Technical Note

Hydrogen as Carrier Gas

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Benefits of using hydrogen as a carrier gas

The selection of carrier gas for your GC application is important as it will affect the efficiency, speed and cost of your application. Helium has long been the standard carrier gas for GC applications but global shortages and increasing cost over the recent years has led to many labs looking for an alternative.

Hydrogen is becoming an attractive alternative to helium for GC carrier gas due to it being more sustainable. Hydrogen is a more cost effective option than helium and it is readily available since it can be generated from water on-site using a hydrogen generator.

The efficiency comparison between carrier gases is given by the Van Deemter curve which relates the efficiency with carrier gas velocity through the column. When compared to helium, hydrogen has a higher linear velocity and is efficient over a wider range of linear velocities. This reduces run times and increases flexibility with flow rates and temperature conditions to optimize separation and maximize throughput. Hydrogen is an optimal choice for carrier gas as it combines high efficiency separation with short analysis times.

Safety concerns of hydrogen use

Hydrogen is an odourless, colourless and tasteless gas which is lighter than air. It is extremely flammable and explosive causing various safety concerns. Hydrogen can be safely used when the right precautions and procedures have been put in place.

Safety precautions when using hydrogen

GC oven accumulation is an area of concern when using hydrogen as a carrier gas. This can occur due to a break in the column in the GC oven. Most GCs will have an inbuilt safety feature which will automatically shut off the carrier gas if it detects a sudden drop in pressure in the column. Hydrogen monitors should be installed in the GC oven and around the lab to ensure leaks are detected early.

To avoid carrier gas and vaporized sample from entering the lab, split vent ducting can be used. This extracts what comes off the split vent line. A gas saver mode' should be implemented when the system is idle or post injection if running in split mode. This will reduce split flow which reduces the amount of gas being vented out the split vent which in turn will reduce costs due to less gas being consumed.

All systems, cylinders, gas lines and regulators should be inspected for leaks and damage periodically. Regulators must be checked for an expiry date and manufacturer guidelines must be followed.

Analytical concerns of hydrogen use

When considering the switch to hydrogen carrier gas, there can be concerns surrounding method translation as maintaining separation and peak shape is crucial. However, the change to hydrogen could actually see improvement in your chromatography due to its increased efficiency. This can result in narrower peak shapes and equivalent separation in a shorter run time.

The viscosity of hydrogen is around half that of helium which means lower head pressure which could cause issues generating the desired column flow rate. This can be resolved by optimising column dimensions by reducing internal diameter size and column length.

Hydrogen is not an inert gas which can lead to issues such hydrogenation of analytes in the GC inlet. This can result in changes to behaviour and response, leading to misidentification of peaks in your sample. Caution should be taken to ensure the switch to hydrogen carrier gas will not cause degradation or alteration to your sample.

Using hydrogen gas for GCMS

When a vacuum is introduced the head pressures must be managed to stay within the GC's working range and therefore to sustain optimal flow, the column dimensions may need to be adjusted e.g. a smaller internal diameter or shorter length.

The lower viscosity of hydrogen will mean the pump will need to work harder to maintain efficient vacuum. Having a suitable pump is crucial to prevent the accumulation of hydrogen in the MS system. An efficient vacuum is required to maintain the sensitivity of your system but it can be expected when using hydrogen to see a decrease in sensitivity compared to helium. There may be an increase in background noise but this can be balanced by high efficiency separation.

Most MS spectra will remain similar but there can be a drop in "spectral match" when using hydrogen but this shouldn't affect the ability to make positive identification.

SCION Instruments Hydrogen Conversion Kit

SCION Instruments offer both a factory built hydrogen suitable GCMS system as well as a hydrogen field kit upgrade for an existing GCMS to convert from helium to hydrogen carrier gas. This kit modifies the existing MS system with some minor hardware changes and increased safety measures. Get in touch with our Applications or Technical Support Team for more information.