LACO TECHNOLOGIES

APPLICATION NOTE

NOTE #20-01

VALIDATING A NEW LEAK TEST SYSTEM: THE DUAL DISTRIBUTION TECHNIQUE

GO / NO-GO LEAK TESTING

A production leak test system is a “go- / no-go” instrument, meaning it is designed to test and sort between parts that leak and parts that do not leak in relation to a specified leak rate reject limit. In a production environment, when short cycle times are often desirable, the leak test systems are designed to give the highest test reliability in the shortest cycle time. Under these high-speed conditions, it is often not practical to provide reliable measurement results for leaks that are much lower than the leak rate reject limit, nor for gross leaks, which are well above the limit.

Of particular concern is ensuring that the system does not pass leaking parts, and very rarely will reject a “no leak” or good part. It is often a tug and pull between test cycle time and leak test measurement reliability or process capability.

This document describes on of a few methods that can be used to set up a hard vacuum leak test system and ensure the process is optimized to achieve reliable test results—no false accepts and no false rejects.

METHODOLOGY OVERVIEW

This method can be used for the following types of hard vacuum test methods. Some variations may be required for different methods. This document will describe an adaptation to the “Fill In-chamber” method.

Fill In-chamber Part

The test part is placed in the vacuum chamber and the internal volume is connected to a helium source via a hose or fixed tooling

Pre-filled Part

The test part has been filled with helium and sealed closed prior to being placed in the vacuum chamber

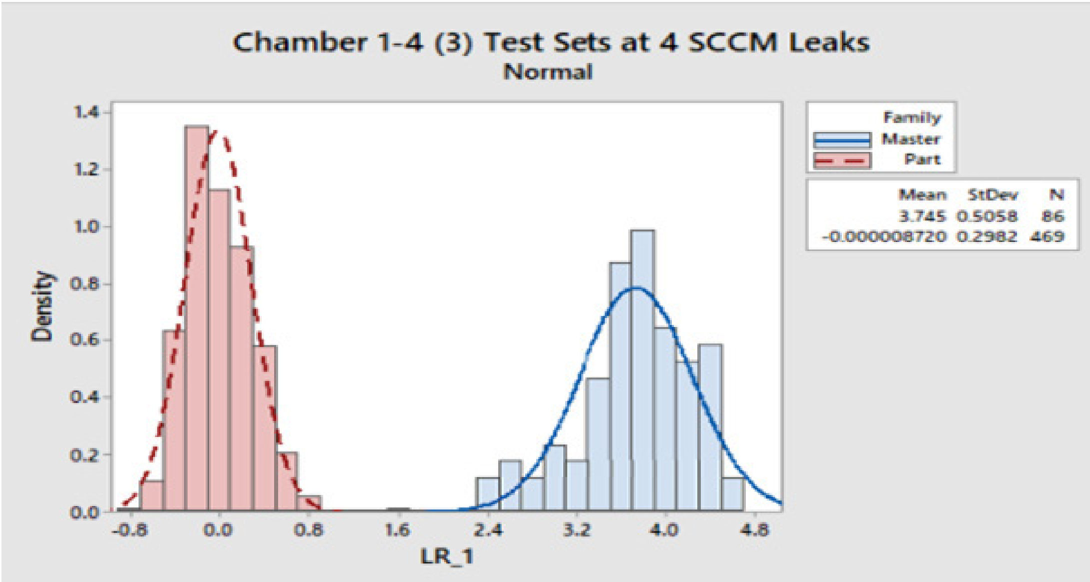
Bombed Part

The test part has been bombed with helium prior to being placed in the vacuum chamber

In simple terms, this method requires testing of several “no leak” parts and several “reject leak” parts, creating a set of test data that can be statistically analyzed as two different normal distributions—a distribution of “no leak” parts, and a distribution of “reject leak” parts. If the two distributions are sufficiently separated, then one has an acceptable robust test setup.

METHODOLOGY OVERVIEW (CONTINUED)

The figure below shows a frequency histogram of what the data might look like.



