Cost Saving Alternative to Helium Usage in Analytical Instrumentation

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The Environmental Protection Agency (EPA) Region 6 Laboratory is working with manufacturers to find solutions to the ongoing Helium shortage that is affecting many laboratories. While most laboratories are still able to obtain ultra high purity Helium, the high cost has forced laboratories to investigate the use of alternative carrier gases for analysis. Hydrogen is one alternative that is widely used and proven as a carrier gas for most Gas Chromatograph (GC) applications; however, its use in volatile and semi-volatile Gas Chromatograph/Mass Spectrometer (GC/MS) methods is not as standard. Detrimental effects on hardware, tuning, sensitivity, and spectral results may occur unless modifications are implemented and thoroughly tested. Nitrogen, another potential carrier gas, is not commonly used for analysis in either GC or GC/MS applications because it requires a slower linear velocity to achieve optimal chromatographic efficiency, resulting in longer analytical runs. Helium still remains the ideal carrier gas for GC/MS applications. For those reasons an alternative solution to changing carrier gas was sought.

To maintain an optimal state of readiness, gas must still flow through GC and GC/MS systems even when they are not actively performing analysis. Most instruments are capable of reducing the total flow rate to conserve gas but this can amount to a significant cost when this gas is Helium. A simple solution to save money is to switch to a cheaper and inert gas during times when the instrument is not used. Nitrogen may not be the ideal carrier gas, but it does make the ideal substitute for Helium when the instrument is idle due to its availability and low cost. In the Region 6 Laboratory ultra high purity gaseous nitrogen is taken from the headspace of a Liquid Nitrogen (LN2) Dewar and centrally distributed to analytical laboratories. The cost is approximately 0.7 cents per standard cubic foot (scf) of gaseous Nitrogen. In contrast the current cost for Helium gas is 21 cents per scf (estimated using 235 scf per cylinder, $50 each) and is expected to rise to 38 cents in 2013 ($89 per cylinder). Using an estimate of 2000 scf per instrument per year (the actual average usage in Region 6), the current cost for a single instrument using 100% Helium is $420 per year ($760 in 2013). The cost for 100% Nitrogen is $14 per year. The current estimated savings per year per instrument is $200 if Nitrogen is used 50% of the time and $100 if Nitrogen is used 25% of the time. In 2013 these savings will rise to $370 and $190, respectively.

Ideally the switch between gases should be automated by the instrument to provide the greatest reduction in Helium usage. Region 6 investigated the use of both automated and manual means of switching but chose the latter to reduce cost. The manual switch is a Swagelok® 3-Way ball valve mounted to a bracket (see pictures below) and connected to the GC where flow may be changed between Nitrogen, Helium, and off. The cost of the valve and bracket was $124. This yields a very short payback time of four to eight months if Nitrogen is used 50% of the time. The only disadvantage to the manual valve is that analyst must remember to change the gas to Helium prior to analysis and to Nitrogen upon completion.

Top and front views of Swagelok® 3-Way Ball Valve (P/N SS-41GXS2) and mounting bracket

During the initial phase of the investigation, this valve was installed on five Agilent GC/MS systems out of eighteen possible instruments; all were semi-volatile analytical instruments. The Helium usage was monitored for six days using the pressure gauge of the central gas distribution system. The usage was reduced approximate 24% after the five instruments were switched to Nitrogen during the evaluation. All instruments were tested using the gas saver mode of 20 ml/minute total flow. Since the installation of the valves approximately two months prior, semi-volatile analysis has been performed on every instrument without any observed negative impacts on hardware or performance. Helium is allowed to flow through the system for at least two to five minutes prior to analysis to flush the column and evacuate the majority of the Nitrogen gas from the mass spectrometer. The Nitrogen was evacuated sufficiently within five minutes of switching to perform an automated tune of the mass spectrometer. To minimize the amount of time necessary to flush the system, the line installed between the valve and the GC should be as short as possible.

In the next phase of the investigation, Region 6 will install the manual valves on the remaining instruments that use Helium, unless there are concerns from other instrument manufacturers, and will continue to monitor the reduction in Helium usage. Region 6 will also investigate a prototype solution for the GC from Agilent to automatically switch between gases and determining optimal method settings.

In conclusion this simple cost saving alternative to switching carrier gases can be implemented immediately with no time needed for method development and without any noticeable effects on hardware or performance. Depending on the number of instruments and time between uses, this has the potential to save laboratories thousands of dollars per year and as well as conserve the much in demand Helium.

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EPA does not endorse any product or vendor mentioned in this paper.