SEALED COMPONENT LEAK TESTING WITH ATEQ'S PRIMUS F620

Leak Testing Academy
Measurement Education and Studies

PURPOSE: To provide a basic understanding of how to air leak test products that do not have an opening using a Primus F620

LEAK TESTING is an important quality control test in the manufacturing industry. Since there is no such thing as a completely leak-free component, the key is to determine what leak rate is acceptable in order to manufacture products that are safe and adequate for the customer's needs.

This article is designed to assist people that have never used an air leak tester to quality control test a fully sealed component. This includes guidance on different test methods, formulas, test fixture designs, test time, test materials, part temperature and test environments that are involved in ingress leak testing products that do not have any openings to connect to a tester such as: food packaging, waterproof electronics, watches, cosmetics, and medical devices.

ABOUT THE AUTHOR

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Anne-Marie Dewailly is ATEQ's North American Technical Director responsible for carrying out feasibility studies, training customers and employees. Currently residing in Nashville Tennessee, she has 32 years of experience in industrial leak testing. Originally from France, Anne-Marie started with ATEQ in 1988 as a product development engineer acquiring extensive experience in industrial leak test applications and instrumentation. She is a listed inventor in patents in the air leak test field.

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ATEQ is the leading global manufacturer of fast and accurate leak testing equipment. Since 1975, ATEQ has been building a leak testing knowledge portfolio filled with hundreds of renowned manufacturing companies and how to leak test thousands of different manufactured components.

ATEQ provides leak testing instruments to all manufacturing industries including: automotive, medical, electronics, valves, packaging, appliances, aerospace, HVAC, agricultural and batteries.

ATEQ has experienced application engineers in more than 40 countries all around the world that can provide consulting and leak testing instruments to create efficient leak or flow testing solutions. ATEQ can assist with teaching the science of leak testing, application studies, developing testing specifications, selecting the right leak tester, integrating leak testers into automated production lines, training, instrument calibrations, technical support, repairs and preventative maintenance.

SEALED COMPONENTS

A sealed component is a part that cannot be pressurized on the inside to perform an air test.

APPLICATION EXAMPLES

Sealed components have no opening to pressurize and are common in the food packaging, pharmaceutical packaging and waterproof electronics industries.

Food packaging needs to be airtight to keep liquid in, bacteria out and to keep contents fresh. However, not all food products in sealed packages are 100% tested on the production line for small leaks, only sample bench tests are performed.

Medical packaging often has strict leak testing specifications because it is very important that contents stay contained, fresh and sterile. For pharmaceutical and medical products, the requirement is 100% production line testing for small leaks.

Electronics typically have an IP rating that defines the level of sealing effectiveness of electrical enclosures against intrusion of foreign bodies like dust, moisture and liquid. These portable waterproof electronics and digital sensors, require 100% production line testing.

TEST METHODS

ATEQ offers 14 different test methods using compressed air, vacuum, ionized air, tracer gas, evaporation and test methods for devices sealed with breathable membranes.

This article is exclusively about testing using air pressure or vacuum to test a device that is fully sealed to air/gases and has some empty space inside. Air pressure or ionized air tests are typically the go-to choice for leak testing sealed components over using the more expensive tracer gas as a testing medium.

Sealed component tests are a little bit tricky, due to the fact that they can only be pressurized from the outside and only a finite amount of air can get in.

The amount of air flowing in though a leak decreases in time as the device under test fills up. Once the component is filled with air, there is no more pressure decay or leak flow. So a device under test with a large leak behaves like a device with no leak at all.

The usual pressure decay leak test cycle can not be used to test sealed components. For example, if two chaffing fuel cans are enclosed in a very tight test chamber, one good can and one with a hole, the test would show no pressure decay because the can with the hole would be immediately filled with test pressure.

Because of this, ATEQ came up with the various sealed component test cycles, for testing fully sealed devices with some empty space inside, like the chaffing fuel cans. To test devices with no empty space inside, ATEQ has other test methods. Contact ATEQ for more details.

TESTING SEALED PARTS WITH EMPTY SPACE

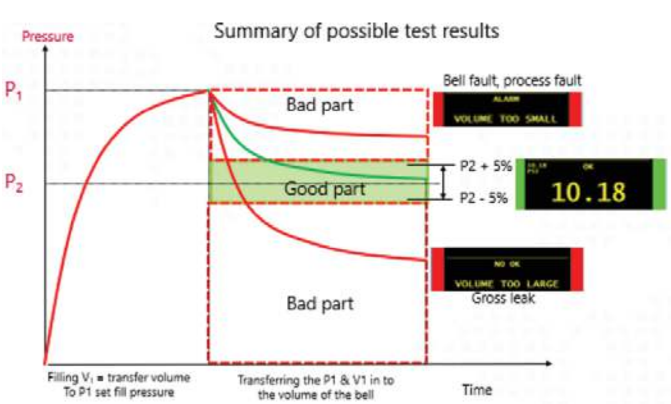
To test a fully sealed part, it is put into a sealed test chamber and undergoes a large leak volume air pressure test followed by a standard pressure decay test.

