Chokes For Leak Testing High Pressure Systems

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Introduction

The purpose of this note is to describe the operation and use of a gas flow choke for leak detection. Newly installed vacuum systems and systems that experience a component failure, commonly have leaks which are above the highest test range of current helium mass spectrometer leak detectors, but below the detection range of sonic leak detectors. In many cases of new construction or maintenance large leaks are part of the initial testing of the vacuum system. The use of a gas flow choke will allow the operation of a leak detector at a much higher pressure.

Equipment Choice

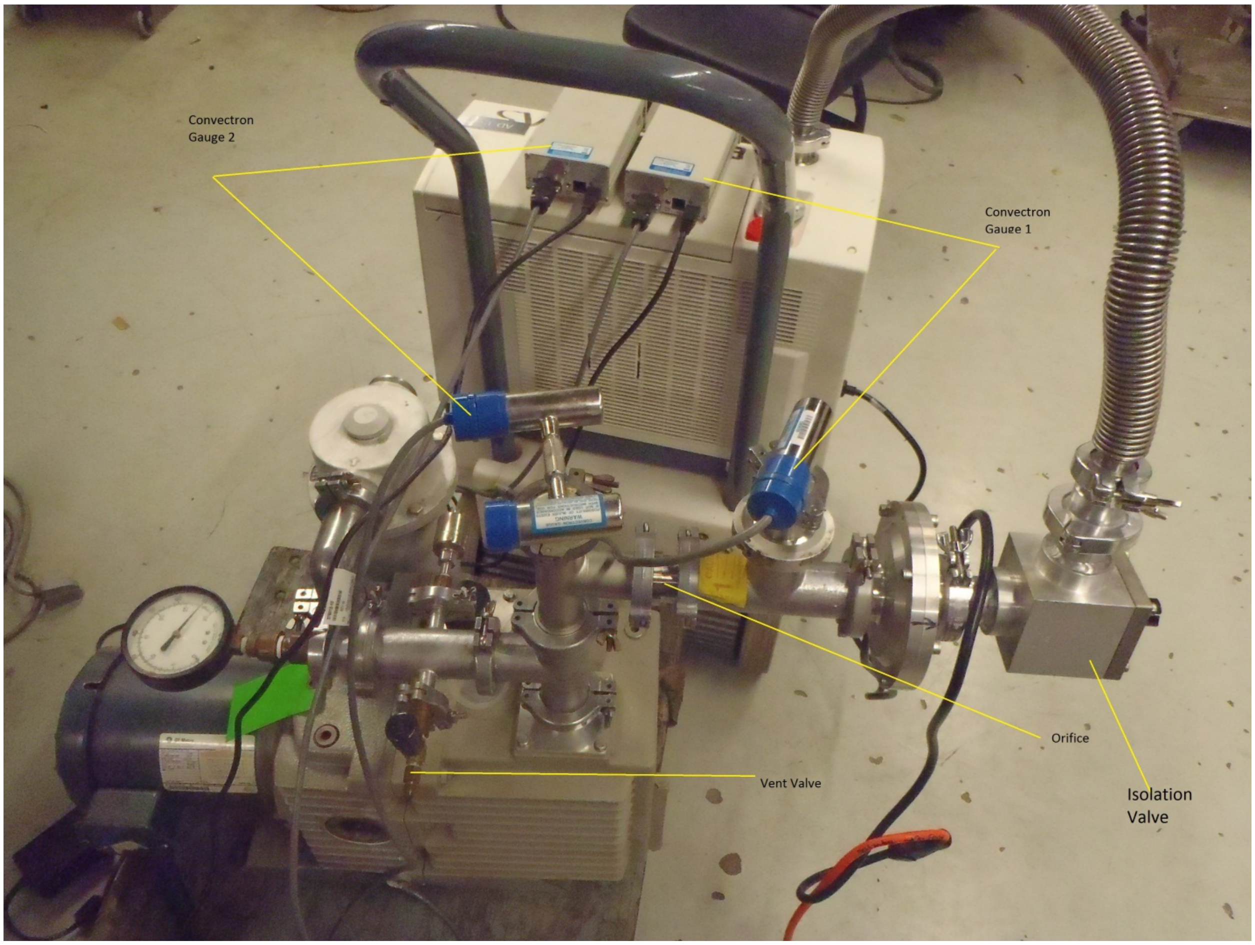
The leak detector used during this test is a Adixen ASM142D graph. The ASM142D graph has a helium pumping speed at the test port of 1.3 l/s. The maximum inlet pressure is 10 mbarr (7.5 torr) in gross leak test mode. The inlet pumping speed of this machine is small compared to a Adixon 182TD+. The Adixon 182TD+ has a helium pumping speed at the test port of 4.4 l/s. The maximum inlet pressure is 30 mbarr (22.5 torr) in gross leak test mode. This higher inlet pumping speed will allow the use of the chokes at a higher system pressure.

