

12.5.1 Metody hledání netěsností v částech systému

Metoda bublinová

Do zkoumané komory se vpustí plyn o vyšším tlaku. Potom se místo předpokládané netěsnosti pokryje vodním roztokem mýdla. V místech netěsností se začnou tvořit snadno pozorovatelné bubliny. Není-li prověřovaný systém velký, je možno hledání přetlakovou metodou provést ponořením do skleněné vany s vodou. Metoda není vhodná pro případ malých netěsností.

Metoda vodíkového hledače

Provádí se detekce stop vodíku pomocí palladiového ionizačního vakuometru. Vodík se přivádí buď v čisté formě nebo jako složka tzv. formovacího plynu (20 % H_2 , 80 % N_2). Palladiová anoda zahřátá na teplotu kolem 1100 [K] (toho se dosáhne jejím bombardováním elektrony) propouští H_2 , ale ne jiné plyny a páry. Je-li systém netěsný, proniká vodík přepážkou a jeho přítomnost ve vakuometru vede ke vzrůstu iontového proudu. Po skončení se H_2 z vakuometru odstraní difúzní vývěvou.

Metoda halogenního hledače

Ve vakuovém systému, který byl předběžně vyčerpán, se vytvoří přetlak zavedením plynu obsahujícího chlor (arkton, freon). Unikání tohoto plynu netěsností se zjišťuje zvláštním detektorem:

- *acetylenová lampa* – plamen lampy ohřívá měděnou destičku do červeného žáru. Když vnikne do trubičky chlor netěsností, plamen se zbarví zeleně (vzniká $CuCl$),
- *halogenní detektor* – dochází k velkému zvětšení emise kladných iontů z povrchu horké platiny, jsou-li v okolním prostředí páry sloučenin chloru.

12.5.2 Metody hledání netěsností ve vakuových systémech

Citlivost systému na impuls zkušebního plynu

Aby byl vakuový systém pokud možno citlivý na impuls zkušebního plynu (jenž přichází do hledače přes netěsnost), je nutno splnit některé podmínky.

Až do okamžiku vniknutí helia do vakuového systému je kolektorový proud hmotnostního spektrometru velmi malý. Při přemístování trubičky heliového hledače v blízkosti netěsnosti se v analyzátoru zvýší tlak (následkem vniku helia) a potom se opět rychle zmenší (následkem čerpacího procesu). Charakter vzrůstu a poklesu tlaku závisí na poměru čerpací rychlosti S k čerpanému objemu V . Aby spektrometr reagoval na změnu tlaku, musí být poměr $\left(\frac{S}{V}\right)$ větší než určitá zadaná hodnota (například $100 [s^{-1}]$).

Závislost odezvy hledače na jeho umístění ve vakuovém systému

Závisí na vzájemné poloze hledače, vývěvy a netěsnosti. Kromě toho i na čerpací rychlosti vývěvy.

Pomocí vakuometrů ve vakuovém systému

Při ustáleném stavu v čerpaném vakuovém systému, v němž je netěsnost, udávají vakuometry určité konstantní tlaky (vyšší než očekávané), přičemž tyto tlaky se mohou v různých bodech systému lišit.

Obklopí-li se místo netěsnosti zkušebním plynem, začne vnikat do systému. Potom je-li přítom citlivost vakuometru pro zkušební plyn větší než pro vzduch, nebo je-li vodivost netěsnosti pro zkušební plyn větší než pro vzduch, dojde k vzrůstu údajů vakuometru.

Nechť existuje ve vakuovém systému o objemu V odděleném od vývěvy netěsnost, jejíž vodivost pro atmosférický vzduch a zkušební plyn je C_{vz} a C_p . Nechť v okamžiku $\tau = 0$ (odstavení vývěvy) je ve vakuovém systému tlak $p_0 \ll p_a$. Působením spádu tlaků $p_a - p_0 \approx p_a$ proudí do systému

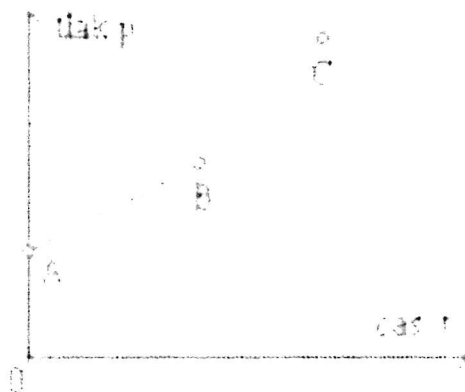
proud vzduchu:

$$g_G = \frac{V dp}{d\tau} = C_{vz} p_a,$$

což má za následek vzrůst tlaku podle vztahu:

$$p \approx p_0 + \left(\frac{dp}{d\tau} \right)_{AB} = p_0 + \frac{C_{vz}}{V} p_a \tau,$$

tento jev znázorňuje křivka AB. V okamžiku vniknutí zkušebního plynu do systému se zvětší sklon křivky vzrůstu tlaku (poněvadž $C_p \ll C_{vz}$), jak ukazuje úsek křivky BC. Změny charakteru vzrůstu tlaku je možno zjistit vakuometrem.



Jiskrovým výbojem

Ve skleněném vakuovém systému se dá najít netěsnost pomocí speciální vysokofrekvenční elektrické zkoušečky. Principem je posouvání její elektrody s vysokým napětím po stěnách systému, v místě trhlinky vznikne (ve vzdálenosti řádově 1 [cm]) povrchový výboj jdoucí po skle od elektrody k netěsnosti, což se projeví intenzivním červenobílým zářením v kanálku netěsnosti, jíž proniká vzduch.

Tato metoda se používá při tlacích 1 [Pa] až 1 [kPa].

Pomocí doutnavého výboje

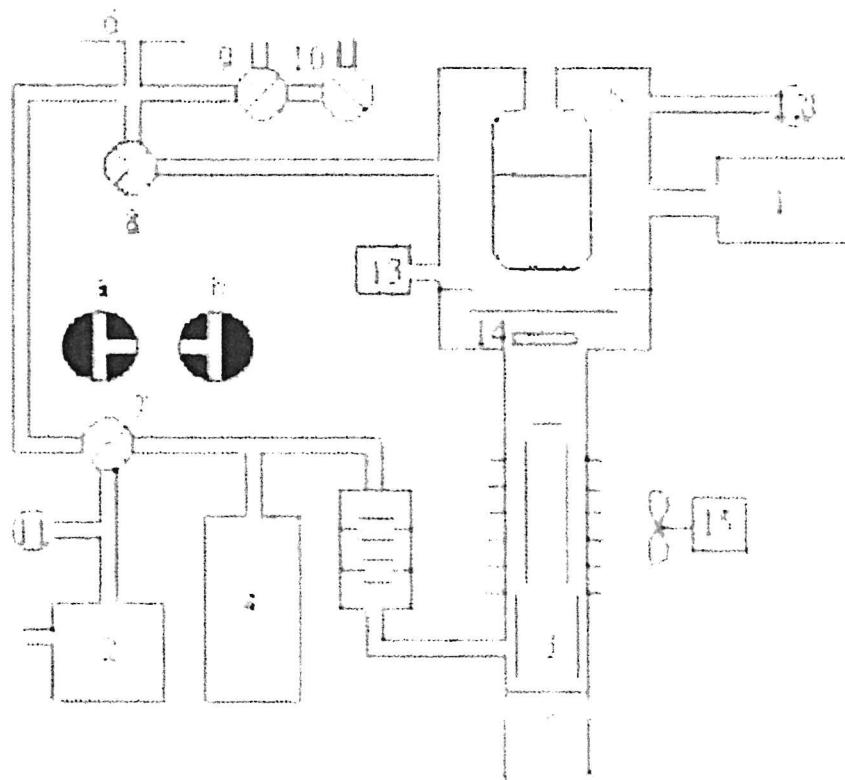
Ve výbojové trubici připojené k vakuovému systému, v němž se hledá netěsnost, se vybudí doutnavý výboj plynu. Jsou-li v aparatuře zbytky vzduchu, má záření načervenalou barvu. Přiložíme-li k místu předpokládané

netěsnosti vatu namočenou do lihu, nebo rozptýlíme-li rozprašovačem líh v její blízkosti, je možno pozorovat změnu barvy záření v aparatuře způsobenou parami lihu prošlými netěsnostmi.

