Reducing or Replacing Helium Carrier Gas Usage in Emerson Gas Chromatographs

The majority of online gas chromatographs with Thermal Conductivity Detectors (TCD) use helium as a carrier gas. Recently, many suppliers of chromatograph grade helium have been experiencing supply shortages, in turn leading to increasing prices. Many users are looking for alternatives to decrease or eliminate the usage of helium.

Helium is used with TCD applications because it has a very high thermal conductivity compared to many of the components being detected (refer Table 1) and therefore provides a large detector response to the measured components. Other inert gases (such as Argon) are not generally suitable as they have a thermal conductivity close to the measured components and will not provide the required amount of resolution for most applications.

Table 1 - Thermal Conductivities of Various Components

Component	Thermal Conductivity at 300 K (mW / mK)
Hydrogen	186.9
Helium	156.7
Methane	34.1
Oxygen	26.3
Nitrogen	26
Ethane	21.3
Propane	18
Argon	17.9
Butane	16.4

Hydrogen can be used as an alternative carrier gas to helium as it has a similar thermal conductivity and therefore will provide a similar detector response. However, hydrogen is a flammable gas and therefore raises hazardous area approval issues.

The carrier gas is also commonly used as the actuation gas for the pneumatic analytical valves as many installation locations lack a reliable source of high pressure air. This provides the largest potential for reducing helium usage by converting this actuation gas supply to nitrogen or instrument air.

There are two options to reducing helium usage in installed Danalyzer and Rosemount Analytical gas chromatographs:

1. Convert the actuation gas to nitrogen or air.
2. Convert the actuation gas to nitrogen or air and the carrier gas to hydrogen.

Converting the Actuation Gas

The analysis valves in the chromatograph oven typically use the carrier gas to actuate. These valves switch the flow path to direct the analyzed sample and the carrier gas through columns and across the detector depending on the application. Converting the actuation gas to nitrogen or air will reduce the use of helium to less than 20 cc/min for a four-minute C6+ application. The alternative actuation gas should be at 110 PSIG (7.6 BarG), be dry and free of particulates greater than two microns.

Figure 1 - Existing Flow Path with Helium as the Actuation Gas

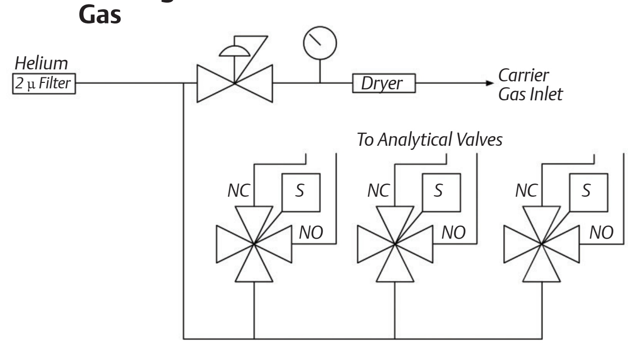

Figure 2 - Flow Path with Nitrogen on Air Actuation Gas and the Pneumatic Shut-off Valve Installed

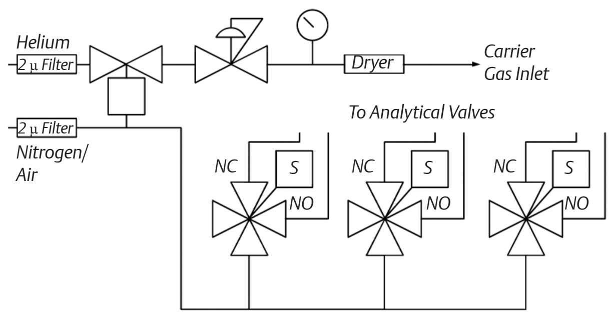

Figure 1 shows the flow path with helium as the carrier gas and the actuation gas. Figure 2 shows the flow path with the alternative actuation gas kit installed. The pneumatic shut-off valve will shut-off the flow of carrier gas in the event of the loss of actuation gas pressure. Without this shut-off, if the actuation gas pressure falls none of the pistons in the analyzer valves will seal. This will create multiple paths for the helium to escape to vent and dramatically increase the use of helium use, possibly emptying the helium supply.