Description of Choke, model .0313 inch hole.

The choke is made from a DN40 KF stub blank (MDC part 715002) and a DN40 KF socket weld flange (MDC part 713003). The stub blank was hollowed out to a 1 inch diameter to a depth that left an end wall of 1/8 inch thick. A hole size .0313 inch was drilled in the center of the end wall. These parts were cleaned and welded together. See photos below

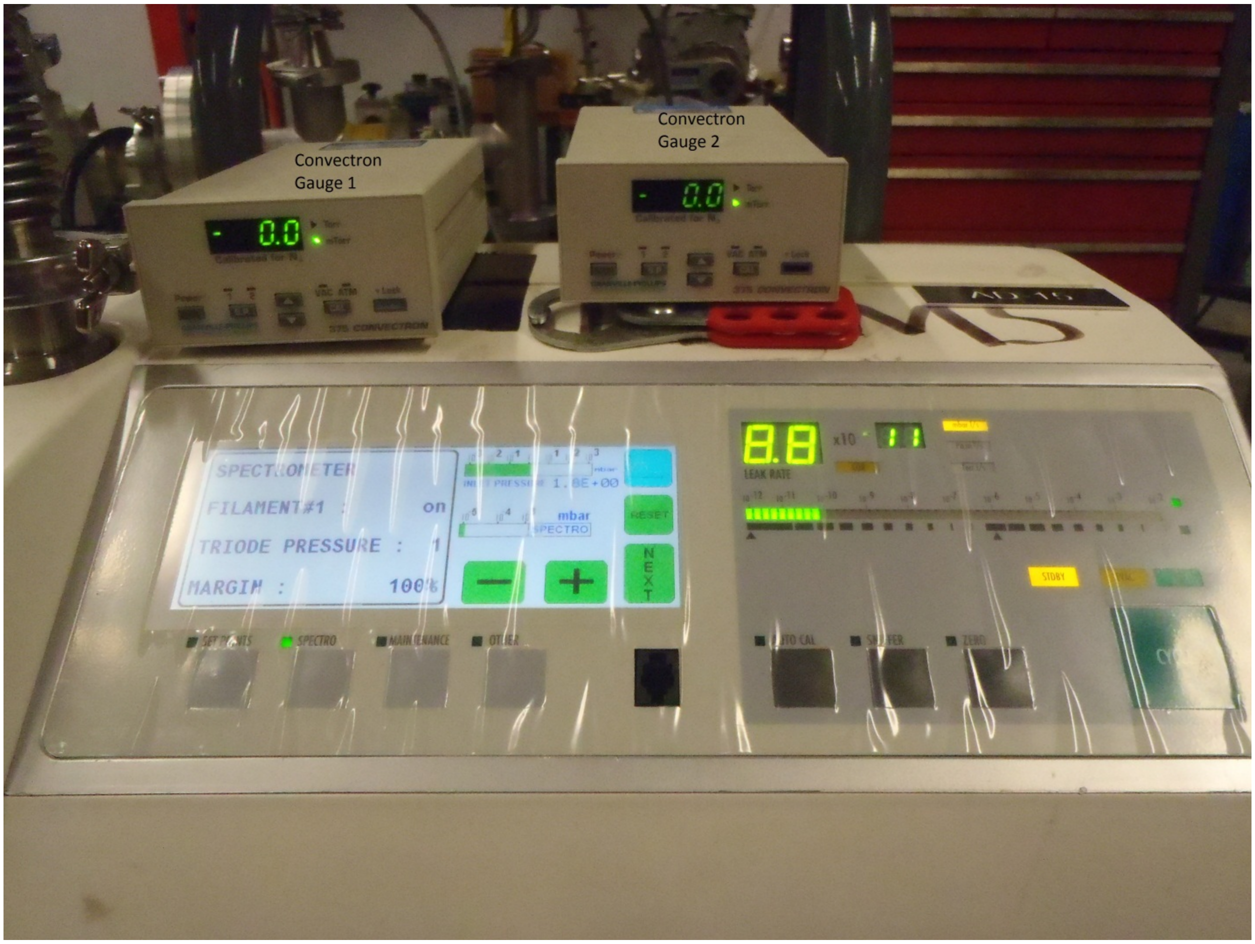
Description of Test Assembly Manifold.

