVG or DV family. The CLP type of the RV rotary valve family could also be used with excellent results. All these valves family have pressure require level of sealing integrity.

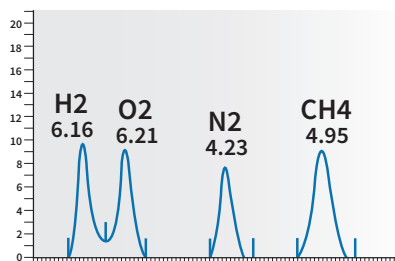
The following chromatograms show examples of improved separation and sensitivity that can be achieved with the use of AFP™ Valve and this method. Our technique of MPGC can add significant improvements to your gas solid chromatography. Generally speaking, the use of high performance valves will always improve the performance of any system.

Benefits :

- ENHANCES PEAK SELECTIVITY
- IMPROVES BACKGROUND SEPARATION
- IMPROVES DETECTOR SENSITIVITY
- ALLOWS SHORTER COLUMN LENGTH AND HIGHER TEMPERATURE OPERATION

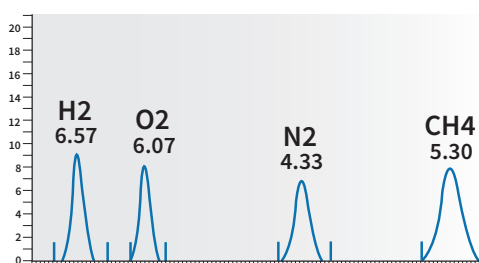
Column outlet and sample pressure at atmospheric pressure. Traditional method

1 -

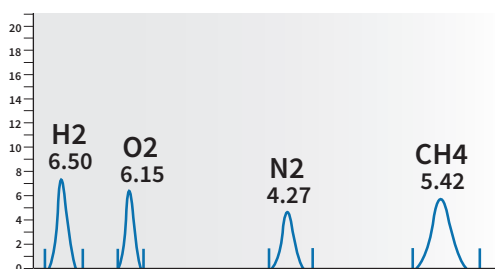


Column outlet pressurized

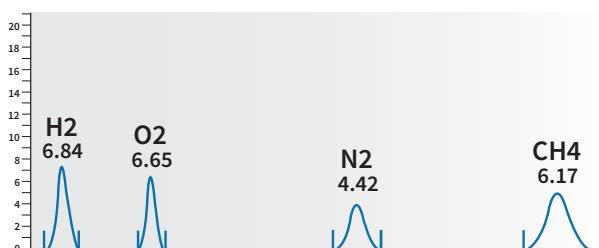
2 - COLUMN OUTLET PRESSURIZED AT 10 PSI (69 KPA)



3 - COLUMN OUTLET PRESSURIZED AT 20 PSI (138 KPA)



4 - COLUMN OUTLET PRESSURIZED AT 40 PSI (276 KPA)

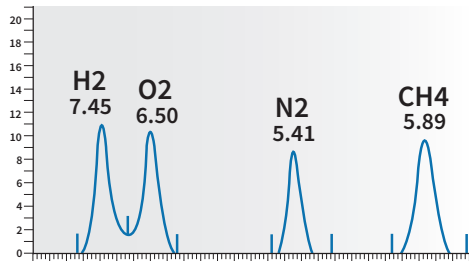


APP. #10

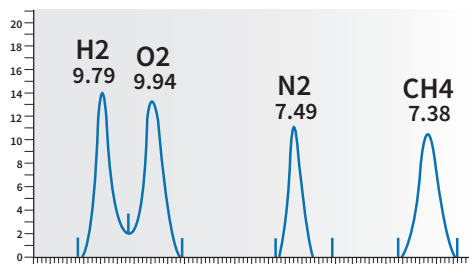
MPGC (Medium Pressure Gas Chromatography) (cont'd)