In order to conduct these tests, the following is required:

- A sample of actual test parts that are known to be non-leaking (a minimum of 5)
- A subset of the above test parts that have a port where a calibrated leak can be connected (ideally 5 parts, but one sample part may be used, if necessary)
- A calibrated leak with a leak rate value close to the reject limit (within ± 10% approximately)
- Optionally, two additional calibrated leaks, one below the leak rate reject limit and one above the limit, typically by about ± 20-30%. These calibrated leas will be used to perform a validation once the system is set up

CONDUCTING THE SETUP TESTS

Ideally, the larger the sample of parts the more statistically significant the tests will be. It is common, however, to rotate through and test parts multiple times to obtain sufficient data. If it is not convenient to have more than one reject limit calibrated leak, or if it's not easy to connect the calibrated leak to a known good part, then one part with the calibrated leak attached may be used.

NOTE: In most applications it is critical to have actual test parts in order to conduct the testing. This is because the parts can often have characteristics that can impact the test cycle (For example, a test part may have high surface area and slow down the chamber evacuation step). However, if parts are not available, dummy parts can be fabricated that have similar characteristics as actual test parts and used in the testing.

Prior to beginning data collection of leak test data, set up the recipe in the software according to the operator manual. Perform a calibration run and record the calibration data from the calibration diagnostics screen. Run a few tests with no lea parts and a few tests with parts that have the reject level calibrated leak connected. Verify that old good parts pass and the leaking parts fail or read very near the failure point (reject limit). Also, verify that the cycle time meets the production needs.

Run between 25 and 50 test cycles (more if practical) randomly selecting leaking and no leak parts, ensuring approximately the same number of test cycles with no leak parts, and leaking parts.

Group the data into the 2 sets of data and plot a frequency histogram of the data as shown in the sample above. Calculate the average and the standard deviation for each sample. Visually verify that the two normal distributions do not overlap. If they overlap, you will need to adjust some recipe parameters to create more separation between the two distributions. Also, verify that there are no outliers of no leak parts that could have indicated a leak due to a tooling or connector issue.

To increase separation of the two sets of data consider adjusting the following parameters (this assumes you are unable to change the reject limit or helium test pressure):

Helium Background Limit

This parameter is typically set between 0.5 and 0.9. This parameter is multiplied by the reject limit and determines the maximum level of the helium signal prior to filling the test part with helium and taking the measurement. Reducing this parameter requires the system to pump down to a lower helium background signal prior to filling the part with helium and taking a leak rate measurement. This will create more separation between the no leak and leaking parts. The typical test sequence is as follows:

1. Evacuate the test chamber (in parallel evacuate in the inside of the test part) Once the chamber pressure is low enough, the helium leak detector is valved into the chamber and the helium signal is monitored
2. During the monitoring step the chamber pressure continues to decrease as does the background helium signal. Once the helium signal reaches the Helium Background Limit, the proceed to the next step
3. Fill the test part with helium and begin to look for any gross helium leaks. If the signal increases above the gross leak reject limit, then end the test immediately and fail the part. Once the helium pressure is achieved go to the next step
4. Monitor the helium signal for a period of time, called the Test Time. This timer counts down and ensures the helium signal that appears due to a leak has an opportunity to rise and stabilize. Once the Test Time expires record the final leak rate reading and compare to the reject limit and pass or fail the part accordingly

Test Time

Adjusting the test time to a longer time frame will ensure that the helium signal reaches full strength and/or stability before making the final pass/fail decision

A simple way to ensure that the two sets of data do not overlap is to do the following calculation.

- Calculate the standard deviation (SD) of each data set
- Locate the point on the horizontal axis (leak rate) that is 3 x SD to the right of the average of the no leak data set
- Locate the point on the horizontal axis (leak rate) that is 3 x SD to the left of the average of the leaking (calibrated leak) data set
- Ensure there is still separation, no overlap, of these two points

If one wants to be conservative and ensure with high degree of confidence that almost no leaking parts will be passed, then set the reject limit 3 standard deviations to the left of the average calibrated leak data set. On a LACO leak test system, the Calibration Safety Factor can be used to accomplish this. This factor is typically set between 0.5 and 1.0 and is multiplied by the leak rate reject setpoint to lower the actual reject limit used to reject a part. The graph below shows a reject limit set at 2 x SD to the left of the average calibrated leak data set.