A manifold was assembled to test the orifice. The manifold was assembled in a manner that would allow the admittance of gas on the pump side of the orifice. Pirani Convectron gauges were installed to measure pressure on each side of the orifice. An isolation valve was installed to separate it from the leak detector. A filter, not labeled, was also installed to keep the oil mist from the roughing pump out of the leak detector. See photo below.

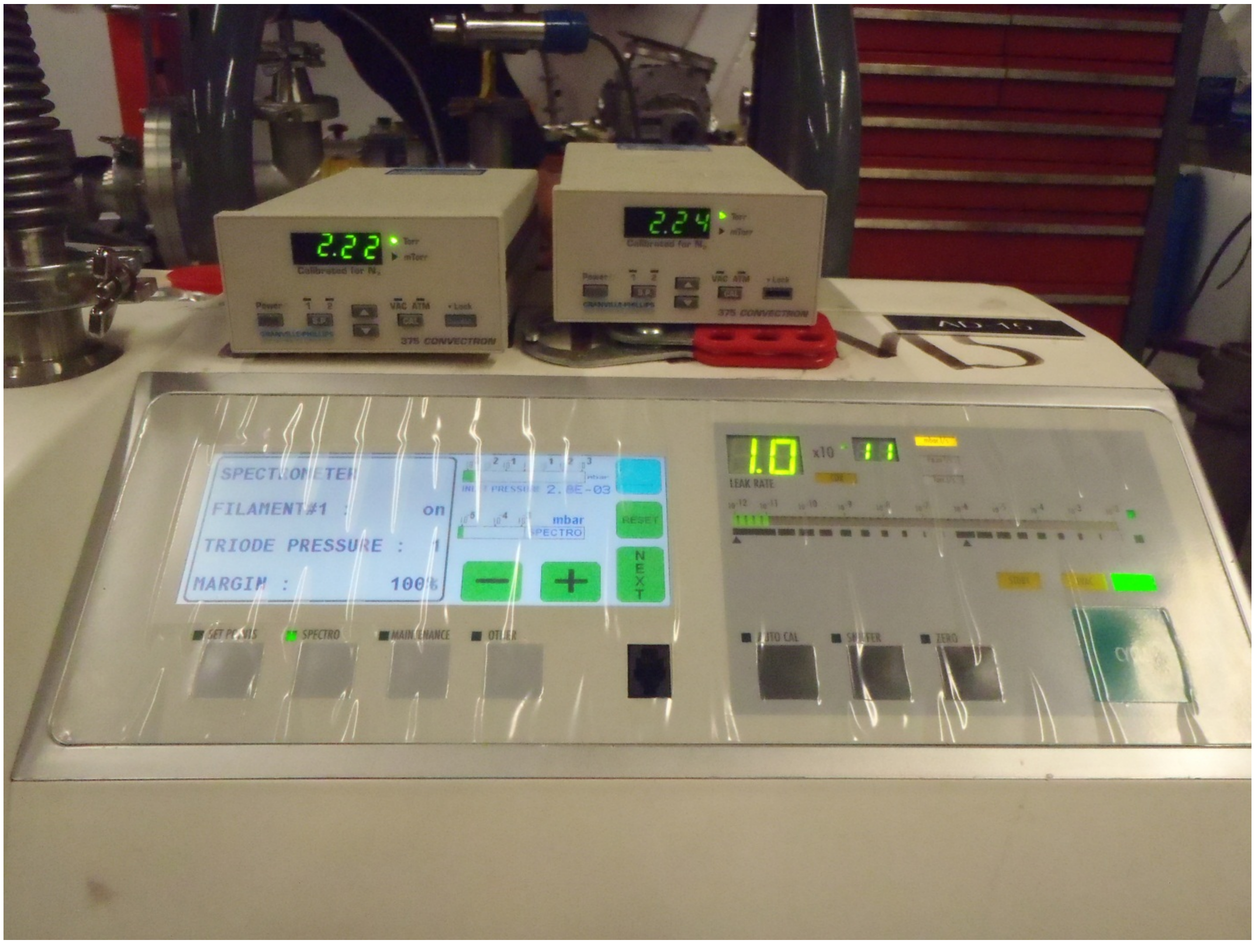


Test Conditions Choke, model .0313 inch hole.

