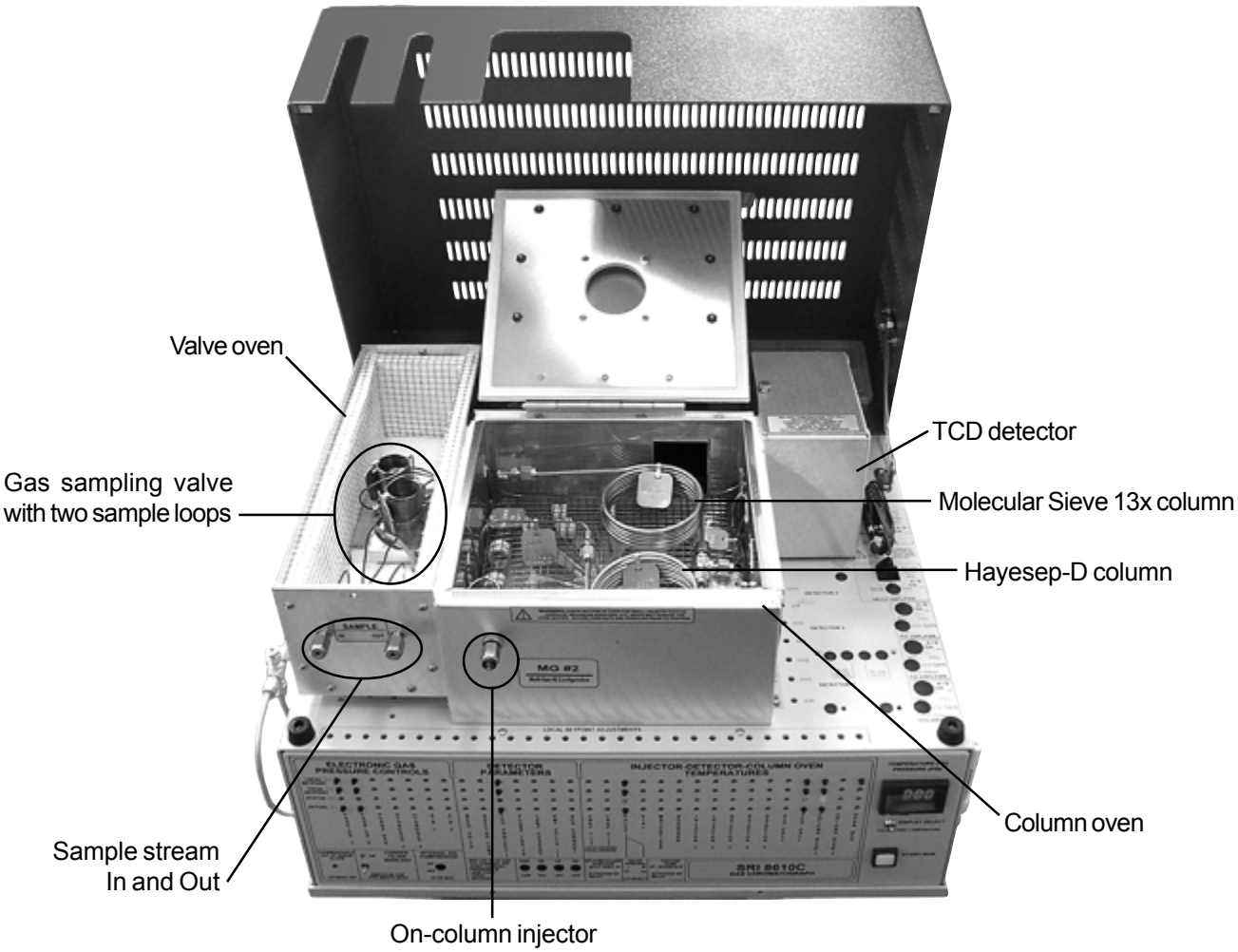
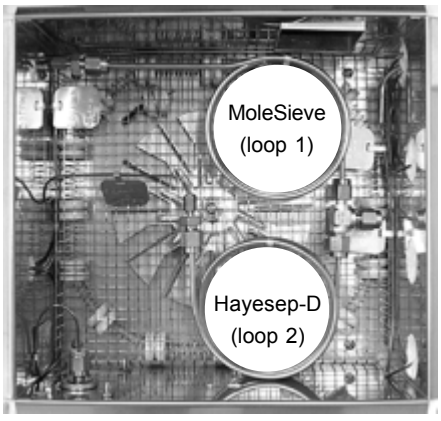
System Overview

