Hydrogen the underrated Tracer Gas

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When analysing the physical properties of gases, relevant for leak testing one immediately finds that hydrogen is superior to all other gases. It is also the cheapest tracer gas available. Experts have nevertheless previously ruled it out because it is commonly regarded dangerous. This is because hydrogen can form explosive mixtures with air. Few have realized that hydrogen can be totally safe when handled in the right form: diluted with nitrogen.

The ban on Freons, the high prices and maintenance costs of mass spectrometers and the advent of an new high-performance hydrogen leak detector has led industry to re-discover hydrogen.

Hydrogen is the ideal tracer gas for leak testing. It is the lightest substance in the universe, its molecular velocity is the highest, and its viscosity is lower than that of any other gas.

These properties make hydrogen behave very differently from other tracer gases. It is much easier to inject into test objects, it mixes quicker with air and other gases, it has a much higher leak rate, and it is very much easier to ventilate.

The normal background level of hydrogen in air is only 0.5 ppm, while the level of helium which is another common tracer gas, is 5 ppm. The background level limits the practical sensitivity of any gas detector.

Hydrogen is a naturally occurring gas which is totally non-toxic and has no adverse effects on the environment. It is also the cheapest tracer gas of all, especially when industrial grade is used.

Thought of as dangerous

There are essentially two reasons why hydrogen has not been widely employed for leak detection:

a) no suitable hydrogen leak detectors has been available, and

b) hydrogen is commonly regarded dangerous because of the potential explosion hazard when high concentrations are being handled.

It is a widespread misconception that the flammability of hydrogen would make it impossible to benefit from its advantageous properties in leak testing. In fact, hydrogen is only flammable in the concentration range 4% - 75% in air or oxygen and can only detonate in the range 18% - 60% in air or oxygen. By using pre-diluted hydrogen one can avoid the flammable concentration range altogether. Standard hydrogen/nitrogen mixtures are for example, commonly used as a protective atmosphere in industrial furnaces.

Non-flammable mixture

Hydrogen, like many other substances, such as ethanol, hydrogen peroxide, etc. is only flammable at high enough concentrations, and totally non-flammable when suitably diluted. Hydrogen can therefore safely be employed for leak testing if used at the right concentration. Other tracer gases are also often used in diluted form, but then for cost reasons.

A suitable concentration to use is the standard 5% hydrogen / 95% nitrogen mixture which is available in industrial grade from most gas suppliers. The price is only a fraction of the price for helium. Special mixtures can be made to order, but at a much higher price. The 5% mixture is classified as non-flammable according to international standard ISO 10156. This standard not only describes how flammability limits of gas mixtures are to be determined, but also states that hydrogen/nitrogen mixtures containing less

than 5,7% hydrogen are non-flammable, irrespective of how this mixture, in turn, is mixed with air.

Less accumulation

The high molecular velocity, low viscosity and low density of hydrogen make it extremely easy to inject the gas and get it to spread evenly inside the test object. It is also very easy to ventilate away gas that has leaked out into the working environment. Hydrogen, released through leaks or otherwise, does not accumulate as much as other tracer gases do. It is in fact, very much easier to work with than the second lightest gas-helium.

No need for vacuum

The extreme lightness of hydrogen can be of use when carrying out integral leak testing, i.e. when testing a whole object at once rather than sniffing over its surface. The test object is simply enclosed in a hood in which the air is out into circulation with a fan. This technique is often not very successful with heavier gases but works extremely well with hydrogen. Employing this technique and a hydrogen detector that works at atmospheric pressure is a quicker method than conventional vacuum methods.
Not having to pump for vacuum in order to collect and detect the tracer gas saves a lot of testing time. Another common reason for pumping vacuum in connection with helium tests is to reduce the background level. This is seldom necessary when hydrogen is used.

Generally speaking, the physical properties of hydrogen are so different from other gases, including helium that leak testing can be carried out much more easily than otherwise. This is essential in industrial leak testing where sensitivity, speed, simplicity, reliability, and cost are the key factors.

	Air	Hydrogen	Helium
Molecular weight	29 g/mol	2 g/mol	4 g/mol
Density	1,2 g/l	0,09 g/l	0,18 g/l
Viscosity	18,3 10^{-6} Pa s	8,7 10^{-6} Pa s	19,4 10^{-6} Pa s
Background	100 %	0,5 ppm	5 ppm

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