Pressurized sample

- 5 -** SAMPLE LOOP AT 10 PSI (69 KPA), COLUMN OUTLET PRESSURE AT ATMOSPHERIC

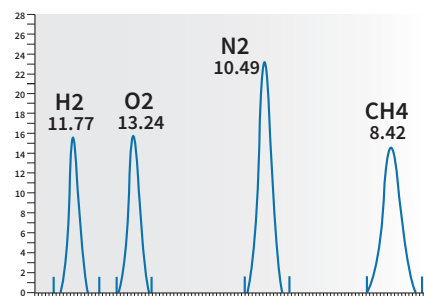


- 6 -** SAMPLE LOOP AT 20 PSI (138 KPA), COLUMN OUTLET PRESSURE AT ATMOSPHERIC

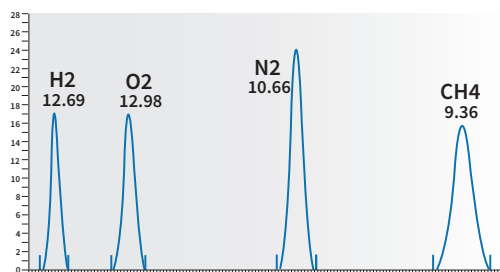


Combined effect

- 7 -** SAMPLE LOOP AT 30 PSI (207 KPA), COLUMN OUTLET AT 10 PSI (69 KPA)

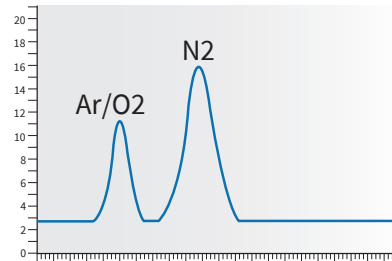


- 8 -** SAMPLE LOOP AT 40 PSI (276 KPA), COLUMN OUTLET AT 40 PSI (276 KPA)

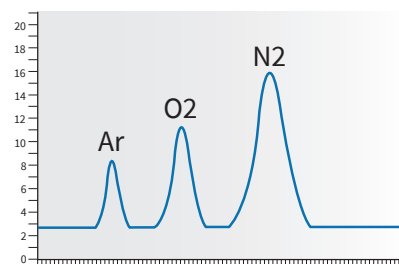


Other application examples

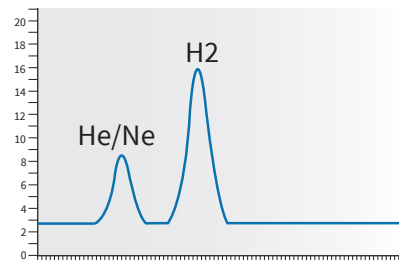
- 1 -** STANDARD CONFIGURATION CHROMATOGRAM OF AIR ON A HEAT TREATED MS 5A COLUMN, TEMP. 25°C. HELIUM AS CARRIER.



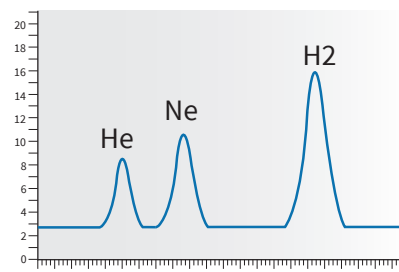
- 2 -** SAME OPERATING CONDITION WITH MPGC CONFIGURATION



- 3 -** STANDARD CONFIGURATION HE/NE/H₂ MIXTURE ON A HEAT TREATED MS 5A COLUMN, TEMP. 25°C. ARGON AS CARRIER.