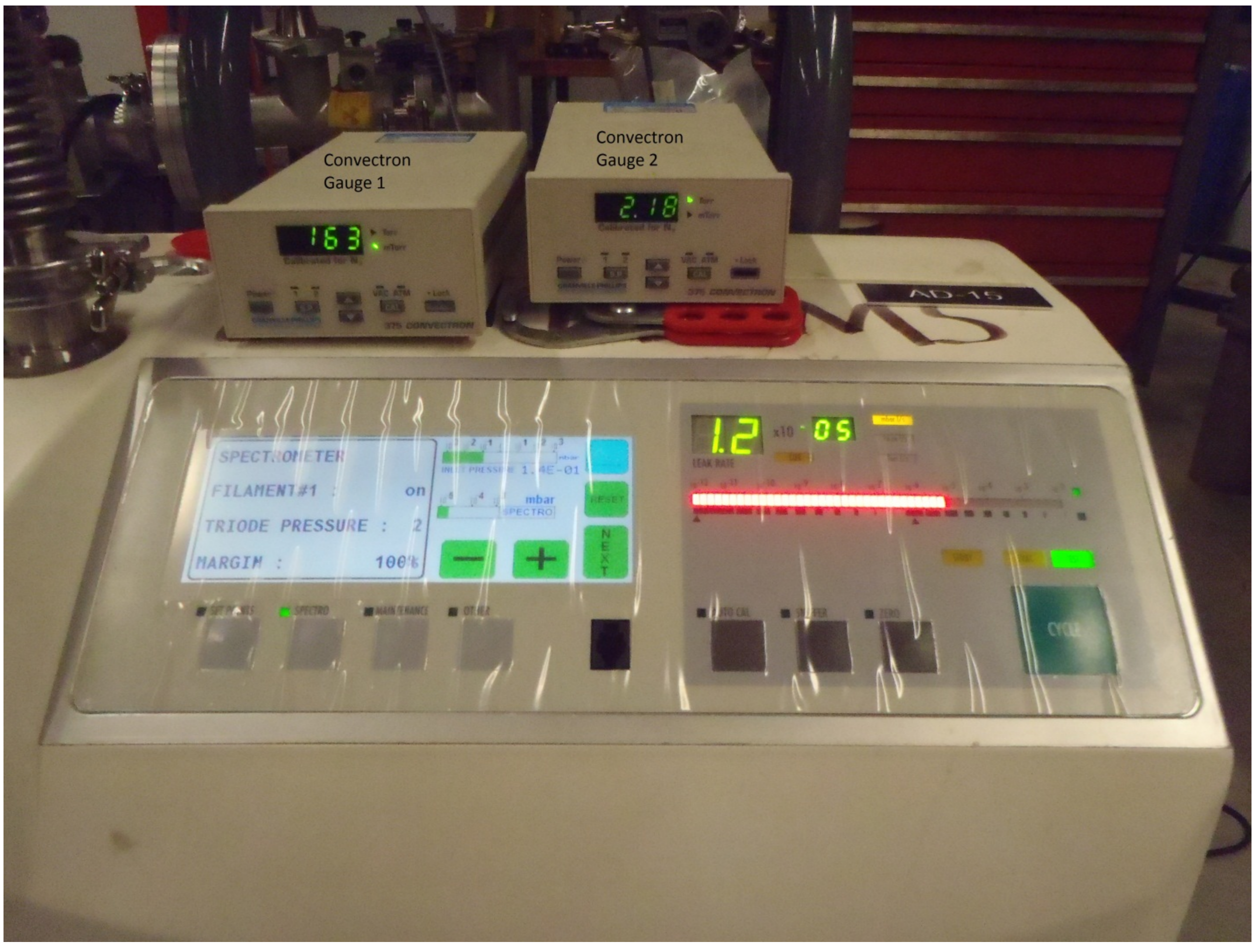
The initial test conditions are as follows. The vacuum pump is running pumping on the orifice. Convectron Gauge1 (CG1), located on the leak detector side of orifice, and Convectron Gauge 2 (CG2), located on the pump side of the orifice, both are under vacuum and less that 1 millitorr. Each gauge was calibrated for atmosphere and vacuum. The isolation valve between the orifice and the leak detector is closed. The leak detector, an ASM 142 D Graph, was calibrated, and is in standby mode. See photo below.



