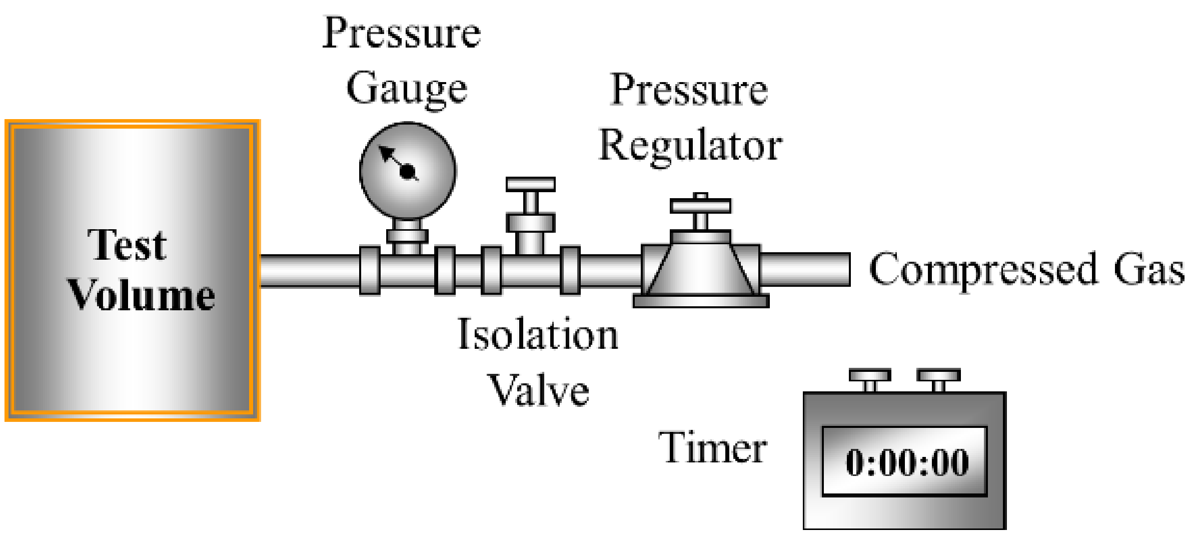
The Pressure Decay Test Method

Pressure Decay Testing Arrangement

Pressure decay is probably the most widely used method of leak testing in manufacturing production lines. The process is uncomplicated, relatively inexpensive and easily automated.



Air is simply injected into a test object, after which the pressure source is valved off. Any decrease in air pressure over time signifies a leak.

For pressure decay, sensitivity is a function of the object's size and the time interval of the test. Medium and large objects require a longer cycle time to achieve an adequate level of sensitivity for most applications. For medium-size objects, sensitivity is limited to the detection of leaks emitting 0.5 – 1.0 cc/min.

Note:

The sensitivity provided by the pressure decay method is perfect for many tests requirements in the automotive industry such as oil pans, most casted part, engine blocks and cylinder heads.

It is important to know that the pressure decay method is ill suited for testing elastic or plastic materials. Elasticity in components counteracts the pressure decay and creates the opposite effect if material gives way under pressure.

The key element for many decay systems is the construction of the fixturing and especially the presence of elastomers. This will be explained under fixturing details later in this document.

- When using pressure decay, the following information is important:
- The pressure drop is directly proportional to the leak rate
- The detected pressure drop can be converted to a leak rate if:
- The internal volume of the tested part is known.
- The pressure drop is measured accurately.
- The time of the test is recorded.

The leak value when using the pressure decay method can be calculated by the following equation:

$$Q = \frac{(P_1 - P_2) * V}{t}$$

With:

Q = Leak rate in mbar.l/s

P_1 = Initial Pressure in mbar

P_2 = Final Pressure in mbar

V = Volume in liters

t = Time in seconds

The smallest change in pressure that can be detected is about 0.1 Pa, 0.001 mbar or 0.0000145 psi. Temperature variations are to be observed closely for maximum accuracy.