The SRI Multiple Gas Analyzer #2 (MG#2) is configured on the 8610C chassis. It is equipped with a gas sampling valve plumbed with dual sample loops in a heated valve oven, and two packed columns in the column oven. The basic model, shown below, comes with a TCD detector. The MG#2 may optionally be equipped with a FID/methanizer or HID detectors in addition to the TCD. A capillary column in parallel with the Hayesep-D column is an option for separating out hydrocarbons through C_{20}.



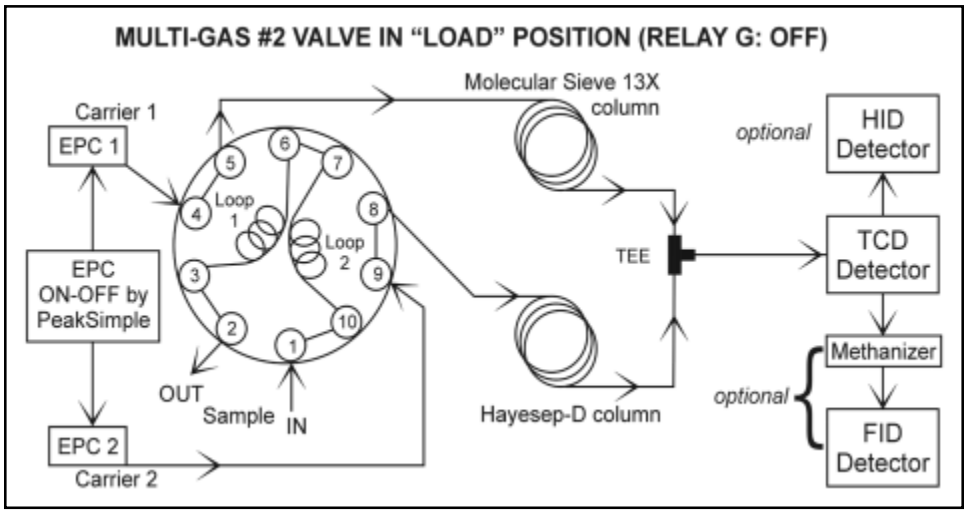
The MG#2 separates a wide variety of peaks without co-elution by turning the carrier gas flow to the two packed columns ON and OFF individually at different times during the run. The carrier to the Molecular Sieve 13x column (carrier #1) is turned ON first to complete the separation of H_2, O_2, N_2, CH_4 and CO. At this point, the MoleSieve carrier flow is turned OFF and the Hayesep-D carrier (carrier #2) is turned ON. All compounds in the C_1-C_6 range are then separated by the Hayesep-D column. The MoleSieve column is connected to sample loop 1, and the Hayesep-D to loop 2.