The leak detector was placed in test mode. The vent valve was opened to admit air to the pump side of the orifice and adjusted for approximately 2 torr. CG1 and CG2 both reflect this approximate pressure. The leak detector touch screen was set to show the triode pressure of the analyzer cell.



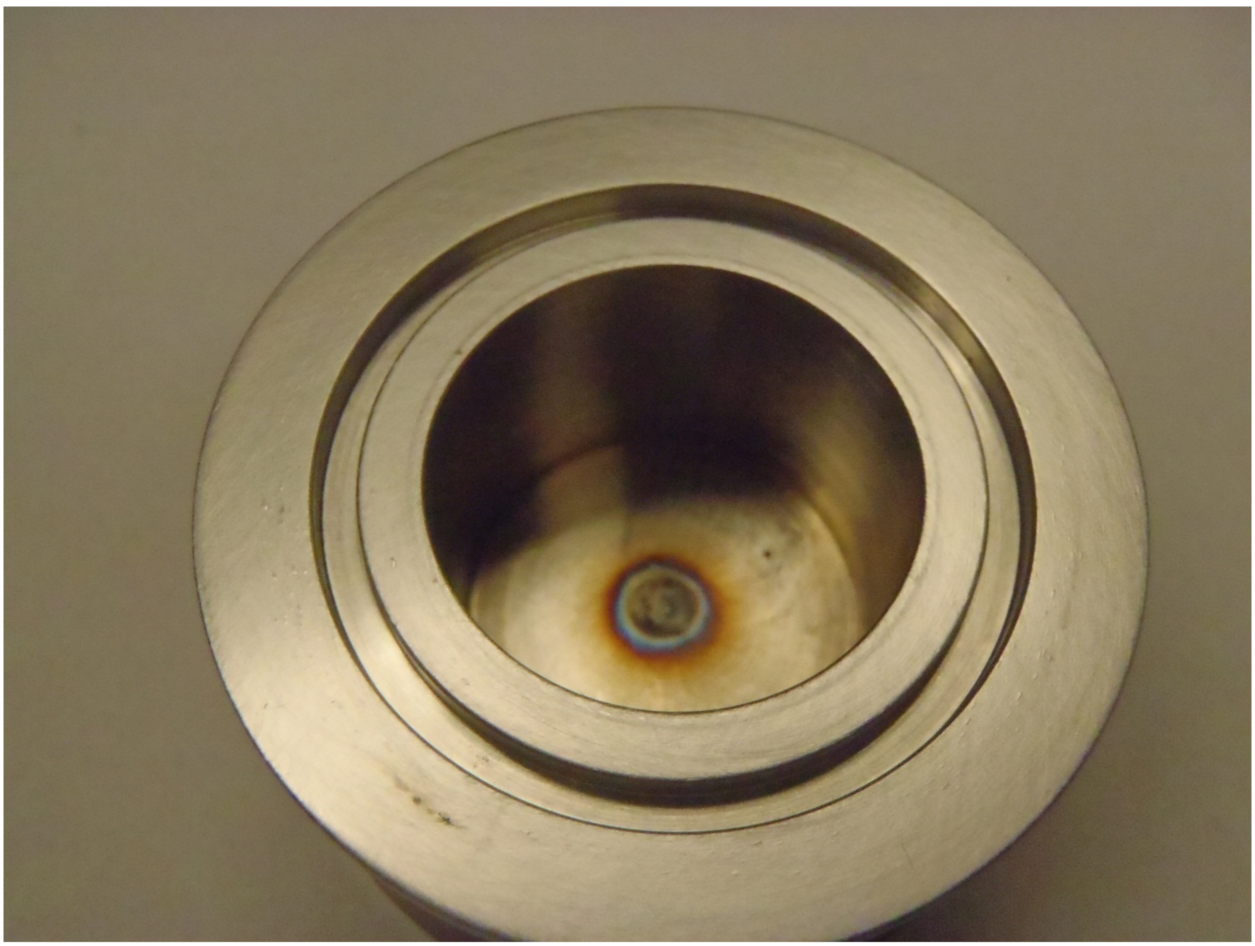
The isolation valve was slowly opened and in steps. The triode pressure was never allowed to exceed 4. The leak detector side of the orifice, CG1, started to rapidly pump out and then settle off at 163 millitorr. The pump side of the orifice reduced a few millitorr. The internal pressure of the leak detector rose to 140 millitorr. The triode pressure finally settled at 2.

