What,Why, How of Leak Detection

By Ion Science

Why Leak Check?

A "leak" implies something unwanted - a fault in a component. Early and reliable leak detection improves quality leading to higher customer satisfaction. Food stays fresher for longer because packaging can be tested to higher degrees of seal security. Valves on gas pipelines emit less pollution. Automotive fuel systems are now designed to avoid those annoying oil leaks and exhaust systems to leak less toxic fumes. Just a few examples of where leak testing has and will continue to ensure that products perform to the optimum.

To What Level?

The most critical decision to make is "to what level of leak tightness". In practice everything leaks to a greater or lesser extent even solid steel. We therefore need to be more specific that "it must not leak" and a level established between acceptable and unacceptable leakage based on Fitness for Purpose.

Let us take the example of a chiller filled with 60 gm of refrigerant: over 10 years a 1% p.a. loss in refrigerant can be accepted without any fall in performance, then the maximum possible leakage will be 6kg per 10 years or 6gm/yr. It would be possible to test for global leakage of 0.1gm/yr, with vacuum leak testing, but this would add nothing to the performance, but would add 200 times the cost. So the question remains, To What Level of Leak Tightness?

The bubble chart below gives an order of magnitude for different leak tests compared to underwater testing (simply immersing pressurised components under water and waiting for tell-tale bubbles). Modern leak detection instrumentation can see to incredibly low levels of leakage in just a few seconds when the equivalent under water could take 19 years.

How to Leak Test?

Having decided the level of leak tightness, we need to decide how to perform the test. The first consideration is to choose a test method that simulates the working conditions in the most convenient form. For example take an oil system: to test weld seals using oil would mean that it would have to be cleaned before any re-work is made, by using pressurised air this problem is avoided.

Accurate simulation should account for all the factors that influence leakage: working pressure, the viscosity of the gas/liquid to be contained and the material and structure of the component. Testing speed should match production output to avoid bottle-necks and of course all testing should be to recognisable standards and relevant quality standards.

Which Leak Test?

It is generally held idea that there are thousands of ways to leak test, however, virtually all of these can be placed into four distinct categories:

1. Pressure Decay

This is probably the most popular form of leak detection with its advantages of speed and cost effectiveness compared to any other technique.

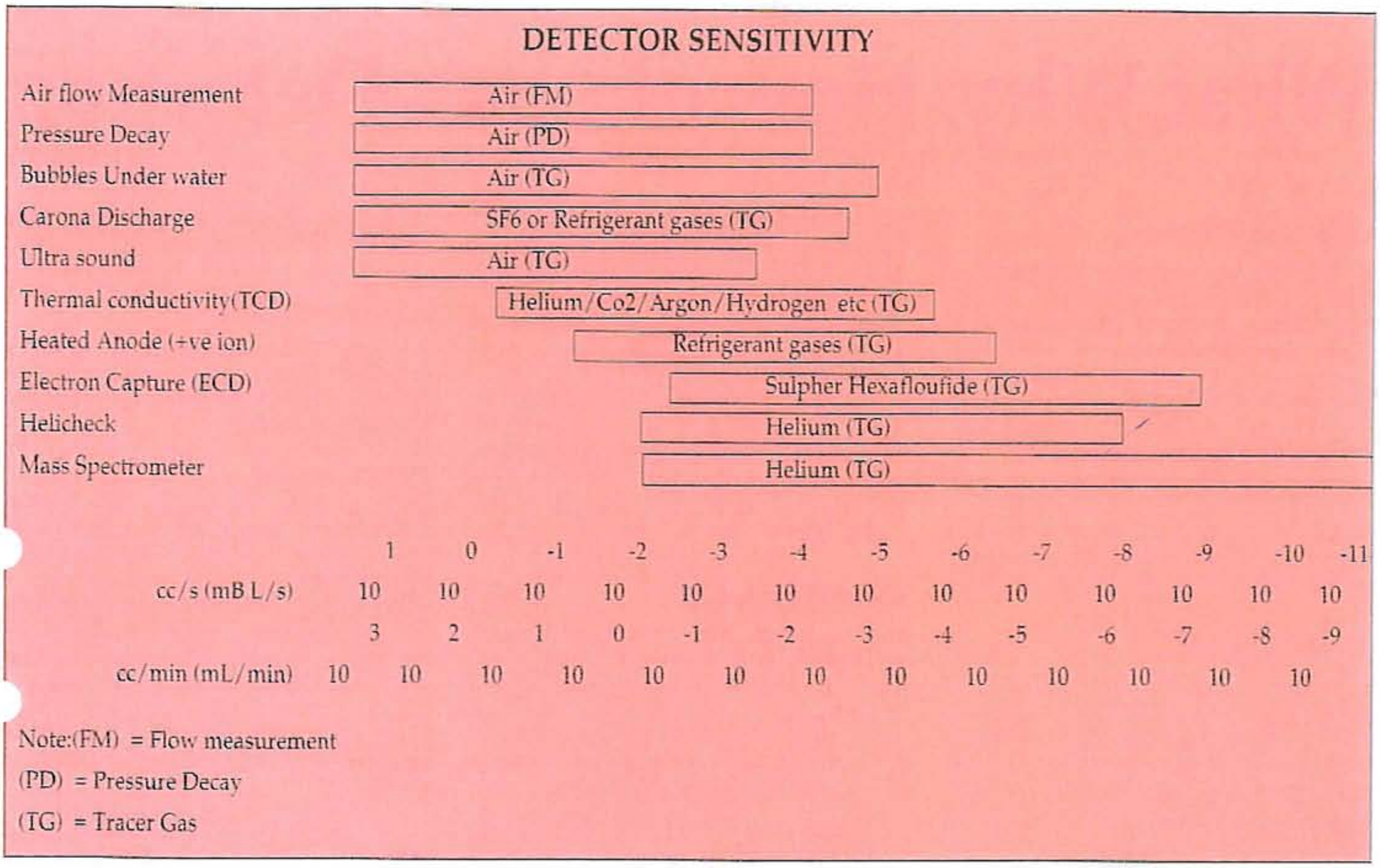
It works on the principle that if we arrange air pressure higher on one side of the component, than the other, then air will flow through the leak as the pressure equalises. The pressure change is sensed through a transducer and electronics and microprocessor interpret the movement as a leak rate.

