



Helium Leak Testing

Guide to the Fundamentals of Helium Leak Testing

What is helium leak testing?

Helium is used to find small leaks or possibly larger leaks in bigger volumes. The helium is used as a tracer gas and its concentration is measured. .

Why use helium for leak testing?

Helium is one of the smallest gas molecules and is inert (remember your periodic table from Chemistry?). Being inert it is relatively safe to use (rather than hydrogen) and will not react with any of the materials within the part to be tested. In most helium leak testing applications, one uses a mass spectrometer tuned to detect helium. Helium leak testing can be generally be between one thousand and one million times more sensitive than using pressure decay techniques.

What are the benefits of Helium Leak Testing?

Using this technique you can leak test to find smaller leaks than with other test processes, using a temperature stable, dry technique. This should result in a longer product life.

There are 2 basic techniques; high vacuum testing which allows leak test thresholds to be set down as low as 1×10^{-12} mbar.l.sec⁻¹, or sniffing which is generally used for helium leaks down to 1×10^{-6} mbar.l.sec⁻¹. For reference 1 cubic millimetre per second is approximately 1×10^{-3} mbar.l.sec⁻¹.

Most tests use readily available Balloon Gas (yes, this is what is put in kiddies balloons!). On rare occasions certifiably pure gas is used. On a safety note, please remember that helium contains no oxygen and is therefore an asphyxiant.

It is worth remembering that leakage is a flow of fluid from a higher pressure to a lower pressure through a fault in an assembly or manufactured part.

The high vacuum technique requires that the test volume to which the instrument is connected is at high vacuum i.e. less than 10mbar. Can the part or assembly withstand this pressure?

It is possible to test a part at high pressure and high vacuum at the same time. You need to arrange these pressures either side of the leaking boundary. This may mean putting the part under test inside a leak tight chamber.

When testing using helium it is possible to flood the mass spectrometer with helium if there is a large leak. In most instances, where there are many minutes between each test, this is not a problem, one just waits for the instrument to clean itself up.

One can also either sniff or spray helium. Sniffing is used where the part can be pressurised above atmospheric and a sniffing gun is manually positioned round the part. Spraying is where the part can be evacuated and helium is manually sprayed over the outside of the part.

Background Helium concentration.

Helium can and will get everywhere if it can. It gets quite difficult sometimes to determine where the helium is coming from.

There is approximately 5 ppm Helium in the atmosphere. If the part under test is filled with helium it is important that the test charge is taken away and not just released into the immediate area. For just a few tests, the helium can be diluted in the immediate area. For more frequent testing, this may mean piping the extract away to the outside of the building on the downwind side and well clear from doors or windows that could allow it back in.

To locate helium leaks one usually either sprays or sniffs, the latter being the norm in high volume testing. When sniffing one starts with 5 ppm and would usually look to detect an increase of a further 5 ppm.

One can use this detectable rise in helium concentration to test parts inside a shroud where the test pressure is at or near atmospheric pressure. By circulating the air within the shroud and passing it by a mass spectrometer in sniffing mode, you can set an alarm limit at say 8ppm. Again it is important to flush or extract away any contaminated air once the test has completed.

Helium leak testing at high production rates.

When high volume production requires high vacuum, you must also consider the time taken to pump down to the required level of vacuum, this can be significant.

At higher production rates, having much shorter time to test a part, large leakers may be a problem. The flooding of the leak test instrument with helium may take several minutes for the helium to reduce to a level where testing can recommence. To reduce the effect of a large leaker one can; build up to the full test pressure, build up to the full concentration, flush the mass spec with a gas with no helium present or pre-screen using an air decay technique before helium testing (this would only allow small leakers to be helium tested).

When testing at high speed it is important to reduce the test time to its minimum. To do this one may have to employ a number of techniques to; reduce the test volume (by infilling voids and ensuring minimum pipe run volumes), nitrogen flush, etc. Of course at high speed the automatic handling of the product and automatic connection play a large part.

Helium mixing, helium recovery and helium re-use

When testing large volumes, at higher pressures and at high speed, the quantity of helium being used may become significant. There are a number of techniques to reduce the consumption of the helium gas.

First of these is to mix the helium with another lower cost gas either nitrogen or compressed air. This is only possible where the sensitivity of the test is not compromised by the mixing process.

The second of these is to re-use the gas from one test by extracting it from the device and then pushing it into the next device. This can often be implemented by a combination of a vacuum pump and simple air cylinder arrangement if the volume is not too large. Between cycles it is possible to use the mass spectrometer to monitor the concentration of helium that is being reused; when the concentration falls below an acceptable level it is dumped and a new charge of helium is used.

The third technique is helium recovery. Here one extracts the helium into an intermediate holding vessel to be compressed to high pressure to recover the helium.

I hope you find the above a useful introduction into the area of helium leak testing. If you have a project in mind or would like a more detailed discussion on the possibilities of helium leak testing your product please contact us at TQC.