Nedostatkem této metody je, že kapaliny pronikají nepatrnými trhlinkami velmi pomalu a změna barvy záření probíhá se zpožděním často již v době, kdy se zkouší netěsnost v jiném místě aparatury, což může vést k mylným výsledkům. Proto je lépe místo kapaliny používat plyn (chlorid uhličitý nebo i oxid uhličitý), který září nazelenale. V okamžiku styku plynu s místem netěsnosti se změní načervenalé záření ve výbojové trubici typické pro vzduch rychle v zelenavé. Pozorování změn barvy záření je nejlépe provádět v tzv. *prostoru kladného sloupce doutnavého výboje*.

Spektroskopickým přístrojem

Hlavními součástmi zařízení jsou: hmotnostní spektrometr 1 (obvyklý nebo zjednodušený s úzkým intervalem spektra molekulových hmotností, zasahujících například pouze helium), soubor vývěv (olejová rotační 2, difúzní olejová 3 se vzduchovým chlazením), vakuová komora 5 chlazená kapalným dusíkem a pomocná zařízení (vakuový zásobník 4, ventily, vakuometry, relé).



System, v němž se hledají netěsnosti, se připojuje ke vstupu 6 do spektrometrického systému (ventily 8, 9 a 10 jsou uzavřeny, kohout 7 je v poloze *b*) a je v něm primární vakuum. Měření tlaku tepelným vakuometrem 11 umožňuje zjistit, zda není v systému nějaká velká netěsnost. Po otočení kohoutu 7 do polohy *a* se vyčerpává vývěvou 2 levá část vakuové aparatury a po dosažení primárního vakua (měřeného vakuometrem 11) se uvede do chodu difúzní vývěva 3. Tlak v hlavní vakuové komoře 5 se měří ionizačním vakuometrem 12. Když tento tlak dostatečně poklesne ($\sim 10^{-2}$ [Pa]), sepne relé 13 a zapojí iontový zdroj hmotnostního spektrometru. Potom se naplní vymrazovačka v komoře 5 kapalným dusíkem a po ověření tlaku vakuometrem 11 se otevře ventil 8. Dále se pomocí záklopy 14 reguluje čerpací rychlost difúzní vývěvy, aby tlak ve vakuové komoře 5 byl 10^{-2} až 10^{-3} [Pa]. Po zapojení hmotnostního spektrometru se vypustí do komory, v níž je prověřovaný objekt, zkušební plyn (nejlépe helium) a sledují se údaje hmotnostního spektrometru.

Při prověřování těsnosti vakuové aparatury jako celku se otvor 6 uzavře a aparatura se připojí k ventilu 9. Kohout 10 slouží k napuštění vzduchu do aparatury.

Obvykle je zařízení hledače do značného stupně automatizováno (například ventily jsou ovládány elektromagnety).

Appendix B. Introduction to Leak Detection

B.1 Leak Testing—Why is it Needed?

Helium is a superior choice of tracer gas used to find leaks for a multitude of reasons. Helium is:

- Non-toxic
- Inert and non-condensable
- Normally not present in the atmosphere at more than trace amounts
- Relatively inexpensive
- Readily passes through leaks due to its small atomic size
- Non-flammable
- Available in various size cylinders
- Available in purities appropriate for medical usage

The only molecule smaller than Helium (mass 4) is Hydrogen (mass 2), which is not inert. Helium is much lighter than the next heavier inert molecule, Neon (mass 20) which is much more expensive. Helium is present at a concentration of only 5 ppm in normal atmospheric conditions.

B.2 Agilent's Helium Leak Detection Technologies

A Mass Spectrometer Leak Detector (*MSLD*) is a complete system for locating and/or measuring the size of leaks into or out of a device or a container. This method of leak detection is initiated when a tracer gas, helium, is introduced to a test part that is connected to the MSLD system. The helium leaking from the test part diffuses through the system, its partial pressure is measured, and results are displayed on a meter.

The MSLD operating principle consists of ionization of the gases in a vacuum and their acceleration across a voltage drop and a magnetic field (Figure B-1). The helium ions are separated and collected, and the resulting ion current is amplified and indicated on the meter or display.

A mass spectrometer leak detector consists of the following components:

- A spectrometer tuned to detect the mass of helium
- A vacuum system to maintain adequately low pressure in the spectrometer
- A mechanical pump(s) to evacuate the part to be tested

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- ❑ Valves that enable the various stages of the leak detection cycle, from evacuation, to test, to venting
- ❑ Amplifier and readout instrumentation that monitors spectrometer output signal
- ❑ Electrical power supplies and controls that sequence valve's, protective circuits, etc.
- ❑ Fixturing that attaches the part to be leak-tested to the leak testing equipment

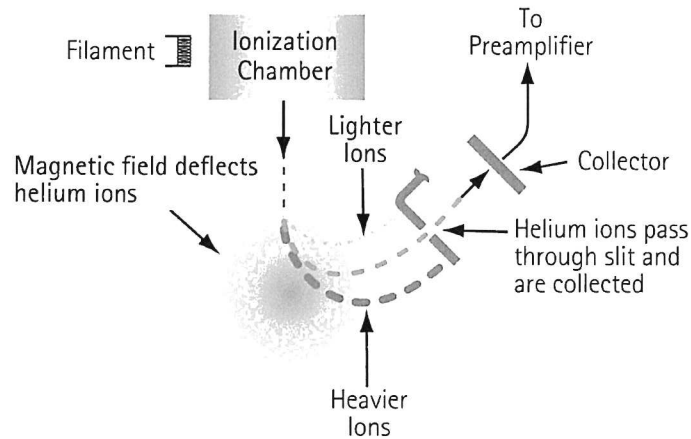


Figure B-1 Magnetic Separation Principle

Our *SIPD* family of products is also sensitive to helium and is based on a patented technology called Selective Ion Pump Detection (Figure B-2). The sensor technology incorporates an ion pump connected to a quartz capillary tube and maintained under high vacuum. This membrane is heated with a coiled platinum filament. Once heated, the membrane becomes permeable to helium. As the partial pressure of helium in the ion pump increases, so does the current draw of the ion pump. This current is proportional to the pressure and is therefore representative of the helium at the test probe of the instrument.

