Helium
Economising world usage

Part 2. How the industrial gases business is developing alternatives to helium in a myriad of applications and economise world usage of this finite resource.

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With the global helium supply chain in limbo and a relatively uncertain future lying ahead, the gauntlet has been thrown down – could helium be replaced in the myriad of applications that presently rely on it, and if so, with which gases?

While one area that could be significant in the helium supply chain is recovery and recycling, the new century's leading scientific minds are also working to find the alternative solutions for arguably the hottest of today's hot topics.

Dan Baciu, as Head of Global Helium Business Development at Linde, is one of those at the forefront of this quest for future solutions and explained, "There are two approaches that will help economise on world helium usage. One is substitution through use of another gas and the other is recovery and recycling of helium."

"Some industrial sectors have come up with their own alternatives to helium. About five years ago, there was an understanding that cooling down photovoltaic panels required helium in the same way as it is required by electronic wafers. When this technology first emerged, this industry believed helium was the only way to cool the glass substrate."

"Naturally, gas suppliers watched these developments with some concern, particularly the amount of helium that these manufacturers were projecting to require in the following 5-10 years. In fact, the industry itself discovered that helium could be replaced with argon or, in some instances where less sophisticated photovoltaic panels were manufactured, even nitrogen."

Baciu continued, "The price of one cubic metre of argon is significantly less than the same quantity of helium and when you move to nitrogen, this gas costs significantly less than argon. So these industry players managed to save significantly on operating costs before any helium was even required, because all this took place during the forecasting phase."

Helium is also used in leak testing and Baciu says Linde is working to move some of these users from high to low helium concentrations. Leak testing is typically carried out on an industrial scale with a mix of helium and nitrogen and sometimes, particularly in the US where helium has been traditionally more abundant and less expensive, many manufacturers choose to use 100% helium.

"Now we're trying to educate this industry - with the support of the manufacturers of leak testing equipment – that using a high percentage of helium is unnecessary, because a lot of that helium is simply being wasted. In fact, using 100% helium reduces the chances of finding the leak, because with so much helium in the surrounding environment, the highly sensitive leak test equipment might 'sniff out' some waste helium in the environment instead of the leak. For this type of application it's possible to go as low as about 5% helium in nitrogen," he explains.

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Another alternative that has been identified for certain applications involving helium is the substitution of hydrogen for the helium. Like the helium atom, the hydrogen molecule has a very small size, making it a viable alternative. It is now believed that many users of helium, including those in the laboratory environment could actually employ hydrogen in certain instances. An initial obstacle to replacing helium with hydrogen is, of course, hydrogen's flammability. The flammability range for hydrogen in air is 4-75% volume, but, typically operators will target the percentage level of hydrogen in the workplace environment to be below 50% of the lower explosion limit (LEL), so only 2% of hydrogen in the atmosphere is regarded as a safe working environment. However, good operating practices which avoid hydrogen gas leaks coupled with the added security of hydrogen gas sniffers or gas detectors can often mitigate the risks of these flammability concerns.

Laboratory alternatives

In a laboratory environment, a carrier gas transports the samples to be analysed in a gas chromatograph through a column into a detector, where the sample is then analysed. Typically helium, hydrogen and nitrogen are used in this application. The choice of carrier gas is dependent on the type of detector, the specific application, which type of column is used for separating the sample, and also the level of safety required.

Stephen Harrison, Global Head of Specialty Gases and Specialty Equipment at Linde, says that often the main drivers for the transition from helium to hydrogen are the shortage of helium and its high cost relative to hydrogen. However, hydrogen also has the analytical advantage of having a lower viscosity, which makes the analysing time faster, increasing the laboratory productivity. In addition, hydrogen has a broader range of separation performance, as a result of this lower viscosity, and is therefore used specifically for capillary columns in a gas chromatograph, which are very narrow.

"This type of application is found in market sectors where environmental analysis is conducted to determine air quality or for emissions monitoring, as well as in laboratories undertaking analysis for the food, pharmaceutical and petrochemical industries and also universities," he explains. "The most commonly used detector for these carrier gases is the gas chromatograph flame ionisation detector (FID), which is used for analysing hydrocarbons and volatile organic compounds (VOCs) and is the workhorse of these types of laboratory.

"Other types of detectors able to use either helium or hydrogen are the thermal conductivity detector (TCD) and the electron capture detector (ECD), which is used specifically for environmental testing and can detect to very low parts per million (ppm) or even to parts per billion (ppb)."

In the petrochemical industry, the flame photometric detector (FPD) can use hydrogen as a carrier gas to analyse sulphur and sulphurous compounds to determine the sulphur content of fuels, for example.

"There are, however, some applications where helium must be used and it cannot be substituted with hydrogen," says Harrison. "For example, the helium ionisation detector (HID) is a very specific type of detector that can analyse volatile inorganics in very low ppm levels and it relies on the specific properties of helium to function. Hydrogen also cannot be used when analysing unsaturated or aromatic hydrocarbon solvents, because it is a reactive gas that could possibly hydrogenate these samples and thereby distort the analytical results."

Laboratories that opt to replace helium with hydrogen in suitable applications can source this gas from a hydrogen generator, hydrogen cylinders, or a combination of both. Where cylinders are used, switchover panel technology can also be used to monitor the pressure of a cylinder and automatically swap to an adjacent full cylinder of the same gas when the first one runs empty, thereby ensuring continuity of supply.

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"In a laboratory, continuity of gas supply is critical and the last thing you want is to start a sequence of analysis, only to run out of gas halfway through, effectively ruining the sample and then having to abort the sequence," says Harrison. "A switchover panel allows personnel the opportunity to change out the first cylinder while the second one is running, ensuring an uninterrupted and trouble-free flow of gas."

Another option with high supply integrity is a hydrogen cylinder switchover panel as a back-up to a hydrogen gas generator. This option can automatically switch supply to a cylinder when the generator gas runs too low, for example in the event of the hydrogen generator water reservoir running dry, or a power outage when the gas generator will no longer be able to function.

Security of supply

Carlos Nulman, Head of Global Helium Business at Linde, has the final word, "Due to its unique properties and the fact it is so vital to so many applications, security of supply is often the most critical factor. Because of a variety of factors contributing to great uncertainty to future availability, as a leading helium supplier, Linde is committed to giving customers peace of mind by maintaining a balance between supply and demand through the most diverse source portfolio and the most robust supply chain in the industry."

"Simultaneously," he added, "we are also helping these customers to incorporate recycling and reuse when viable or to find suitable alternative gases for their applications that can do the job of helium wherever possible."

With security of supply, alternatives and recovery and recycling still at the forefront for suppliers and customers alike, the helium supply story is far from over. ❑