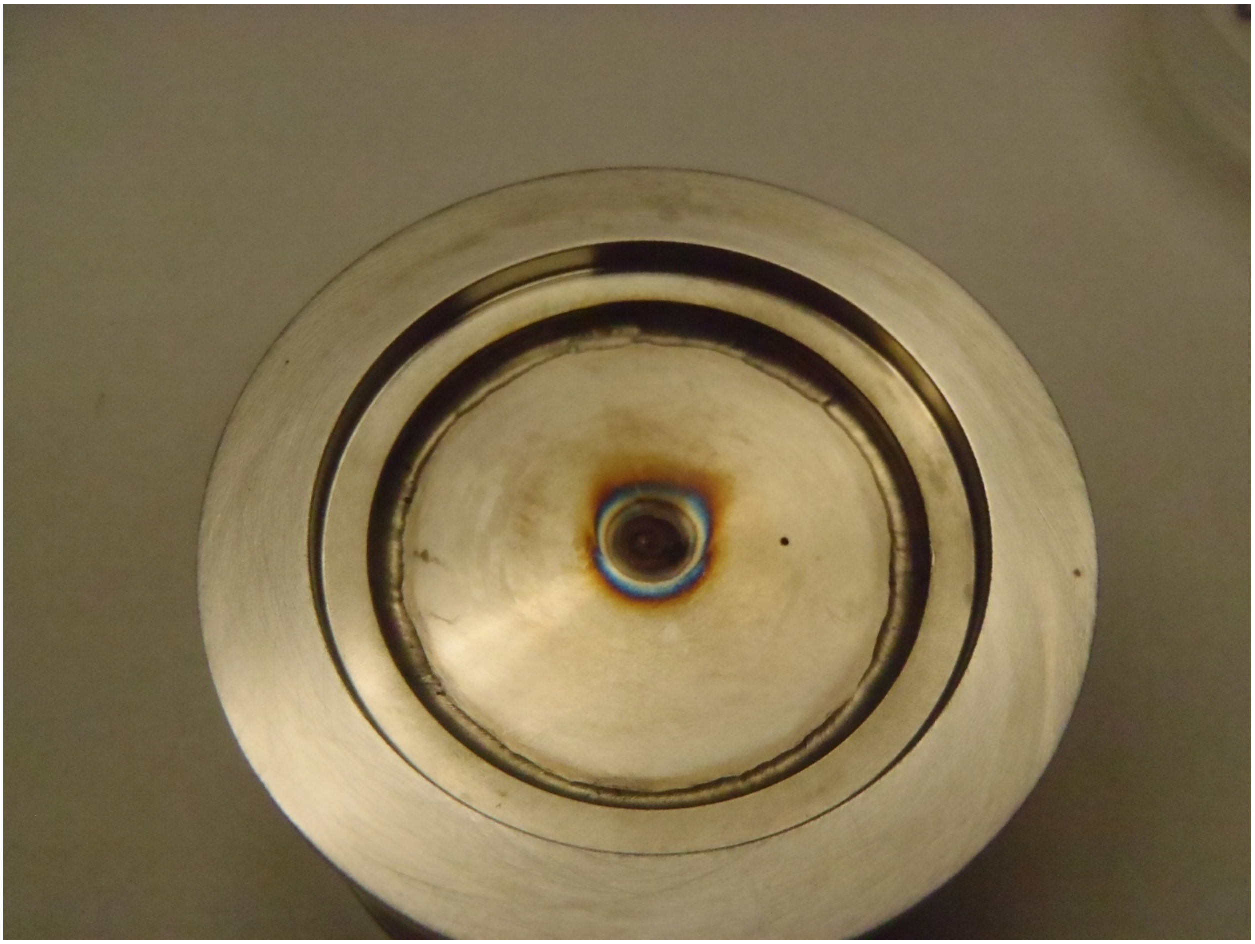


The test condition above mimics a large vacuum leak in the system. Helium gas was sprayed in the air near the vent valve. The leak detector instantly responded to the helium gas and recovered shortly after spraying. This test was repeated several times from the initial condition to the actual sensing of helium in the air near the vent valve. It passed in each test. The maximum pressure was then tested. It appears that the triode pressure will go to 4 with the vent valve set to 2800 millitorr. This size of orifice should only be used at a pressure at or below 2 torr.

Description of Choke, model .0156 inch hole.

The choke is made from a DN40 KF stub blank (MDC part 715002) and a DN40 KF socket weld flange (MDC part 713003). Each is stainless steel. The stub blank was hollowed out to a 1 inch diameter to a depth that left an end wall of 1/8 inch thick. A hole size .0156 or 1/64 inch was drilled near the center of the end wall. These parts were cleaned and welded together. Note: the original hole was welded shut and a new hole was drilled next to the welded shut hole. See photos below



