LEAK RATE

Leak rate is affected by the pressure difference (inlet vs outlet), the type of gas that is leaking and the flow characteristics of the leak path. In terms of units, a leak rate can be defined in different ways, but if the SI units are used, then this is expressed in mbar·litre/second.

1 mbar·litre/sec is the amount of gas necessary to be removed from a 1 litre container in 1 second to reduce the pressure by 1mbar.

More generally, the gas flow produced by a leak in a container can be defined as follows:

$$Q = V \frac{\Delta p}{\Delta t}$$

Where Δp is the difference between the internal pressure and the external pressure, Δt is the time, and V is the volume of the container itself.

The units can be changed using specific conversion factors.

Example: What is the leak rate for a football with the following characteristics?

- Diameter: 22cm
- Pressure: 1.9bar
- The football is flat after 1 month (internal pressure = external pressure)

$V = \frac{4}{3}\pi r^3 = 5.575 \cdot 10^{-3}$ m^3
$\Delta p = 1900 - 1000 = 900$mbar
$\Delta t = 1$month $= 3600 \cdot 24 \cdot 30 = 2.592 \cdot 10^6$ seconds
$Q = 1.935 \cdot 10^{-6}$ mbar·litre/sec

DIFFERENT LEAK RATES FOR DIFFERENT GASES

Different gases have different values of viscosity; therefore the leak rate from an orifice of given geometry in the unit of time will be different if the leaking gas is helium or hydrogen for example.

In laminar flow conditions, the equation linking leak rates of different gases is the following:

$$Q_1 = \frac{\eta_1}{\eta_2} Q_2$$

In molecular flow conditions instead, the equation is:

$$Q_1 = \sqrt{\frac{\eta_1}{\eta_2}} Q_2$$

Where **Q** represents the leak rate of the two gases, and η is the relative viscosity.

Note: Sometimes leak rates are defined in atm.cc/sec. The relationship between atm.cc/sec and mbar·litre/sec is the following:

1atm.cc/sec = 1013mbar·0.001litres/sec = 1.013mbar·litre/s

Interesting fact

Everything that is manufactured leaks to some degree, so having no leak at all in a product is impossible. However it is possible to have different leak rates, which of course depend on the quality of the materials, the precision of the work/forming process carried out on the parts (welding, die-casting, etc.), etc. It is therefore important to define how small the maximum acceptable leak rate is for a product; any component with a bigger leak rate should be classified as a reject or sent to a re-work station. A helium leak detection system is designed to give a measurement of the leak rate associated to a specific component, so that this can be classified as a "pass" or a "fail".