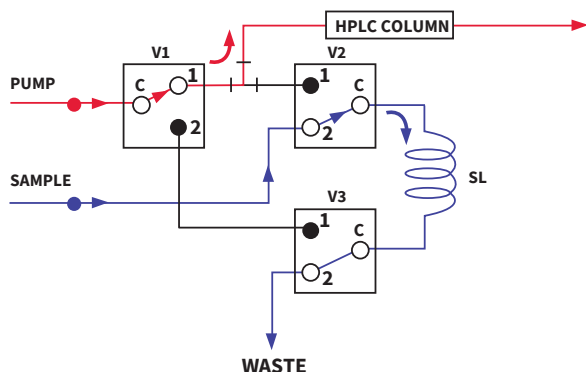
- 4 -** SAME OPERATING CONDITION WITH MPGC CONFIGURATION



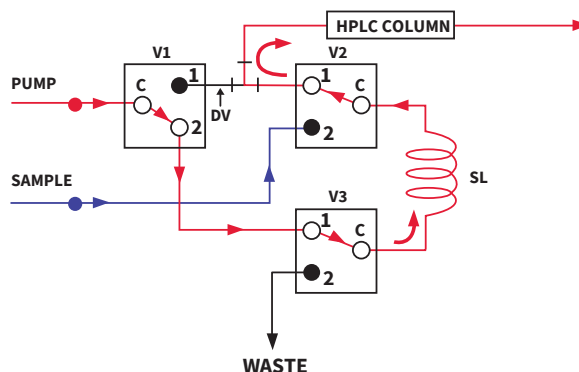
APP. #11

Liquid sample injection

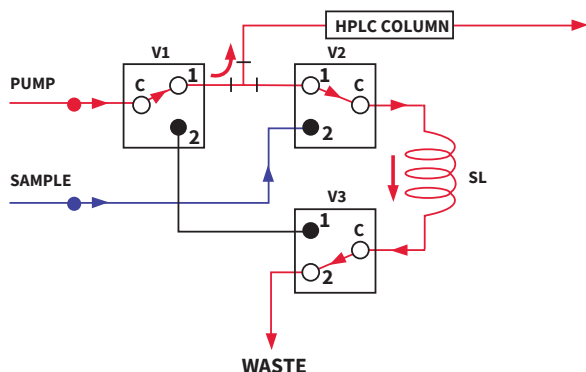
A - SAMPLE FLOWING THROUGH SAMPLING LOOP



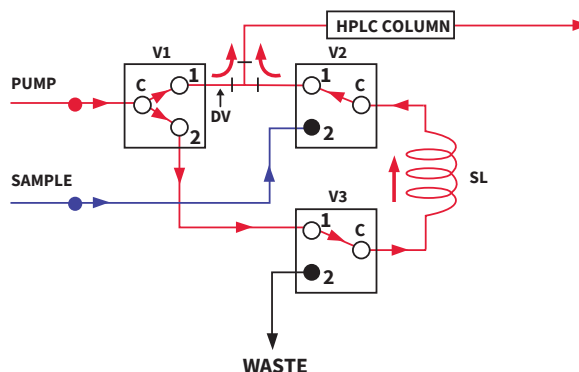
B - SAMPLE LOOP INJECTION



C - SAMPLING LOOP CLEANING OR FLUSH



D - ALTERNATE FLOWPATH SAMPLE INJECTION FOR DEAD VOLUME CANCELATION EFFECT. HERE THE SECTION DV IS SWEEPED.



TIP :

This LC sample injection uses only 3 DV3 valves. However, such configurations creates an unswept dead volume upon sample injection. This dead volume is shown in Fig. B and identified as DV. Such dead volume may cause peak tailing, based on HPLC system operating parameters. If your system falls in this category, an alternate sample injection as shown in Fig. D may be considered. By opening both ports of V1 at sample injection, the DV section is also swept.

LEGEND :