A selective ion pump detector consists of the following:

- ❑ An ion pump and controller
- ❑ A permeable quartz capillary
- ❑ A heater coil that surrounds the quartz capillary
- ❑ Electronics to process the signal
- ❑ Display for access to leak rate and other unit functions

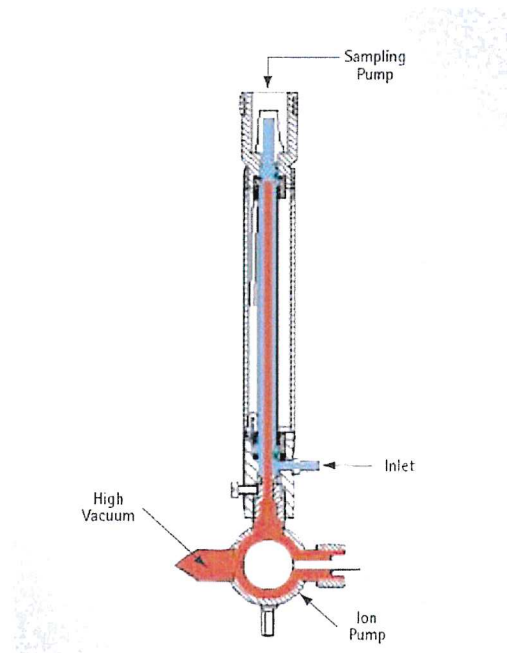


Figure B-2 Selective Ion Pump Detector

B.3 Methods of Leak Testing

There are many different ways to leak test parts using helium as a tracer gas. In general, the leak detection method is selected based on the actual working conditions of the part being tested. It is recommended that during leak testing, the same pressure differential be maintained and in the same *direction* as exists during the actual use of the part. For example, a vacuum system is tested with a vacuum inside the chamber, while a compressed air cylinder should be tested with a high pressure inside the cylinder.

There are two general concerns when leak testing. One is the location of leaks and the other is the measurement of the total leakage rate of the part, as some leakage may be acceptable. In many cases, parts may be first tested to determine if they pass an acceptable level, and if not, the part may be taken off line and subjected to a second test with the intent of locating the leak. Additionally, many parts may be tested in batches. If a batch fails, the individual parts in that batch may then be tested separately to identify the leaking part(s).

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B.3.1 Vacuum Testing Method (Outside-in)

The part to be tested is evacuated with a separate pumping system for large volumes, or with just the leak detector itself. When the appropriate cross over pressure has been reached, the leak detector is valved-in or transfers into test and the part is tested using one of the following methods:

B.3.1.1 Locating Leaks

To pinpoint the location of the leak(s) (but not measure the total leakage rate), helium is administered to the suspected leak sites of the part using a spray probe with an adjustable flow (Figure B-3).

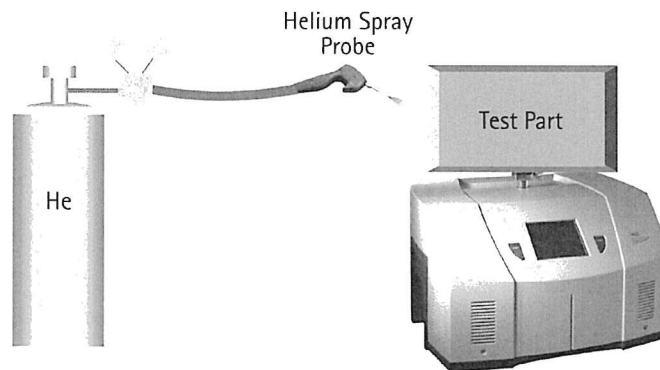


Figure B-3 Locating Leaks: Outside In

B.3.1.2 Measuring Leaks

To determine the total quantity of leakage (but not the number or location of leaks), the part is connected to the leak detector and shrouded by a helium environment. This helium environment can be contained in many methods ranging from a simple plastic bag to more complex bell jar arrangements (Figure B-4).

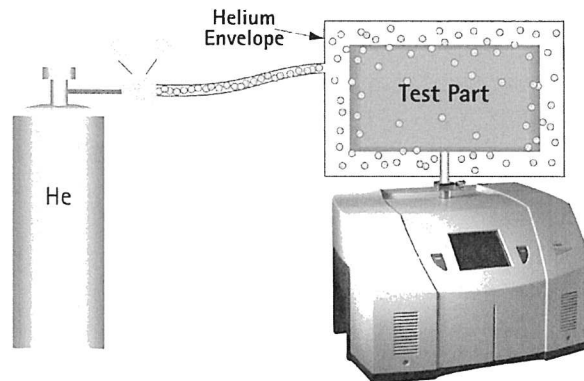


Figure B-4 Measuring Leaks: Outside In

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B.3.2 Pressure Testing Method (Inside-out)

In this technique, the part is pressurized with helium or a mixture of helium and air, and tested by one of the following methods.

B.3.2.1 Measuring Leaks

To determine the total quantity of leakage (but not the number or location of leaks), the part is pressurized with helium (or a mixture of helium and air or nitrogen). This can be done by bombing or backfilling small hermetically sealed parts. Larger parts can be actively pressurized using a hose or tubing to deliver the helium. The part is placed in a volume that is then evacuated by the leak detector. All the helium escaping from the part is captured and quantified (Figure B-5).

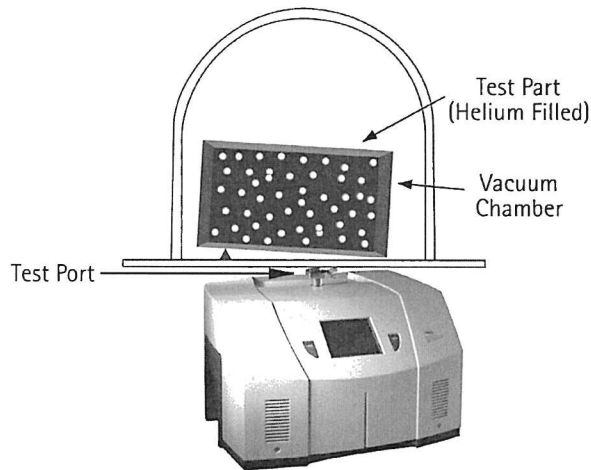


Figure B-5 Measuring Leaks: Inside Out

B.3.2.2 Locating Leaks

To pinpoint the location of the leak(s) (but not measure the total leakage), the likely potential leak sites of the part are scanned using a Sniffer Probe connected to the inlet of the leak detector (Figure B-6).

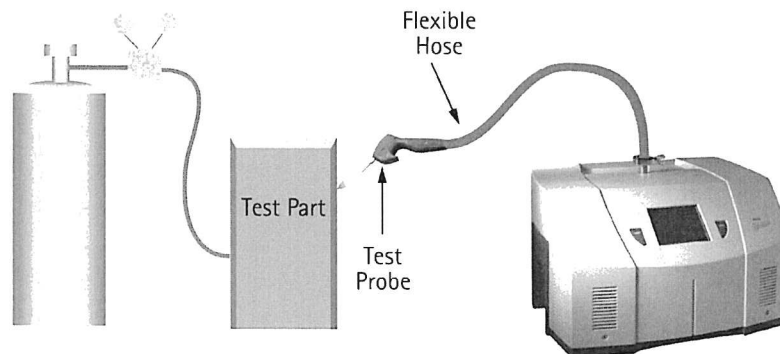


Figure B-6 Locating Leaks: Inside Out

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B.3.2.2.1 Accumulation Testing Method

This method can both locate and quantify leaks. Some type of shroud or hood is placed in such a manner as to envelop a potential leak site. A certain amount of time is given to allow leaking helium to accumulate in the shrouded area, increasing the helium concentration. The leak detector is then valved-in to the shrouded volume. If many potential leak sites exist in a manifold or if many parts are to be tested at the same time, they can be sequentially valved-in to determine which site is leaking (Figure B-7).