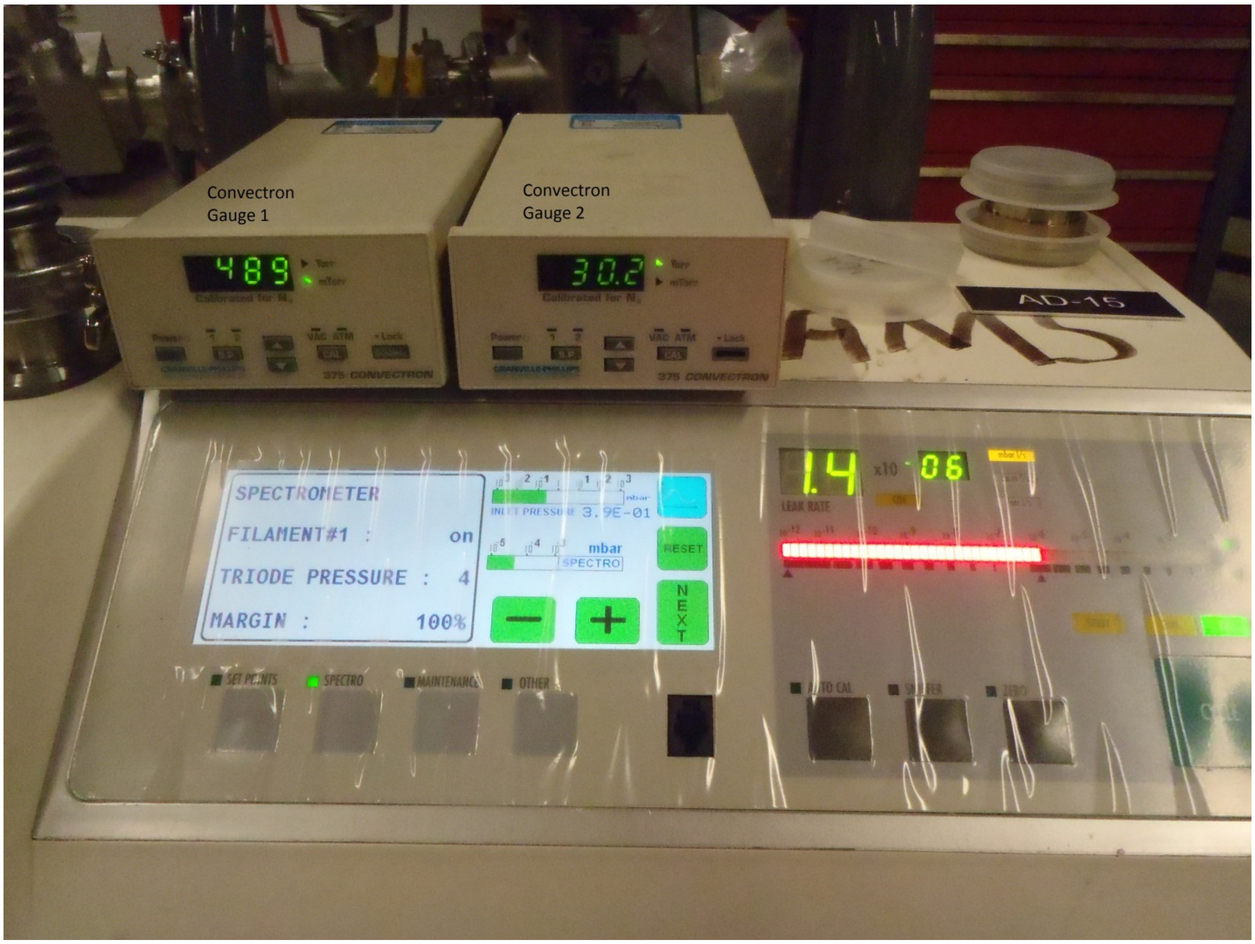


Test conditions for Choke, model .0156 inch hole.

The initial test conditions are as follows. The vacuum pump is running pumping on the orifice. Convectron Gauge1 (CG1), located on the leak detector side of orifice, and Convectron Gauge 2 (CG2), located on the pump side of the orifice, both are under vacuum and less that 1 millitorr. Each gauge was calibrated for atmosphere and vacuum. The isolation valve between the orifice and the leak detector is closed. The leak detector, an ASM 142 D Graph, was calibrated and is in test mode. See photo below.

The vent valve was set so that CG2 was at approximately 6 torr. The isolation valve was slowly opened and in steps. The triode pressure was never allowed to exceed 4. The leak detector side of the orifice, CG1, started to rapidly pump out and then settle off at 89.5 millitorr. The pump side of the orifice reduced a few millitorr. The internal pressure of the leak detector rose to 85 millitorr. The triode pressure finally settled at 1. The vent valve area was sprayed with helium. The leak detector indicated that helium was present.

The vent valve was adjusted so that CG2 was at approximately 30 torr. The isolation valve was open. The leak detector was in test mode. The triode pressure was never allowed to exceed 4. This is the maximum safe pressure for the triode. The leak detector side of the orifice, CG1, stabilized at 489 millitorr. The pump side of the orifice remained at 30.2 torr. The internal pressure of the leak detector rose to 390 millitorr. The triode pressure finally settled at 4. The vent valve area was sprayed with helium. The leak detector indicated that helium was present.



Test Results.

The tests listed above conclusively prove that the two orifices can be used to extend the leak detection fine test mode range beyond its normal capability. The .0313 hole orifice can be used effectively up to 2 torr. The .0156 hole orifice can be effectively used up to 20 torr. These pressures can be increased by adding a leak detector with a higher inlet pumping speed. Caution should be used in not allowing the triode pressure to exceed 4 at any time.

The steps to connect the leak detector to a vacuum system of high pressure.

Connect the orifice, large or small hole, to the leak test connection valve on the vacuum system.

Connect a valve to the orifice.

Connect a vacuum line between the orifice valve and leak detector.

In standby mode perform a self-calibration of the leak detector

Open orifice valve and pump out the hose, valve and orifice.

Perform a leak check of the test setup assembly. Repair any leaks found and re-test.

If no leaks are found, place the leak detector in stand-by mode.

Open the vacuum system isolation valve.

Press the cycle button. The leak detector will pump the connection line out and auto switch to test mode when the pressure drops low enough.

Leak test as normal. Use helium sparingly. The orifice will affect helium cleanup time due to reduced pumping speed. One the leak is found and repaired. The orifice can be removed and leak testing can continue.