Watches often require leak testing. Testing a typical Silicon Valley waterproof smartwatch with microphones and speakers would be leak tested differently than a mechanical watch since the smartwatch has ports to test. A luxury mechanical watch, however, is completely sealed with no ports or equalizing membranes to test.

First the watch is put in a sealed test chamber with minimum air volume. A "volume test" or "large leak test" is performed with air pressure, to detect a volume difference between a reasonably sealed watch and a wide-open watch to first test for major leaks.

The volume test is done using air pressure. The internal volume of the instrument is filled at some given pressure, for example 10 PSI.

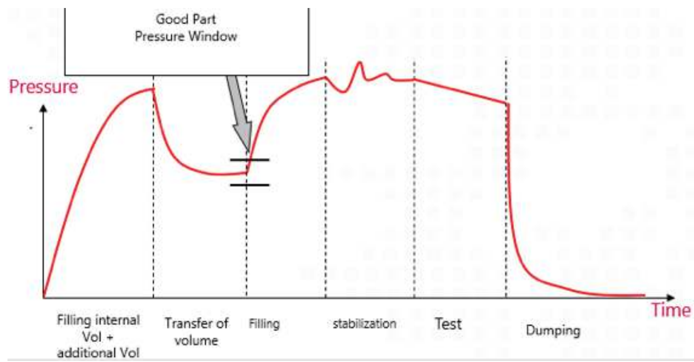
Then it is put in communication with the test chamber. The pressure will equalize between the two volumes and get to 5 PSI, for example, if the watch is perfectly sealed, and to 4 PSI for example, if the watch is not sealed.



Second, a regular pressure decay test is performed if the watch passes the initial "large leak" test.

For example, fill the chamber to 10PSI, close the air supply, let the air stabilize, and verify that the pressure does not drop.

A typical test cycle will look as follows.



The volume test itself has to be very accurate and repeatable. On this system, the test is based on PV=nRT, known as Boyle-Mariotte 's Law.

The instrument fills a volume at a given gauge air pressure (Pg1) and empties it in the test chamber where the watch under test is. The test chamber initially has only atmospheric air pressure (Patm).

When the two are put in communication, the common pressure becomes the Vint (the internal volume of the instrument) and Vchamber (the volume of the test chamber).

FORMULAS

An air test of a sealed watch is a race against time. Given enough time, any leak will end up filling the watch, then there is no more pressure decay to measure.

The volume test is based on detecting the difference Pg2 over Pg'2

Pg2/Pg2'= (Vint + Vchamber + Vwatch) / (Vint + Vchamber))

The difference between a non-leaking watch and a wide-open watch is directly proportional to the initial pressure inside the instrument (Pg1).

The internal volume of the instrument (Vint) does not change over time.

Air Pressure regulators are not perfect so Pg1 will vary over time.

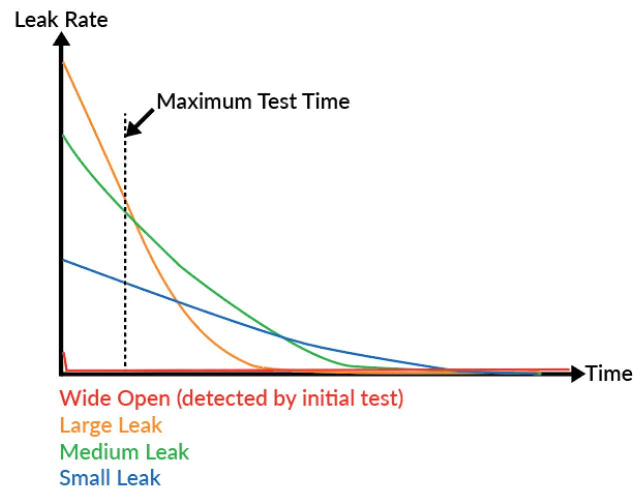
If the pressure difference between a good watch and a bad watch is always changing, how can we test? ATEQ has a solution for that: The rejection criterion is kept in memory as a proportion of the Pg1, so the pass/fail is adapted with the variations of Pg1.

Choosing Test Pressure. The test pressure generally calculated at the depth specification of the device.

If the watch is designed for 100-meter dives, the maximum air test pressure will be 100 meters of water column, close to 142.2 PSI.

The devil is in the details. A watch has a very small internal volume, at times less than a cubic centimeter. This small volume can make watches difficult to test since the part fills extremely quickly with air. Given enough time, any leak will end up filling the watch, then there is no more pressure decay to measure. A leak will first show as a large pressure decay then decrease until at the end there is no pressure decay anymore. The largest leaks will fill the fastest.

LEAK RATE VS. TIME ON A SEALED COMPONENT



There is no time to wait for the perfect repeatable measurement: the faster the better. The goal is to stay in that area defined on the left side of the maximum test time on the diagram.