Using this technique 240 to 300 car radiators per hour are currently being tested by one operator and the company avoids the time and expense of drying processes compared to underwater testing.

Large leaks and small volumes allow the best resolution and this is an ideal technique for testing components that will eventually hold a liquid: pressurised air will always be more leak searching. Small

BUBBLE CONVERSION CHART

LEAK RATE cc/s (ml/s)	LEAK RATE cc/min (ml/min)	Time for 1cc (1 ml)		Time for one 2 mm bubble		Time for one 5 mm bubble	
0.1	6	10	sec	24 bubbles per sec		0.3	secs
0.01	0.6	100	sec	2 bubbles per second		3	secs
0.001	0.06	16.7	min	4.2	secs	30	secs
1E-04	0.006	2.8	hrs	41.9	secs	5	mins
1E-05	6.0E-04	27.8	hrs	7.0	min	50	mins
1E-06	6.0E-05	11.6	days	69.8	min	8.3	hours
1E-07	6.0E-06	16.5	weeks	11.6	hours	3.5	days
1E-08	6.0E-07	165.3	weeks	4.8	days	5.0	weeks
1E-09	6.0E-08	4.5	years	6.9	weeks	49.6	weeks
1E-10	6.0E-09	45.3	years	69.3	weeks	9.5	years
1E-11	6.0E-10	452.7	years	1.9	years	95.4	years
1E-12	6.0E-11	4526.9	years	19.0	years	953.9	years



leaks and or large volumes, plus flexible components are not generally appropriate.

Pressure Decay is often criticised as being sensitive to temperature changes. However, in practice pressure decay instruments now have an advanced array of electronics and software to compensate for these effects and with care need not be a significant problem.

2. Airflow

Flow Measurement Leak Detection is closely related to Pressure Decay, however, instead of measuring the fall in pressure due to a leak, the transducer detects any increase in flow to maintain a pressure: a leak would be indicated by any significant rise in flow, which is measured and recorded by the Leak Detector.

It offers a similar level of advantages and disadvantages as pressure decay, but gives a better resolution on large acceptable leak rates and or large components. It is also allows devices such as taps or valves which have closed (leak tight) and open (pre-set flow rates) positions, to be tested on one instrument.

3. Tracer Gas

For tighter leak specifications and or where it is important to locate the position of the leak rather than just a straight pass or fail, the tracer gas method is preferred.

One side of the component is simply pressurised with a tracer, should there be a leak, the tracers presence will be detected on the other side. There is a vast array of tracers and detectors available and selection largely depends on the degree of accuracy and the speed of testing required.

Choice of Tracer

Generally, gases are used as the tracer, however, dyes, light, ultrasonic sound, are used, but rarely for fast production testing.

Helium is generally preferred, as its natural viscosity facilitates a high propensity of leakage. Worthy alternatives are Nitrogen, Argon, Sulphur Hexaflouride and non flammable mixtures of Hydrogen.

Choice of Detection Method

● **Manual Direct Sniffers**

Sniffing, succinctly describes the nose like process of a detector drawing and analysing a sample for quantities of tracer gas. Generally hand-held at least portable the probe is simply manually traced around any potential points of leakage.

Sniffers vary in sophistication, but a good tracer detector should give an audible and visual signal to pin-point the leak and a direct reading of the leak rate in ml/sec or similar without resort to graphs or charts. Certification to NAMAS is always useful, particularly if testing to ISO 9000. A range of gas sensing technologies are used with varying degrees of sensitivity and selectivity and these are two important considerations when purchasing.

● **Fixed Installation Systems**

To make the tracer technique faster, more accurate and less operator dependent, there are a number of ways to automate the sniffing process. The concentration build up, purge and vacuum method all involve placing the component in a sealed test chamber. By controlling the test environment no contaminates can enter and ensures that all leaks are captured. With manual testing an operator can miss a leak and there is no traceability.

4. Form Change

Used almost extensively for pharmaceutical blister packs and other thin film packaging like Crisp packets and cook and chill meals: form change provides an efficient means of checking seal integrity.

It involves placing the component in a sealed chamber and measuring the rise of the film under a vacuum force and then the fall under pressure. By measuring the difference between the convex and concave positions you can determine the level of seal tightness: a good seal will move more than a poor seal.

The test is completely objective and conforms to all regulatory controls necessary for control of food and pharmaceutical safety, to date the process is manual but research is being undertaken to automate the process to meet the high volume production lines associated with these industries.

Is Fixturing Necessary?

The other main aspect of leak detection is Fixturing: the product needs to be held steady during test and open ports sealed; components marked automatically for traceability; other tests possibly performed at the same time; data acquisition to assist in process control and so on - all these points can be considered with your leak detection specialist.