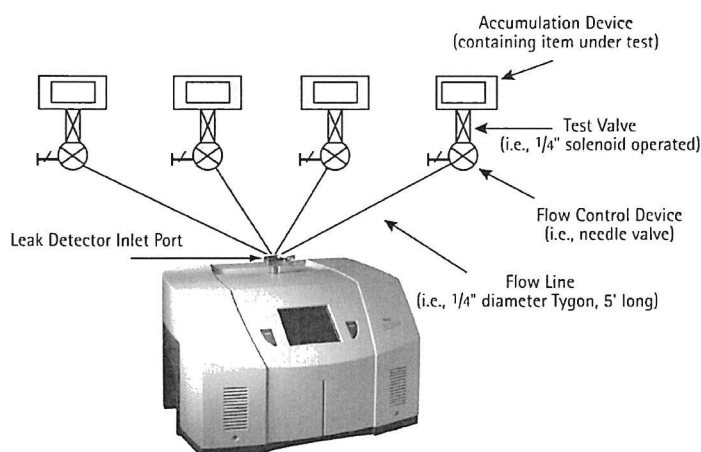


Figure B-7 Accumulation: Inside Out

B.3.3 System Leak Test Methods

Systems, like individual parts, should be tested with the same pressure differential and in the same direction as in actual use. Therefore, systems that are under vacuum while in operation should be leak tested under vacuum, while pressurized systems should be charged with helium to a pressure similar to operational conditions when possible.

B.3.3.1 Vacuum Systems

In general, vacuum systems are tested with a portable leak detector. Typically the leak detector is connected by means of a tee connected in between the foreline of the high vacuum pump and the inlet of its backing pump. A system should be capable of maintaining a foreline pressure low enough to operate the leak detector at this location. Helium is supplied to potential leak site using a spray probe or *bagging* suspected areas. If a leak exists, helium enters the system and rapidly diffuses through it. The leak detector should respond within several seconds or less. Leak detector sensitivity is diminished in systems with large backing pumps. If a system is using a cryopump as a high vacuum pump, it must be valved off before helium is introduced as cryopumps have limited helium pumping capacity (Figure B-8).

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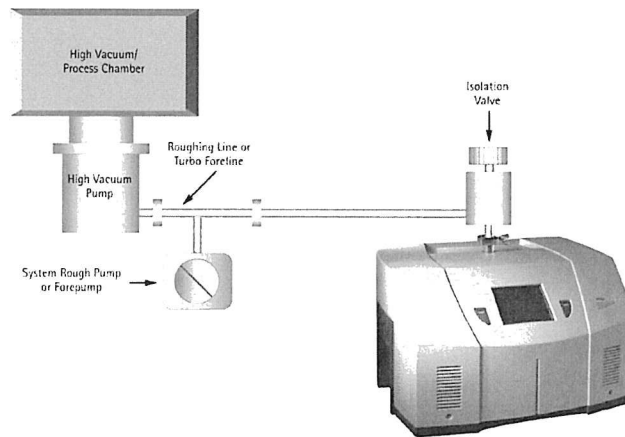


Figure B-8 Vacuum System

B.3.3.2 Pressurized Systems

Many different types of pressurized systems also need to be leak-free. These systems can be charged with helium or some mixture of helium and another gas such as nitrogen. If a diluted helium mixture is used, the helium signal is diminished proportionally. For example, if a mixture of 10% helium and 90% nitrogen is used, the signal reads 10% of the actual value of the leak, or a decade lower. This may be acceptable in many cases as system leak checking is usually to locate rather than quantify leaks. Once the system has been charged with an appropriate amount of helium, leak checking can be performed by means of a sniffer probe, or by *bagging* suspected leak sites so that leaking helium accumulates to a detectable level.



Agilent Technologies

Vacuum Products Division

CE

VS Series Helium Mass Spectrometer Leak Detectors

*MODELS: PR02, MR15, MD15, MD30+, BR15,
BD15, BD30+ AND PD03*

OPERATION MANUAL

Manual No. 699909942
Revision L
April 2015

1.4 Front Panel Display and Controls

The front panel (Figure 1-13) consists of two *hard* buttons: **TEST** and **VENT** and an LCD display to access the software control screens. All operator control and monitoring of results are achieved via the resident software accessed using the Home screen. Table 1-3 on page 1-22 lists the main sub-screens and their purpose. Operational discussions are in Section 2 “Operating the Leak Detector” on page 2-1 and in Section 3 “Set-Up”.

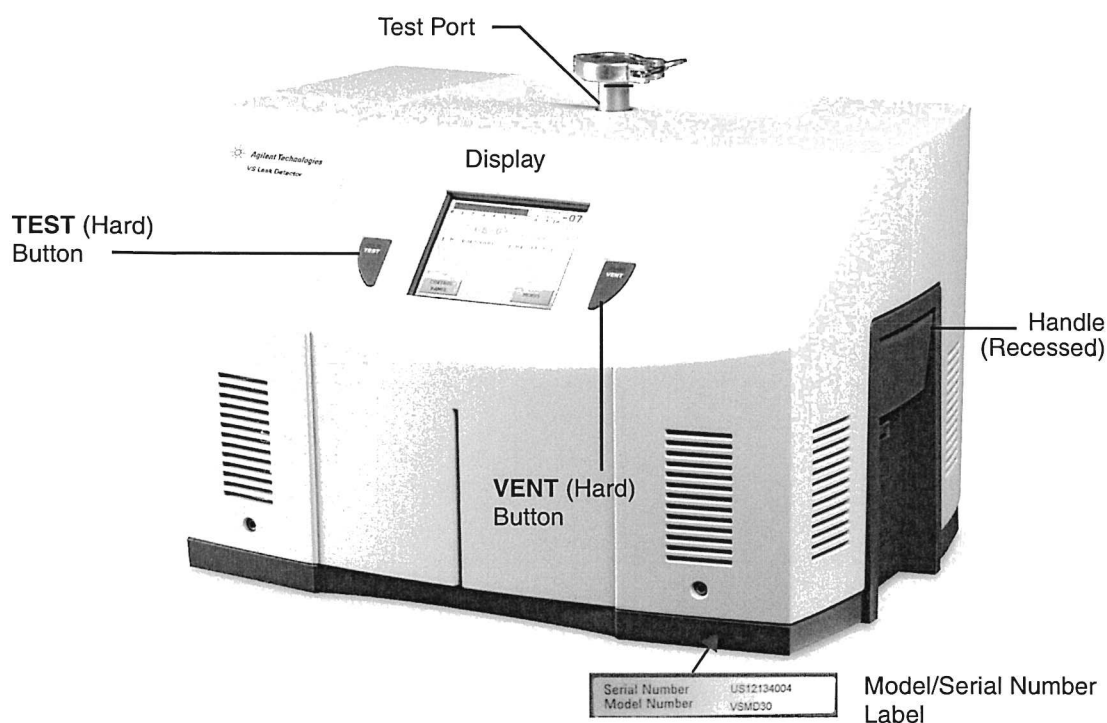


Figure 1-13 Front Panel Displays and Controls

The front panel display touch panel is calibrated at the factory and should not require recalibration. If the touch panel buttons do not respond to pushes, recalibrate as follows:

1. Turn off the leak detector power.
2. Press and hold the center of the touch panel and restart power.
A blue screen appears.
3. Press the four cross hairs on the screen and accept the calibration.