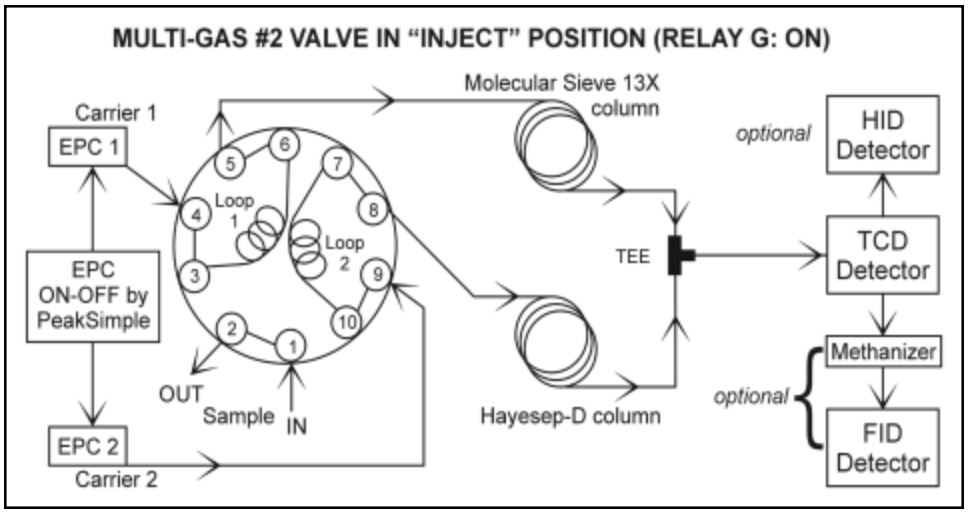
Theory of Operation

The MG#2 GC uses a single automated 10 port Gas Sampling Valve and multiple columns to separate a wide variety of compounds. It achieves this by turning the carrier gas flow to each column on at different times during the run. This procedure allows the Molecular Sieve 13x column to completely separate H_2, O_2, N_2, CH_4 and CO before the carrier flow to the Hayesep-D column is turned on. The Hayesep-D column then separates all compounds in the C_1-C_6 range. An optional 30-meter MXT-1 capillary column separates the remaining hydrocarbons through C_{20}, using the same carrier gas flow as the Hayesep-D column and an FID or HID detector.

The MG#2 is plumbed with two separate carrier gas flows, each regulated by Electronic Pressure Control (EPC) through the PeakSimple data system. Carrier 1 flows through sample loop #1 to the MoleSieve column, then on through the "Tee" to the TCD detector. Carrier 2 flows through sample loop #2 to the Hayesep-D column, then through the "Tee" to the TCD detector. Carrier #1 and #2 flows are turned ON and OFF by PeakSimple, controlled by the user with an Event table.



When the MG#2 valve is in the LOAD position, loops #1 and #2 are loaded with the sample gas stream while carrier flows #1 and #2 bypass the loops and travel on to the columns.



When the MG#2 valve is in the INJECT position, carriers #1 and #2 flow through the sample loops, sweeping their contents to the columns.

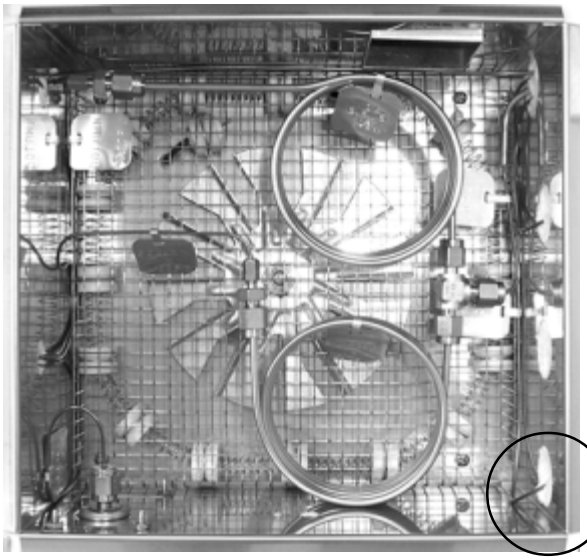
General Operating Procedure

1. Set the gas cylinder pressure 15-20psi higher than the head pressure (helium carrier). The carrier head pressure used to generate the test chromatograms at the factory is printed on the right-hand side of your GC. Verify that with carrier gas turned off at the cylinder, that the actual GC pressure reads ZERO.

