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# 7 Steps to changing carrier gas from Helium to **Hydrogen**

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### 1. Gas Source

**Helium** is becoming increasingly expensive with reports of its price having doubled in some regions between 2013 and 2015. Added to its increased price, supply cannot be ensured in certain regions which is increasing the number of labs looking to change to hydrogen.

**Hydrogen generator**: A hydrogen generator providing carrier grade hydrogen (99.9999%) such as the Peak Scientific Precision Hydrogen Trace is recommended as a safe source of hydrogen that will ensure prolonged column life and the highest quality of analysis.

**Supply tubing:** Supply of hydrogen should be provided through new stainless steel or analytical grade copper tubing. It is important to change the tubing that was previously used to supply helium to the GC, since over time, deposits can build up on the inside of the tubing which hydrogen will strip out, causing higher background signal for a longer period of time.

### 2. Hydrogen Safety

**Safe use of hydrogen:** Since Hydrogen is an explosive gas, it is essential that health and safety in the lab is not compromised and many labs will have restrictions on the use of hydrogen cylinders in the lab.

**LEL:** The lower explosive level (LEL) of hydrogen is 4% in air. Therefore a leak of hydrogen from a cylinder containing around 8000L hydrogen into a well vented laboratory has the potential to reach the LEL very quickly without warning and could create an explosive atmosphere. Added to concerns about large gas leaks, is the cumbersome nature of cylinders which must be moved when replaced, again posing a potential health and safety hazard.

**Gas Generator:** A Peak Scientific Precision hydrogen generator is an ideal source of hydrogen gas, capable of supplying multiple GCs with UHP hydrogen for carrier gas and detector gas, whilst containing a very low volume of gas (less than 0.3L) at a low pressure. Precision hydrogen generators have a number of safety features that will detect any internal or external leaks between the generator and GC and will shut down the generator accordingly.

**Leak detector:** Peak also offer an in-oven hydrogen detector that will shut down the generator if a significant hydrogen leak is detected within the GC oven.

### 3. Hardware

It is important to check the recommendations from your GC manufacturer regarding use of hydrogen carrier gas in your GC. Each manufacturer will have tested their GCs for use with hydrogen and may have specific recommendations depending on the model that you are using. Hardware changes, if required, are most likely to need to be made on GC-MS systems.

**Vacuum Pump:** If you are using a GC-MS, it is important to ensure that your vacuum pump is efficient enough to maintain the vacuum in the source. Pumping efficiency is reduced for lighter molecules, so check the guidelines from your GC manufacturer to ensure that your pumping system can cope with hydrogen carrier gas. If you are purchasing a new GC-MS system, make your supplier aware that you plan to use hydrogen carrier gas so that the correct vacuum pump is supplied.

**Ion Source:** Depending on the manufacturer of your GC-MS, it is possible to get hydrogen upgrade kits, or replacement components for the ion source which will improve sensitivity when using hydrogen carrier gas for analysis of certain compounds. If you are purchasing a new GC-MS system, consult your supplier regarding which ion source will be supplied with the GC-MS to avoid extra cost and downtime at a later date.

### 4. Consumables

**Column:** For standard GC, there is very little that needs to be changed when switching from helium to hydrogen. By using a method translation software, you can simulate the effect of changing carrier gas on carrier gas pressure and oven ramp rates so that you can produce a revalidated method. Depending on your GC method parameters, it may not be necessary to change to a narrower bore column, unless the inlet pressure becomes very low in the translated method, however there are benefits to using a narrow bore column, which the properties of hydrogen carrier gas facilitates. By moving to a narrower bore column, the number of theoretical plates is increased, giving potential for improved efficiency and better sample separation.

**Inlet:** Inlet liners should be changed regularly to ensure that the system stays free of contaminants. When running samples with hydrogen carrier gas, tapered liners are recommended since these minimise contact with the gold seal in GC systems that have a gold seal.

**Septa:** Changing inlet septa is a routine part of GC maintenance and should be conducted regularly to avoid leaks in the system and prevent contamination.

## 5. Method

It is essential to confirm that your method can be used with hydrogen carrier gas. If you are using any regulated methods (eg. EPA, ASTM), first check what carrier gases are permitted. If hydrogen is permitted, then research your method(s) of interest to see whether there are any application notes on this method?

**Method translation software:** Method translation software is available from a variety of sources and can be used to calculate GC settings when using hydrogen carrier gas. This will enable you to optimise your method and explore column options prior to actually setting the system up with hydrogen carrier gas.

**Use of chlorinated solvents:** Formation of hydrochloric acid (HCl) through reaction of Cl and H2 is often cited as a potential problem for GC and GC-MS when using hydrogen carrier gas since HCl will damage the GC system. Reactions between H2 carrier gas and analytes or solvent will normally occur in the inlet, so reducing the residence time of your sample in the inlet is key. Use of pulsed splitless or pulsed split injection can help with reducing residence time of sample in the inlet, reducing the opportunity for formation of HCl or reactions between hydrogen and analytes occurring.

**Inlet temperature:** Using the lowest inlet temperature possible for the method will reduce the potential for reactions between solvents, analytes and hydrogen.

## 6. System setup

**Column conditioning:** When setting up a new GC system with hydrogen carrier gas, you will need to condition the column. Ensure that the end of the column is outside the GC oven when you condition the column to prevent a build-up of hydrogen within the GC oven as this could present a risk of explosion.

**Ion source bakeout:** If you are setting up a GC-MS, it is common to see performance problems when tuning the system, or running samples shortly after setting up with hydrogen carrier gas. This can be seen as high hydrocarbon-like background and a high m/z 29 peak. Baking out the ion source can quickly resolve these issues, with background settling down after an overnight back-out. Details of how to bake out your MSD can be found manufacturers' guides and webinars covering use of GC-MS systems with hydrogen carrier gas.

## 7. Performance checkout

**Signal to noise:** Signal to noise is often reduced when comparing results of samples run with helium compared with hydrogen (2-5 times depending on the system). The reduction in signal to noise can be improved by using SIM detection on a single quadrupole system.

**Fragmentation patterns:** If ion ratios change, it is likely that too much Hydrogen is present in the ion source. This problem can be mitigated by reducing the column ID and therefore reducing the carrier gas flow rate, thus reducing the volume of Hydrogen entering the ion source.

**Peak tailing:** Polar components may suffer more significantly from Peak tailing when using hydrogen carrier gas. After baking out the ion source, peak tailing should reduce and will normally reduce for most compounds after a few days.

**Background:** A few days following changing carrier gas, the background signal should drop to a consistent level.

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