Many gas chromatography (GC) labs use helium as a carrier gas because it is faster than nitrogen and safer than hydrogen. Unfortunately, helium is a limited natural resource that is becoming much scarcer. The current shortage has severely impacted chromatographers who are finding that helium has become significantly more expensive and is not always available when needed. While helium is abundant in the universe, it is rare on Earth where it is produced by fractional distillation of natural gas.

**Safety Considerations**

The first concern when switching to hydrogen carrier gas is understanding and managing the safety issues. Fortunately hydrogen generators minimize most of the risk. In contrast, high-pressure gas cylinders, which typically contain 50 L at 200 atm, hydrogen generators generally store only 60 mL at 7 atm or less. This means that although a generator can continually produce hydrogen on demand, the stored quantity is quite small making it a considerably safer choice. In addition, the flow of hydrogen from the generator is controlled and on typical units, the maximum flow is approximately 500 ml/min, which is well below the 2 L/min of flow required to reach the lower explosive limit (LEL) for hydrogen in air when released in the oven of an average GC. Generators are also equipped with built-in leak sensors and automatic shut-off features, which turn the unit off if a leak is detected. With scarce helium costs, generators pay for themselves, guarantee a gas supply, and also eliminate the risk posed by keeping high volumes of hydrogen in fine-standing, high-pressure gas cylinders.

Another way safety can be improved is by using flow-controlled analysis. In today's GC labs, analysts can choose between pressure and flow-controlled analysis. When using hydrogen, flow-controlled operation is the best option as the worst that can happen is the fused silica capillary column breaks at the injection port. With the flow-controlled method, only the volume of hydrogen in the inlet and column can be released. This is because the pressure regulator in the injector of an electronic pressure regulation GC will not be able to build pressure, so the system will sense a problem and will automatically enter standby mode. If greater assurances of safety are desired, systems are available that sample the oven air and detect the presence of a different gas (e.g., helium or hydrogen). As a further level of protection, analysts can use metal capillary MXT™ columns, which are virtually unbreakable, instead of more fragile fused silica columns. Metal capillary columns are standard for high-temperature applications, such as simultaneous distillation and biodiesel analysis, but they also perform very well for lower temperature work. While some metal columns may have activity issues, excellent results can be obtained when highly inert, Stellite™-treated columns are used.

**Benefits and Application**

The biggest advantage to using hydrogen as a carrier gas is that it can significantly decrease analysis time. Realistically, analysis times can be reduced by a factor of 1.5 to 2 with very minor losses in separation, which greatly improves throughput and productivity. A quick review of a van Deemter plot for common carrier gases makes this quite clear (Figure 1). Nitrogen offers the greatest efficiency (shortest height equivalent to a theoretical plate), but its maximum efficiency is only obtained when operating at a very slow rate (~10 cm/sec), when linear velocity is increased, efficiency is lost at a dramatic rate. Helium is somewhat less efficient, but offers more reasonable operating rates (~25 cm/sec is optimal and less efficiency is lost at higher rates). However, the best chromatographic performance is seen using hydrogen. Maximum efficiency is comparable to helium, but good results can be obtained across a much wider operating range. Optimal linear velocity when using hydrogen is approximately 40-45 cm/sec, this means analysis times are much faster compared to when using helium, and in many cases results can be obtained in half the time. The theoretical benefits to productivity when using hydrogen are clear, but let’s look at a practical example. Figure 2 shows the analysis of a hydrocarbon mixture in the same GC using helium versus hydrogen. When using hydrogen, twice the linear velocity was used and the components elute twice as fast with minimal negative impact on efficiency. Peak separations were significantly improved.

**Figure 1:** Using hydrogen as the carrier gas allows efficient separations to be obtained in half the time compared to when using helium.

**Figure 2:** Hydrocarbons can be separated in half the time using hydrogen as the carrier gas, significantly improving productivity.
Hydrogen can be reliably produced on demand using hydrogen generators, which are safer and more cost-effective than freestanding, high-pressure gas cylinders. In addition, using hydrogen allows efficient separations to be obtained twice as fast compared to helium, which offers clear benefits to sample throughput and overall lab productivity.

Restek Corporation
Restek is a leading developer and manufacturer of chromatography columns, standards, and accessories. We provide analysts around the world with the innovative products and services they need to monitor the quality of air, water, soil, food, pharmaceutical, chemical, and petroleum products.
www.restek.com

References

Read, Print, Share or Comment on this Article at: Petro-Online.com/Articles