GAS FLOW RATES

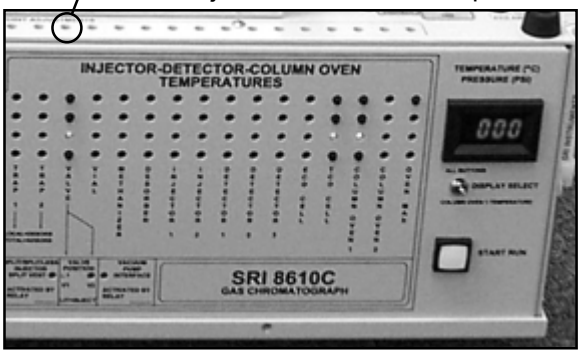
CARRIER 1:	MOL. SIEVE	:	10	PSI =	10	ml/min
CARRIER 2:	HAYESEP-D	:	7	PSI =	10	ml/min
P&T PURGE:		:		PSI =		ml/min
HYDROGEN 1:		:		PSI =		ml/min
HYDROGEN 2:		:		PSI =		ml/min

2. Damage or destruction of the TCD filaments will occur if current is applied in the absence of flowing carrier gas. ALWAYS verify that carrier gas can be detected exiting the TCD carrier gas outlet BEFORE turning ON the TCD current. Labelled for identification, the TCD carrier gas outlet tubing is located inside the column oven. Place the end of the tubing in liquid and observe. If there are no bubbles exiting the tube, there is a flow problem. DO NOT turn ON the TCD current if carrier gas flow is not detectable. A filament protection circuit prevents filament damage by shutting OFF the TCD current when the column head pressure is below 3psi. Because this protect circuit cannot prevent filament damage under all circumstances, any lack of carrier gas flow should be corrected before proceeding. NEVER turn both carrier #1 and carrier #2 OFF at the same time. Please see the TCD manual section for more information about the detector.



The TCD carrier gas outlet tubing is located inside the column oven. If there is also an FID detector on your MG#2, the TCD carrier gas outlet tubing is connected to the FID inlet bulkhead in the column oven wall. If your MG#2 has a TCD only, the end tubing will be on the outside of the column oven, on the detector side.

Use the trimpot directly above the "VALVE" zone to set or adjust the valve oven temperature.



3. Set the valve oven temperature to 90°C using the trimpot on the top edge of the GC front control panel.

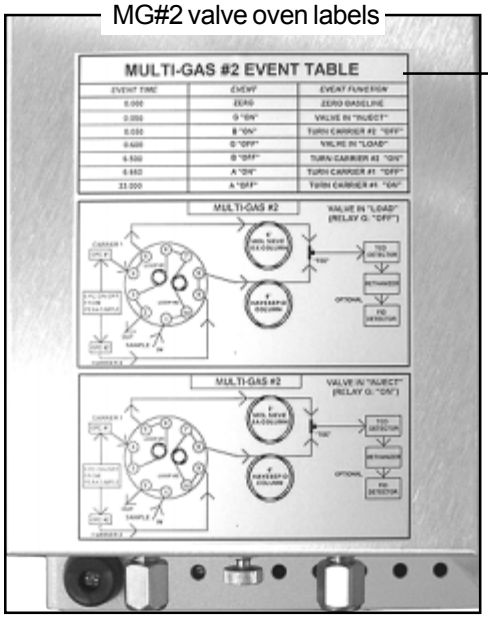
4. Turn the TCD current ON to LOW. If present, ignite the FID/methanizer and set the temperature to 380°C. If present, turn ON the HID current.

5. Set the column oven temperature program in PeakSimple as follows. (This is an example; your analysis may require a different temperature program.)

Initial	Hold	Ramp	Final
50.00	3.00	20.00	220.00
220.00	25.00	0.00	220.00

General Operating Procedure continued

MG#2 valve oven labels

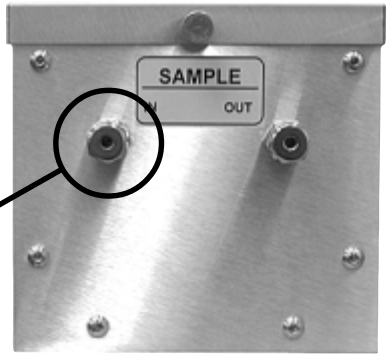


Example event table:

Time	Event
0.000	ZERO (zero data system signal)
0.050	B ON (carrier #2 OFF)
0.500	G ON (valve INJECT)
3.500	B OFF (carrier #2 ON)
3.600	A ON (carrier #1 OFF)
18.000	A OFF (carrier #1 ON- MoleSieve Bake Out phase)