R: FLOW RESTRICTOR

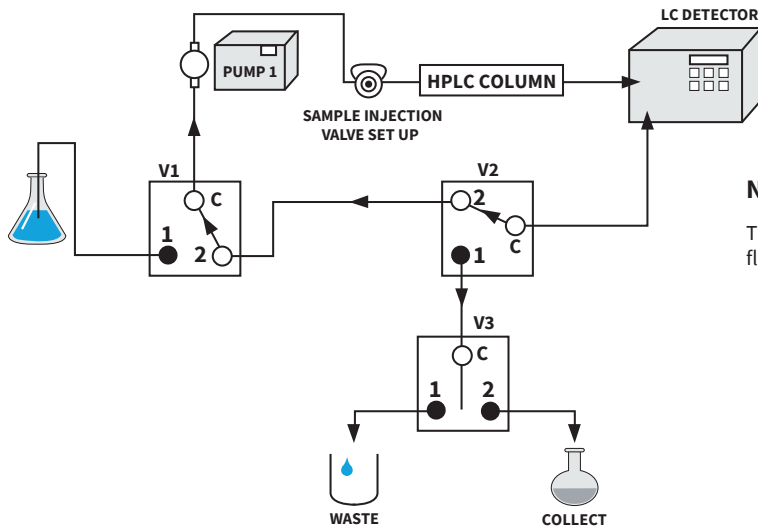
C: INDICATE THE COMMON PORT

● PORT CLOSED

○ PORT OPEN

APP. #12

Liquid application shave / recycle system

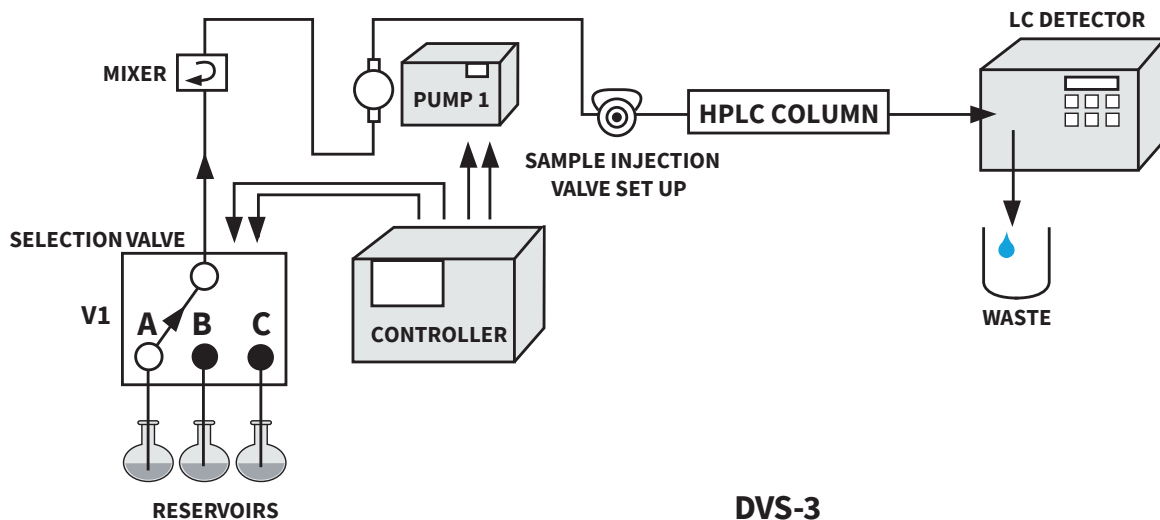


NOTE :

There are no valve stems nor circular seal in the wetted part of the valve flowpath that can contaminate or generate leak of the fluid being controlled.

APP. #13

Liquid application / proportioning valve gradient system



LEGEND :

R: FLOW RESTRICTOR

C: INDICATE THE COMMON PORT

● PORT CLOSED

○ PORT OPEN

APP. #14

Tip and hints

- Since all ports are independently controlled, the column pressure could be re-equilibrated before restoring the flow to the detector. This eliminates baseline upset due to sudden pressure flow change.
- When a carrier is directed to vent through an orifice, the associate valve port could be closed, economizing carrier gas.
- Port size may be done to answer the users needs.

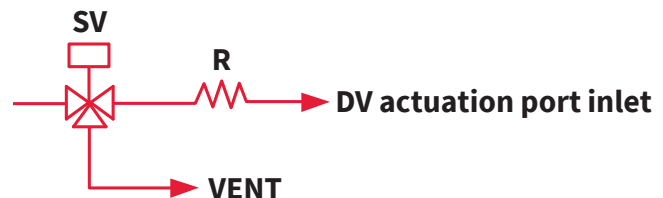
Start up :

- During the start up cycle, all valve's ports could be opened at the same time in order to purge the system and bring it faster to equilibrium.

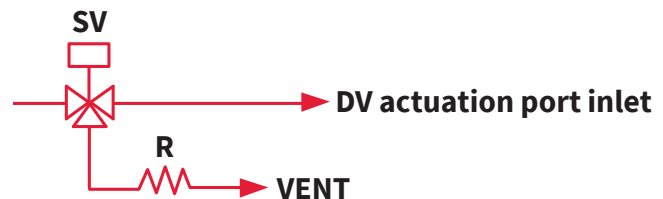
Slowing down port actuation speed :

- This helps to eliminate or minimize the “hammer” effect in a high pressure liquid system. It also may help to avoid pressure shock on column packing. Generally speaking, eliminating or reducing pressure transient will improve overall system performance. The flow restriction “R” could simply be made of a reduce internal diameter tubing. By adjusting its length, the actuation speed is also adjusted. CV-1 is a small check valve. Required hardware is available from AFP.

A - SLOW CLOSING / SLOW OPENING



B - QUICK CLOSING / SLOW OPENING



C - SLOW CLOSING / QUICK OPENING