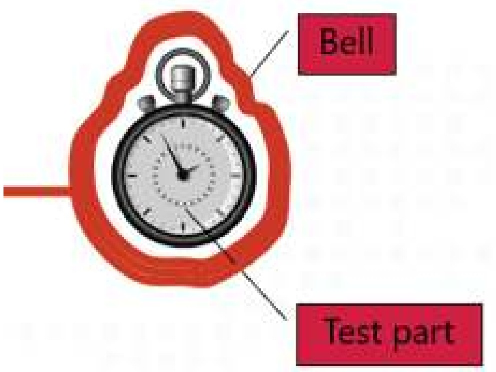
TEST CONSIDERATIONS

Chamber design along with part volume variations and flexibility need to be considered when designing sealed component leak tests.

The tester itself has to have a very small volume, and has to be able to quickly detect very small pressure changes.

Also, a Pascal leak size of pressure drop to air flow in standard cubic centimeters per minutes (sccm) correlation is impossible because a large leak fills the watch fast and could give the same pressure drop reading as a small leak (where the curves cross on the diagram).

The test chamber volume has to be minimal, and the chamber (bell) has to be very rigid so no volume variations affect the readings.



Watch manufacturing is not perfect. Production watches will have volume variations. These volume variations prevent the test chamber from being of a design that is too tight, and they also create a variability in the initial volume test.

Good vs. bad test parts can be confusing if it is not known which part is good and which has a leak. If the bad part is not known, a man made leak can be created. Making a large leak in a watch can be done using a drill press.

In order to ensure a good non-leaking watch is used, it can be submerged under hot, but not boiling, water. The hot water will heat up the watch and the air inside of it will cause the pressure to build up (PV=nRT). If there is any leak, it will create a stream of small bubbles.

Flexibility issues: PV=nRT but V changes. If the watch is made of a somewhat flexible material, like a plastic housing, the collapse of the sides could build up a pressure inside nearly equal to the test pressure. Both the volume test and the pressure decay leak test would become irrelevant.

If this is the case, ATEQ has other solutions to test these types of parts. Contact ATEQ for more information regarding this type of application.

TESTING DESIGN TIPS

ATEQ instruments have leak tested hundreds of thousands of watches at assembly plants all around the world.

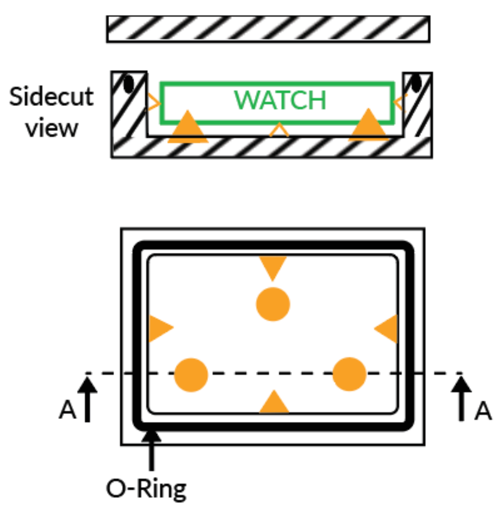
Temperature issues: PV=nRT but T changes. If the watch is not at the ambient temperature, or at the temperature of the test chamber, T will change during the test and the pressure decay test will be affected.

The watches should be handled by an operator with insulating wool gloves to keep the operator's hands at body temperature, which is generally superior to plant temperature.

If the watch is not at the exact same temperature as the test fixture, the heat exchange by contact would be huge. The solution is to minimize the surface of contact, and make the surface out of insulating material, like plastic. Plastic is softer and does not scratch the watch.

Minimizing the contact surface also prevents any contact with the test fixture that seals a leak path. The points of contact are chosen in an area that is not likely to leak.

7 POINTS OF CONTACT TEST HOUSING



7 Points of contact in plastic to minimize heat exchange between the watch and the test chamber

Environmental Conditions. It is always advisable to put heat insulation and reflective tape on the outside of the test fixture and test hoses. The test environment can heat up or cool down the test station, despite insulation.

So do not put the test station behind a window, under a heating/air conditioning duct or any other source of heat.

The part under test has to be dry since water tends to seal the leaks. The fittings in the test circuit have to be glued on the first thread. The choice of fittings and hoses in the test circuit is crucial.

ATEQ is here to help through the entire process. It can be difficult to know where to start when it comes to leak testing. ATEQ's Leak Testing Academy offers an Intro to Leak Testing training class for those who are new to leak metrology. If a manufacturer has an application but needs help determining testing specifications, ATEQ can provide consulting based on our extensive global application portfolio.

ATEQ also has many years of experience working with machine builders to figure out how to create custom fixtures to automate leak testers into production lines.

ATEQ has a dedicated support team available to troubleshoot any issues that may arise along with in-house or on-site repairs, calibrations, ISO 17025 calibrations, preventative maintenance and service packages.

Please contact ATEQ for all of your leak/flow testing needs.

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