6. Type in an Event table. The example shown is labeled on the MG#2 valve oven. The event table should allow for the elution of CO from the molecular sieve column before carrier #2 is turned back ON. The column oven temperature may be increased to speed the elution of the H_2, O_2, N_2, CH_4, and CO. Hydrocarbons like ethane and propane end up on the Molecular Sieve 13x column after its carrier is turned OFF and the Hayesep-D carrier is turned ON. The example Event table also turns Carrier #1 ON at the end of the run, while the column is still hot enough to bake the hydrocarbons out of the MoleSieve column. This Bake Out phase is required to get rid of any residual peaks, so that following analyses are not compromised. Keep Carrier #1 ON and the column oven hot long enough for any contamination peaks to elute. Click the Edit drop down menu in the main PeakSimple window, then choose Overall, then make sure that the "Reset relays at end of run" checkbox is selected. Otherwise, you will have to include G OFF at the end of the event table.

7. Load your sample gas stream by connecting the flow to the sample inlet port ("SAMPLE IN") on the front of the valve oven with the provided 1/8" swagelok nut and brass ferrule.



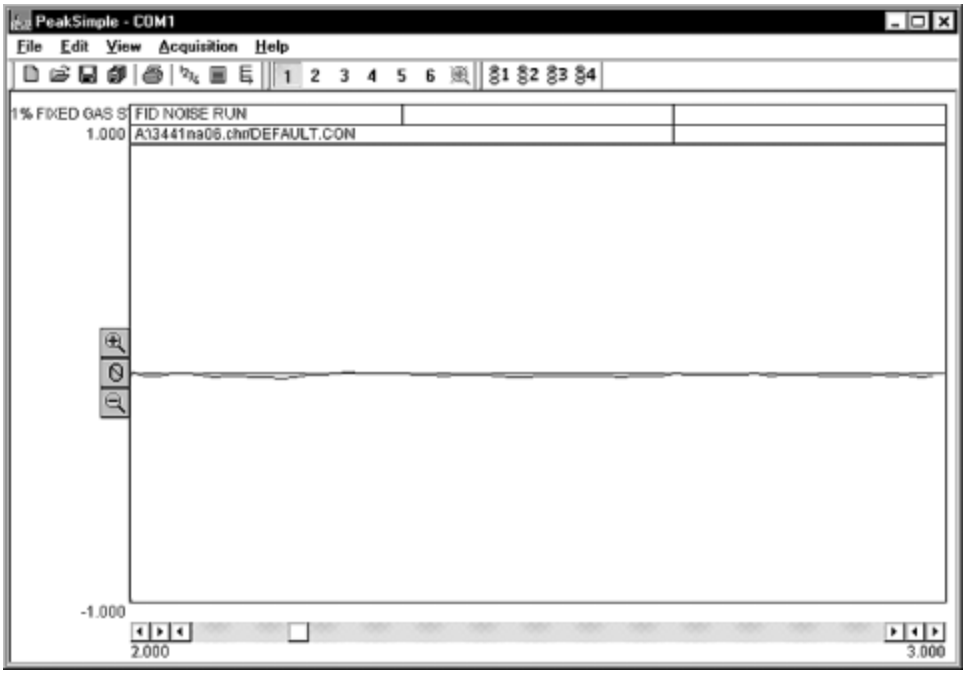
Sample inlet port

8. Start the analysis by pressing the START RUN button on the front of your GC, or by pressing your computer keyboard spacebar.

The START RUN button is on the lower right hand corner of the GC's front control panel.

Expected Performance

These two noise runs were made with identical parameters (carrier flow, columns, temperature program) on a Multiple Gas Analyzer #2 GC equipped with FID and TCD detectors. The only differences are the detector particulars, which are listed next to the appropriate chromatogram.