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The actuation gas conversion kit to be used depends on the model and application of the gas chromatograph:

GC Model	Part Number
Model 500	2-3-0500-185
Model 700 single carrier	2-3-0700-426
Model 700 dual carrier (e.g. Helium/Argon for C6+ with He/H_2)	2-3-0700-427
700XA single carrier	2-3-0710-261
700XA dual carrier (e.g. Helium/Argon for C6+ with He/H_2)	2-3-0710-262

If you are unsure which kit is required for your gas chromatograph, please contact your local GC sales representative and provide the Sales Order (SO) number that is on the GC nameplate.

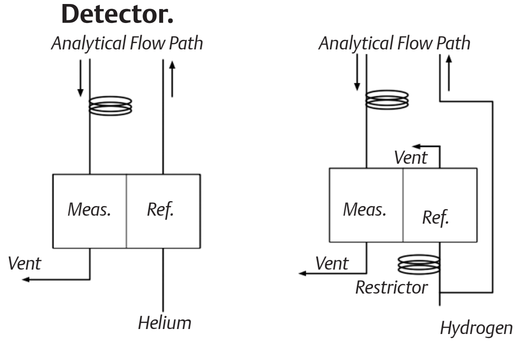
Components that are not included in the conversion kit but may be required include:

- Actuation gas bottle regulator(s)
- Stainless tubing for connection to the gas supply

Converting to Hydrogen Carrier Gas

To convert to hydrogen as a carrier gas the analytical flow path will also need to be altered. Most helium carrier applications have the high-pressure helium supply pass over the reference detector (Figure 3). If high pressure hydrogen is passed over the detector, the thermistors will degrade rapidly.

Figure 3 - Typical Detector Flow Path (left) and the Hydrogen Carrier Flow Path (right) Across the Detector.



To avoid the rapid degradation of the detector, the hydrogen carrier is routed to the reference detector through a restrictor and the hydrogen supply to the analytical flow path is routed around the detector. The restrictor is matched to the restriction of flow of the analytical flow path to ensure the flow across the reference detector is similar to measure detector.

Additionally, the existing detectors should be replaced with thermistors designed for hydrogen use. For gas chromatographs installed inside an analyzer house, the hydrocarbon Lower Explosion Limit (LEL) room monitors may need to be replaced with monitors that detect hydrogen and hydrocarbons.

NOTE: Helium carrier gas CSA/UL Model 500 GCs purchased prior to 2013 are not certified for hydrogen use. Only Model 700, Model 1000/A, 700XA, 1500XA, and ATEX Model 500 GCs are suitable for this application upgrade.

Cost Calculations

Use the following table to help calculate the costs to convert your gas chromatograph(s) to an alternative actuation gas by entering your pricing for the various components in column A, and then calculating the total costs accordingly. For detailed pricing for the helium shut-off kit and other components, contact your local Emerson gas chromatograph sales representative with the part numbers provided above, or the model number and serial number of the gas chromatographs to be converted.

Table 2 - Cost Calculation for Alternative Actuation Gas

	Capital Costs	A Unit Cost	B Number	C Total Cost
1	Alt. Gas Regulators		2	
2	Helium Shut-off Kit		1	
3	Installation Labor			
4			Total Capital Costs	
	Current Operational Costs		**# per year**	
5	UHP Helium		4	
6			Current OpEx Total	
	New Operational Costs			
7	UHP Helium		2	
8	Alt. Gas		2	
9			New OpEx Total	

Return on investment $= \frac{\text{Total Capital Cost}}{\text{(Current OpEx - New OpEx)}}$

= C4/(C9 - C6)

= ____________________

Table 3 - Cost Calculation for Conversion to Hydrogen Carrier Gas.

	Capital Costs	A Unit Cost	B Number	C Total Cost
1	Carrier Shut-off Kit		1	
2	Hydrogen Regulators		2	
3	Installation Labor			
4	Hydrogen TC Detectors		1	
5	H_2/HC/LEL Detectors			
6			Total Capital Costs	
	Current Operational Costs		**# per year**	
7	UHP Helium		4	
8			Current OpEx Total	
	New Operational Costs			
9	Alternative Gas		2	
10	Hydrogen		2	
11			New OpEx Total	

Return on investment $= \frac{\text{Total Conversion Capital Cost}}{\text{(Current OpEx - New OpEx)}}$

= C6/(C11 - C8)

= ____________________

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