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1.6 Rear Panel

The rear panel of the leak detector with an external mechanical pump (Model VS MR15, MD15 or MD30+) and a wireless remote control option is shown in Figure 1-15.

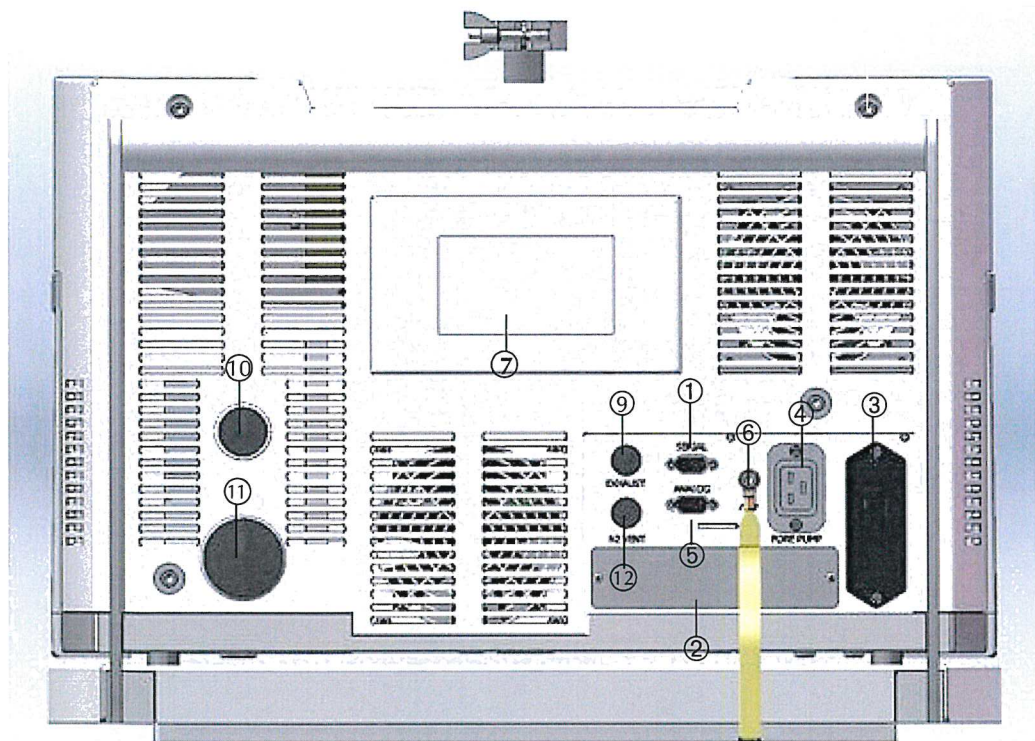


Figure 1-15 VS Series Rear Panel

- ① **Serial Connector** A 9-pin male D-type connector to interface with an external PC via RS-232 type communications protocol for system diagnostic or control.
- A detailed summary of information related to serial communication is provided in Section A "Communications Protocol" on page A-1.
- ② **Cover Plate** Access to expansion slot. This is not used when an optional I/O PCB is installed. A rear panel of the optional I/O PCB is shown in Figure 1-16 on page 1-25.
- ③ **Power Entry Module** Provides supply power, overcurrent and EMI protection for the leak detector. The Power Entry Module consists of:
- ❑ Power Input Connector - An IEC/EN60320/C20 standard, three-prong grounded Inlet connector.
 - ❑ Power Switch (I/O) - A 20A rocker type Power Switch/Thermal Circuit Breaker.
 - ❑ 20 A EMC line filter.

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1.3.3 Bench System Installations

Figure 1-10 and Figure 1-13 represent the process for installation of the bench system version of the VS Series Leak Detector.

Figure 1-10 is a drawing of a Bench Mount Leak Detector with External DS302 Wet Rotary Vane Pump, Model VS BR15 with individual components shown.

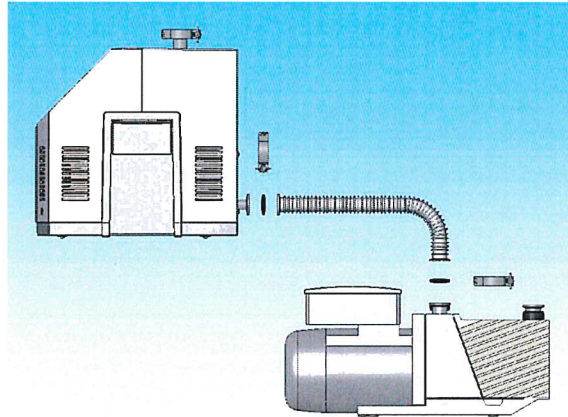


Figure 1-10 Bench Mount Leak Detector with External DS302 Wet Rotary Vane Pump, Model VS BR15

Figure 1-11 is a drawing of a Bench Mount Leak Detector with External TS620 Dry Scroll Pump, Model VS BD30+ with individual components shown.*

NOTE *Cut the 3/4" black tubing into two equal parts as shown.*

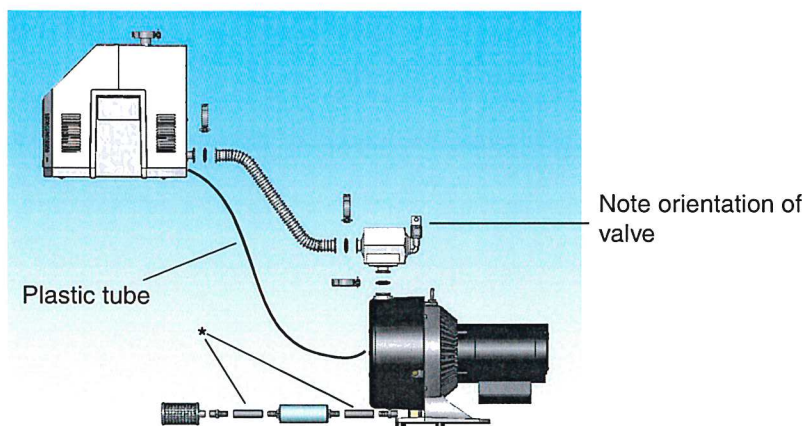


Figure 1-11 Bench Mount Leak Detector with External TS620 Dry Scroll Pump, Model VS BD30+

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Figure 1-3 shows the outline drawing and physical dimensions of a Mobile Leak Detector with External TS620 Dry Scroll Pump on a Cart, Model VS MD30+.

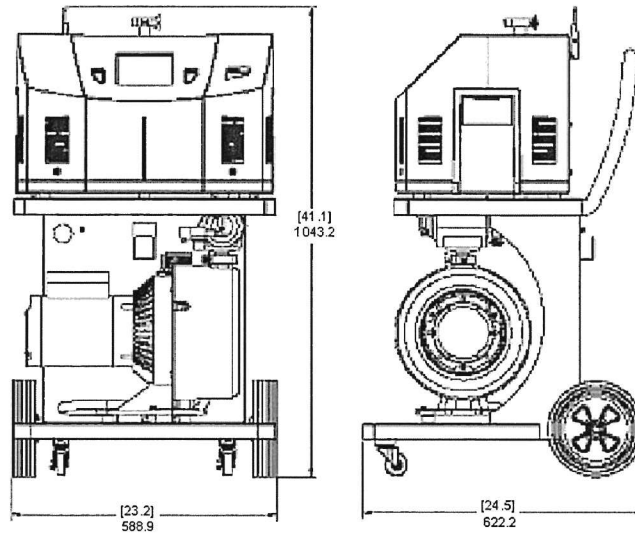


Figure 1-3 Mobile Leak Detector with External TS620 Dry Scroll Pump on a Cart, Model VS MD30+, Dimensions*

* Cart front panel not shown for clarity.