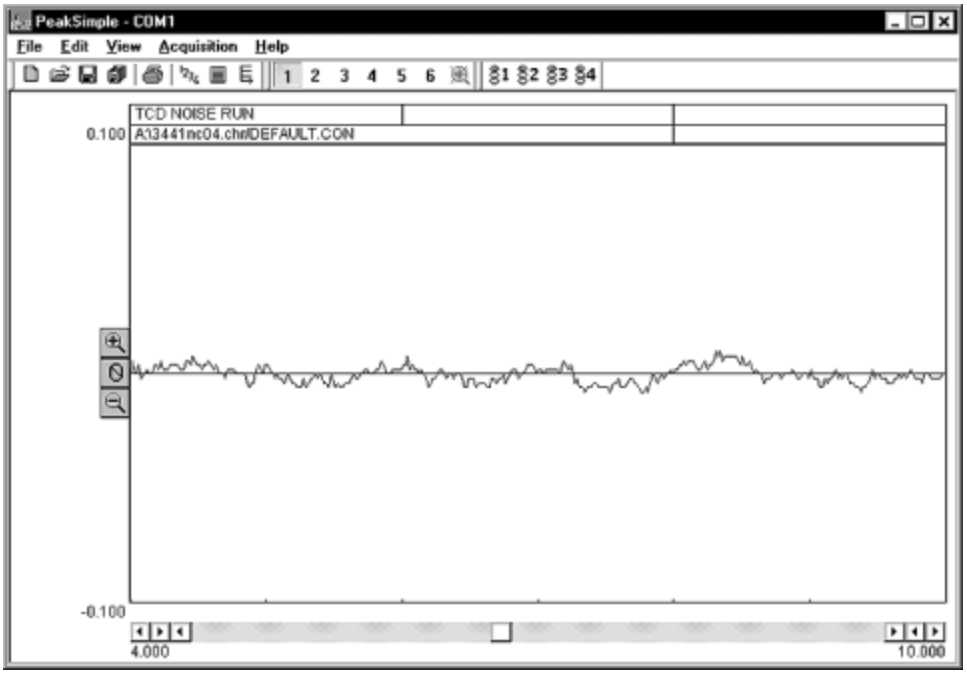
FID noise run

FID gain = HIGH
FID temp = 380°C
FID ignitor = -400
Methanizer in FID
detector body

Valve temp = 90°C
Carrier #1 Mol. Sieve 13x = 20mL/min
Carrier #2 Hayesep-D = 20ml/min
Total carrier flow = 40mL/min

Temperature program:

Initial	Hold	Ramp	Final
80°C	20.00	0.00	80°C



TCD noise run

TCD current = LOW
TCD temp = 150°C

Expected Performance

The first chromatogram shows the TCD response to a 1% Fixed Gas Standard sample. Using the same valve temperature, column oven temperature program, carrier flow and event table, the second chromatogram shows the TCD response to a Natural Gas Standard sample. The event table used is shown on the ***General Operating Procedure continued*** page.

Columns: 2-meter Hayesep-D, 2-meter Molecular Sieve 13x
TCD current = LOW; TCD temp = 150°C

Carrier: Helium at 40mL/minute combined (20mL/minute through each column)
Valve temp = 90°C

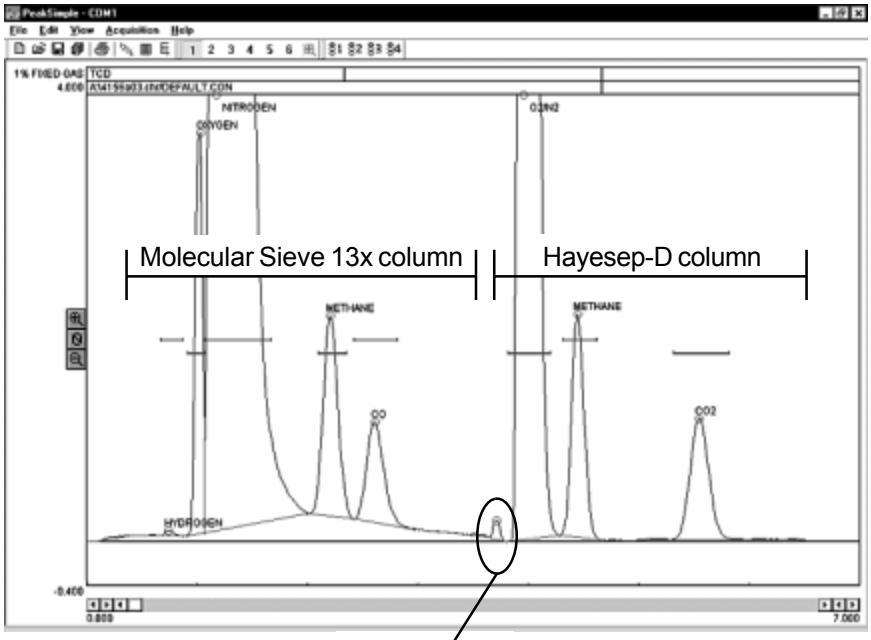
Column Oven Temperature program:

Initial	Hold	Ramp	Final
50°C	3.00	20.00	220°C
220°C	25.00	0.00	220°C

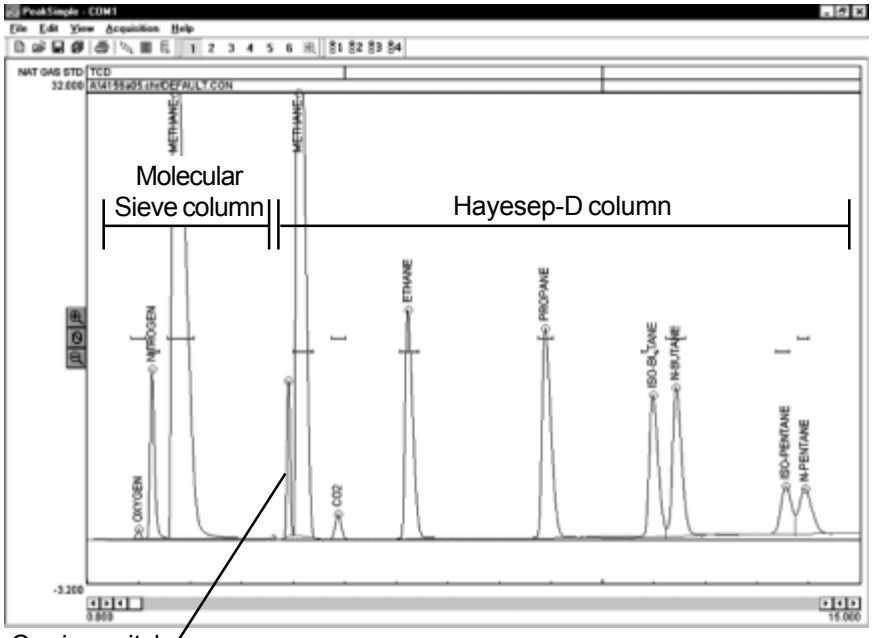
1% Fixed Gas Standard

RESULTS:

Component	Retention	Area
Hydrogen MS	0.733	00.2510
Oxygen MS	1.016	16.0495
Nitrogen MS	1.166	1108.7680
Methane MS	2.200	16.5050
CO MS	2.600	09.7370
O_2/N_2 Hay-D	3.950	863.6340
Methane Hay-D	4.433	15.7300
CO_2 Hay-D	5.533	12.9205
TOTAL		2043.5950



Carrier switch



Carrier switch

Natural Gas Standard

RESULTS:

Component	Retention	Area
Oxygen MS	0.983	3.4190
Nitrogen MS	1.250	72.5450
Methane MS	1.683	706.7920
Methane Hay-D	4.083	587.7140
CO_2 Hay-D	4.850	14.7710
Ethane Hay-D	6.216	169.1275
Propane Hay-D	8.866	180.2660
Iso-Butane Hay-D	10.966	126.6950
N-Butane Hay-D	11.400	134.1470
Iso-Pentane Hay-D	13.533	50.1540
N-Pentane Hay-D	13.916	54.4740
TOTAL		2099.1045