Nolek Pressure Decay Instruments

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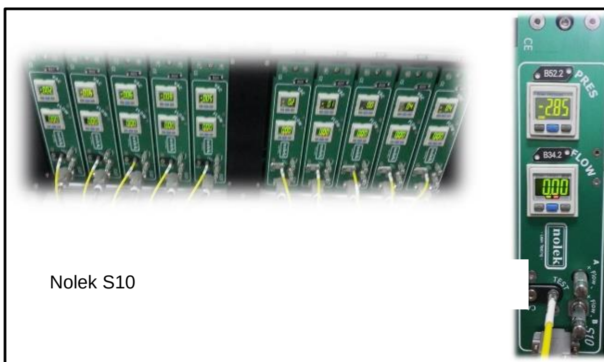

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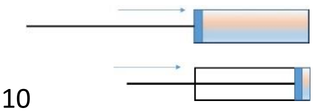
Decay Calculations

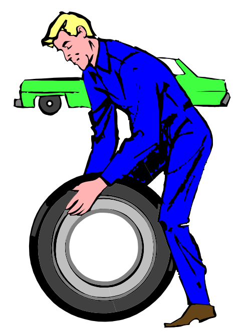
An air leak is a flow of air that is often expressed in Normal.Liters per minute (NL/min). This is a unit of mass for gasses, which is equal to the mass of 1 liter at a pressure of 1 atmosphere and at a standard temperature (Most often 0^0 C).



If air under the conditions as stated above is trapped under a piston in a 10 liter cylinder at atmospheric condition, the cylinder would hold 10 NL of air. Driving the piston down and reducing the volume to only 1 liter would result in a pressure rise to 10 atmosphere. (Assuming no temperature variations). It is important now to understand that the cylinder still holds the same 10 NL.

With this knowledge, the total quantity of gas in a pressurize cylinder can easily be calculated and expressed in NL by multiplying the pressure indicated on the gauge (+ 1 atm) in atmosphere by the cylinder internal volume in liters.

In case of a leak we will see that we lose “Normal Liters” over time, but as “leak quantities” are normally very small we express this volumetric loss in different ways such as 4 mm^3/min or 0.01 mbar.l/sec.



A practical example

In the following simple example, we can calculate the leak in an automotive tire when we lose 2 PSI or 0.136092 atmosphere in 60 days. (In this example, we consider that the volume of the tire does not vary/diminish because of the pressure).

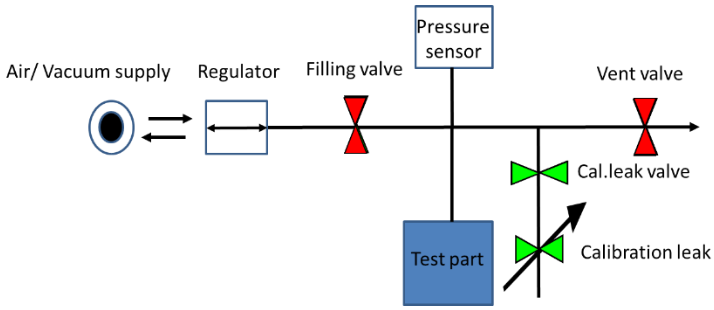
With the tire having a volume of 30 liters and a pressure of 32 PSIG or 2.177471 atmosphere, we calculate that the tire contains 30 * 2.177471 = 65.32413 NL.

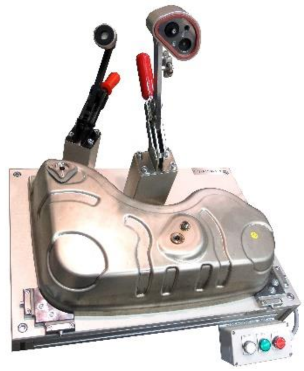
A loss of 2 PSI or 0.136092 atmosphere equals a volumetric loss of 30 * 0.136092 = 4.08276 NL equals 4082.76 Normal Cubic Centimeter.

60 days converts to 5184000 seconds. So we can now express this leak in atm.cc/sec being 4082.76 / 5184000 = 0.00078757 atm.cc/sec or scientifically notated as 7.8757E-4 atm.cc/sec. This is equal to 7.95 * 10^{-4} mbar.l/s or 0.805 mm^3/s

(The unit mm^3/s is generally used for larger leaks and is most common in the automotive industry. The unit g/year is often used for smaller leak rates and is widely used in the refrigeration industry).

Simple Decay Arrangement





Testing manual fixture for exhaust parts