Figure 1-4 shows the outline drawing and physical dimensions of a Mobile Leak Detector with External IDP-15 Dry Scroll Pump on a Cart, Model VS MD15.

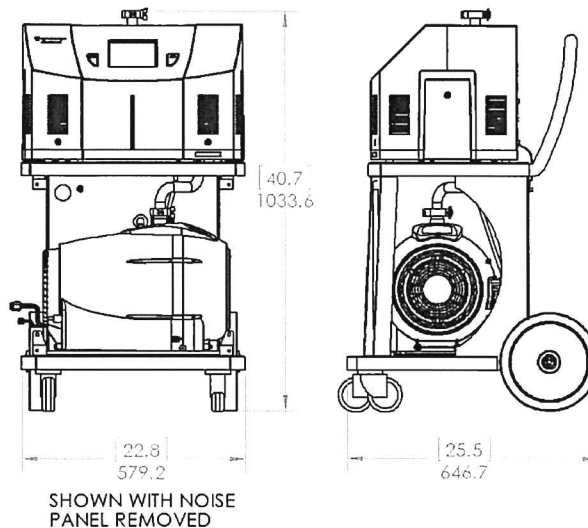


Figure 1-4 Mobile Leak Detector with External IDP-15 Dry Scroll Pump on a Cart, Model VS MD15, Dimensions*

* Cart front panel not shown for clarity.

VS Series Helium Mass Spectrometer Leak Detectors

Table 3-1 Leak Detector Valve State Table - Single Mechanical Pump System

Leak Detector Operating State	V1 Foreline Valve	V2/V3 Contra-Flo w Valve Test Mode	V4/V5 Midstage Valve Fine Test Mode	V6 Calibrated Leak	V7 Vent Valve	V8* Ballast Valve	V8* Exhaust Valve
Vent	O	C	C	C	O	C	O
Rough	C	O	C	C	C	C	C
Gross Leak Test	C	O	C	C	C	C	N/A
Contra-Flow Test	O	O	C	C	C	C	O
Midstage Test	O	C	O	C	C	C	O
Hold	O	C	C	C	C	C	O
Sniff	O	O	C	C	C	C	O
Read Std Leak	O	C	C	O	C	C	O

O: Open

C: Closed

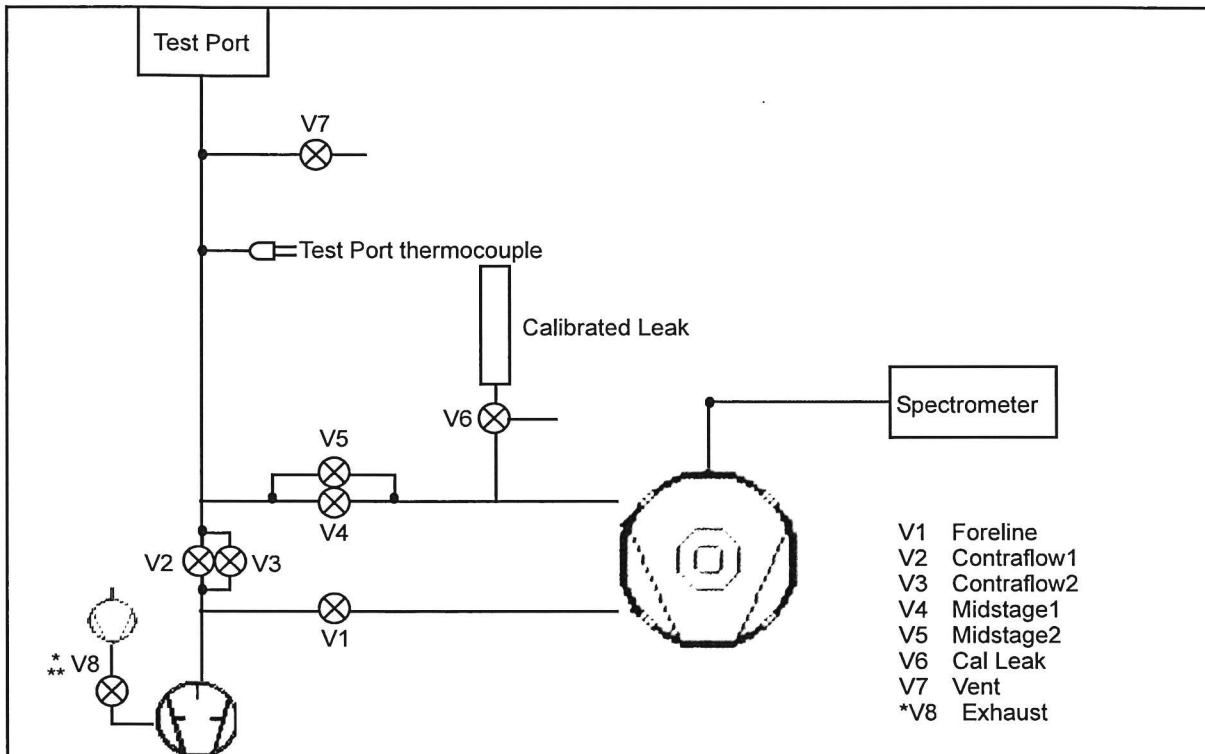


Figure 3-7 Leak Detector Vacuum System Diagram

* Normally open valve, powered closed during all operations. ** Model PD03, MD15, BD15, MD30+ during the roughing sequence.

PRO ČIŠTĚNÍ PISTOLÍ SE POUŽÍVÁ "HIGH PRESSURE TEST"
 (= CONTRA FLOW)

VS Series Helium Mass Spectrometer Leak Detectors

Table 3-1 Leak Detector Valve State Table - Single Mechanical Pump System

Leak Detector Operating State	V1 Foreline Valve	V2/V3 Contra-Flow Valve Test Mode	V4/V5 Midstage Valve Fine Test Mode	V6 Calibrated Leak	V7 Vent Valve	V8* Ballast Valve	V8* Exhaust Valve
Vent	O	C	C	C	O	C	O
Rough <i>ČERPÁNÍ</i>	C	O	C	C	C	C	C
Gross Leak Test	C	O	C	C	C	C	N/A
Contra-Flow Test <i>HIGH PRESSURE</i>	O	O	C	C	C	C	O
Midstage Test <i>Fine</i>	O	C	O	C	C	C	O
Hold	O	C	C	C	C	C	O
Sniff	O	O	C	C	C	C	O
Read Std Leak	O	C	C	O	C	C	O

O: Open C: Closed

KALIBRACE (CALIBRATED LEAK)

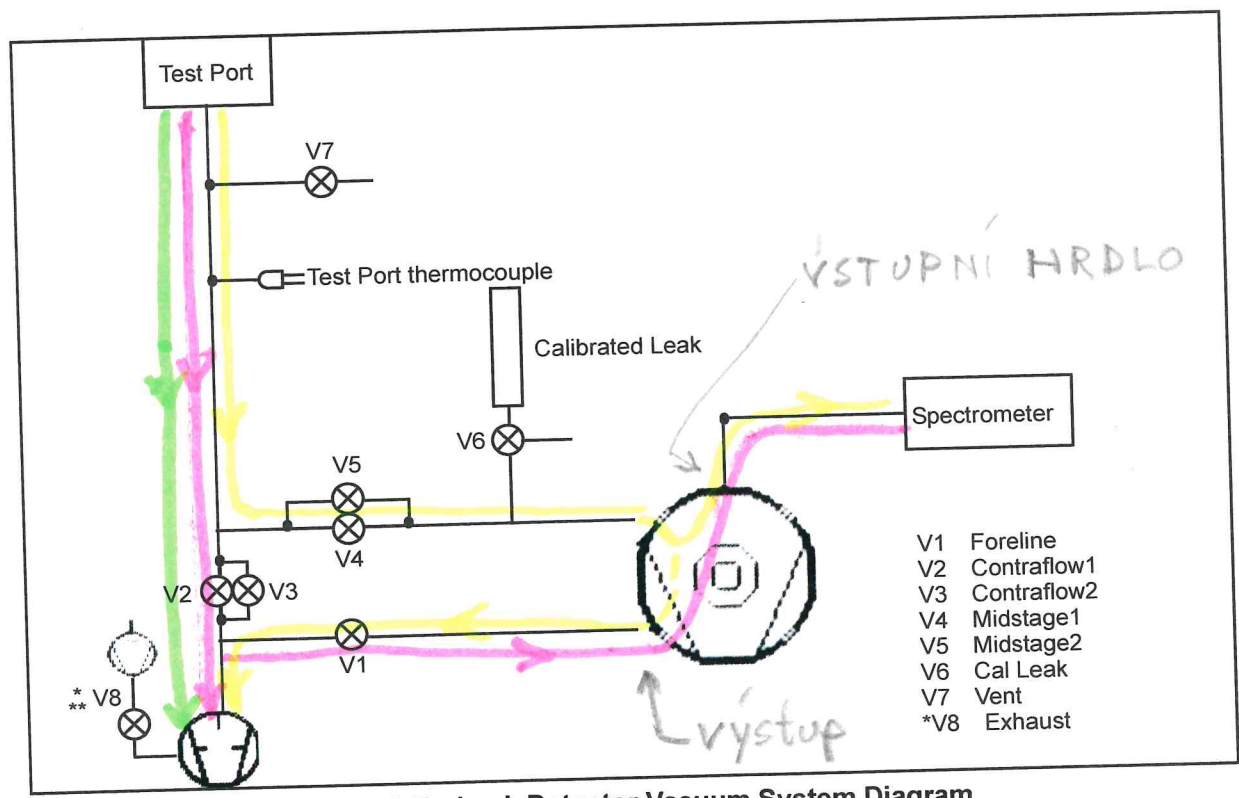


Figure 3-7 Leak Detector Vacuum System Diagram

* Normally open valve, powered closed during all operations. ** Model PD03 during the roughing sequence.

na displeji
 3-12
 " FINE TEST "
 " TEST "
 " GROSS TEST "

● VYSOKÁ CITLIVOST (MIDSTAGE TEST)
 ● NÍZKÁ CITLIVOST (HIGH PRESSURE TEST = CONTRA-FLOW)
 ● BEZ SPEKTROMETRU, JEN MĚŘKA NA VSTUPU
 (viz str. 2-6)



ELD500 LEAK DETECTOR INSTRUCTION MANUAL

Publication number: D135-10-880

Issue: B

Original Instructions

Description

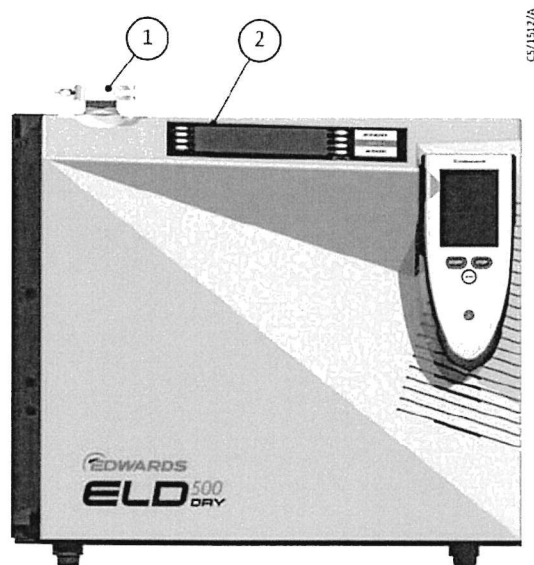
The ELD500 is a leak detector for helium or hydrogen. This instrument may be used to detect the location and the size of leaks on objects under test in two different ways:

When the test sample has been evacuated first and is sprayed with helium on the outside. It is required that a vacuum connection is provided between the ELD500 and the test sample (vacuum mode).

or

when a helium overpressure is provided in the test sample and the test sample is searched from the outside with a sniffer probe which is attached to the inlet port (sniffer mode).

Figure 1 View of the ELD500



1. Inlet flange 2. Control panel

Design and function

The ELD500 basically is a helium leak detector for vacuum applications, that is, the part under test is evacuated while the test is performed. The vacuum is achieved with a pumping system that is part of the ELD500. In addition the vacuum can be generated by pumps which are set up in parallel to the ELD500.

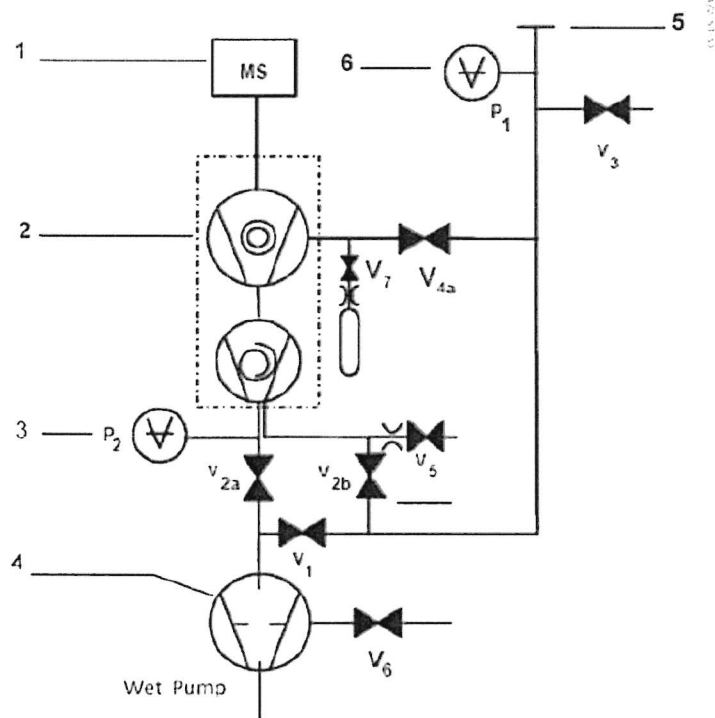
The ELD500 FLEX needs a fore vacuum pump, dry or wet version, to be connected because this unit has no internal roughing pump. The connection (DN25 KF) is on the side or under the bottom of the ELD500 FLEX (Figure 7).

Another operating mode of the ELD500 is the Sniffer mode which can only be used when a sniffer line (see Sniffer mode) is hooked up.

Vacuum diagram ELD500 WET

The vacuum diagram below shows the major components inside the ELD500 WET.

Figure 2 Vacuum diagram ELD500



1. MS: Mass Spectrometer, Helium sensor (180° magnetic field mass spectrometer)
2. Turbo molecular pump (TMP, provides high vacuum conditions in the MS)
3. Pirani gauge P2 (fore vacuum pressure)
4. Fore pressure pump (provides the fore vacuum pressure for the TMP and pumps down the parts under test)
5. Inlet Port
6. Pirani gauge P1 (inlet pressure)

V1 to V7: Electromagnetic Valves to control the gas flows

The mass spectrometer (MS) is mainly composed of the ion source with cathode, the magnetic separator and the ion collector.

Gas molecules getting into the mass spectrometer are ionized by the ion source. These positively charged particles are accelerated into the magnetic field following a circular path, the radius of which depends on the mass-to-charge ratio of the ions. When mass 4 is selected (Default setting) only helium ions can pass this filter and reach the ion collector where the stream of the ions is measured as an electrical current. When selected another mass than 4, only the corresponding ions can pass the filter.

For operation the mass spectrometer requires a vacuum level in the range of 1×10^{-4} mbar and lower. This pressure is provided by the turbo molecular pump which in turn is backed up by a fore vacuum pump.

Besides maintaining the pressure in the mass spectrometer the pump system is used to evacuate the test parts. It is made sure that the pressure in the mass spectrometer is low enough under all circumstances. The valves V1, V2a, V2b, V4a control the gas flows when

Vacuum method

For the purpose of leak detection on a test sample (vacuum method), the sample has to be evacuated so that Helium or Hydrogen which is sprayed on to the outside, can enter through any leaks due to the pressure differential for detection by the ELD500.

The test sample is evacuated - START button (Figure 16 item 10) - by the backing pump or the external pump. In the case of larger test samples an additional external partial flow pump with a corresponding linking valve may be connected in parallel as required.

Inlet valve V1 is opened so that the evacuation can take place. At the same time all other valves are closed in order to prevent an unacceptable pressure increase in the mass spectrometer.

In this context (valve V2a closed) the turbo molecular pump is operated without being supported by the rotary vane pump. Since generally no gas is pumped out of the mass spectrometer, p₂ remains constant or increases only slowly.

The condition for the evacuation process described here is maintained until the inlet pressure p₁ has dropped <15 mbar. Now the valves V2a and V2b are opened additionally. Possibly present Helium or Hydrogen may now flow upstream against the pumping direction of the turbo molecular pump into the mass spectrometer where it is detected. This measurement mode is called GROSS. In this mode, leak rates down to 10⁻⁸ mbar l/s can be detected.

Since the rotary vane vacuum pump continues to evacuate the test sample via valves V2a, V2b and V1 the inlet pressure p₁ will continue to drop. When the pressure drops below p₁ < 0.2 mbar, the ELD500 will switch to the FINE mode, that is, valve V1 and V2b closes and valve V4a opens so that the gas flow enters the turbo molecular pump at the side. This offer two advantages:

1. A part of the high pumping speed of the turbo molecular pump remains available for further evacuation of the test sample. The response time is inversely proportional to pumping speed.).
2. The advantages offered by the counter flow principle can still be utilized

In the FINE mode the full sensitivity of the ELD500 is reached.

Because of the higher base pressure of the diaphragm pump the switching from GROSS to FINE mode of the ELD500 DRY is done by the valve V4b. When the pressure drops below 3.5 mbar the valves V1 and V2b will be close and V4b opens step by step. When valve V4b is open completely, pressure < 0.1 mbar, V4a will open also to get the maximum pumping speed. In PRECISION mode the ELD500 DRY opens the valve V4b only, with the disadvantage of low pumping speed but with the highest sensitivity.

When the leak detection process is stopped – STOP-button – all valves except valve V2a are closed.

Valve V3 is opened during venting of the inlet or test sample.

Partial flow method

In the partial flow mode the test sample is additionally evacuated by an auxiliary pump. Using the optional partial flow pump set offers to the user the following advantages (ELD500 and ELD500 FLEX:

- faster response time
- entry into the measure mode already at an inlet pressure of 1000 mbar
- faster venting of large test objects

Alternatively to a partial flow pump set an external auxiliary pump may also be connected via a tee, this option is possible for the ELD500 dry and ELD500 FLEX also. However, in such a case the ELD500 will not be able to make measurements already at an inlet pressure of 1000 mbar.

Sniffer mode

The ELD500 may simply be converted into a sniffer leak detector via the rugged sniffer line (Cat. No. 252003).

For this the KF flange of the sniffer line is connected to the inlet flange (Figure 1 item 1) and the sniffer mode is selected through menu mode. After pressing START, the inlet valve V1 (Figure 2) opens. The sniffer lines have been designed in such a way that the ELD500 is operated in the FINE mode. If the fore vacuum pressure P2 increases over 0.2 mbar respectively 0.1 mbar a warning sign and audio alarm comes up in the display.

In the measurement mode the helium present in the ambient air is now indicated as the leak rate (about 2×10^{-6} mbar l/s). Smaller leaks may be detected by pressing the ZERO-button. In sniffer mode the smallest detectable leak rate is $< 1 \times 10^{-7}$ mbar l/s.

Supplied equipment

The ELD500 will be shipped in a special cardboard packed separately in a plastic foil as protection against dust.

Supplied equipment includes:

- Leak Detector ELD500
- Set of fuses
- Power cord
- Folder with documents (Operating instructions, Spare part list)
- 2 L-type screwed connections (hose connections)
- 1 hose nozzle
- Blank flange DN 25 KF
- Clamping ring DN 25 KF
- Centering ring DN 25 KF

Technical data

Technical data ELD500 WET

Physical data

Table 1 ELD500 WET physical data

Maximum inlet pressure	15 mbar
Minimum detectable Helium leak rates	
- in vacuum mode	$< 5 \times 10^{-12}$ mbar l/s

- in sniffer mode	$<1 \times 10^{-7}$ mbar l/s
Minimum detectable Hydrogen leak rates	
- in vacuum mode	$<1 \times 10^{-8}$ mbar l/s
- in sniffer mode	$<1 \times 10^{-7}$ mbar l/s
Maximum Helium leak rate which can be displayed	0.1 mbar l/s
Measurement range	12 decades
Time constant of the leak rate signal (blanked off, 63% of the final value)	<1 s
Pumping speed (Helium) at the inlet	
- GROSS mode	0.4 l/s
- FINE mode	> 2.5 l/s
Detectable masses	2, 3 and 4
Mass spectrometer	180° magnetic sector field
Ion source	2 filaments; Iridium/Yttrium-oxide
Inlet port	DN 25 KF
Run-up time (after starting)	< 2 min

To get down to the minimum detected leak rate range some conditions must be fulfilled:

- ELD500 WET has to run at least 20 minutes.
- Ambient conditions must be stable (temperature, no vibration/accelerations).
- The part under test has been evacuated long enough without using the zero function (background is no longer decreasing).
- ZERO must be active.

Electrical data

Table 2 ELD500 WET electrical data

Power supply	230 V a.c., +/- 5%, 50/60 Hz
	115 V a.c., +/- 5%, 60 Hz
	100 V a.c., +/- 5%, 50/60 Hz
Power consumption	420 VA
Type of protection	IP40

Other data

Table 3 ELD500 WET other data

Valves	Solenoid
Dimensions (L x W x H) (mm)	495 x 456 x 314
Weight (kg)	40.0
Noise level (dB (A))	< 54

OPERATING MANUAL

iina70en1-15-(2202) Translation of the original handbook



Catalog-No.

UL 1000:
550 - 000A
550 - 001A
550 - 002A

UL 1000 Fab:
550 - 100A
550 - 101A

from software version V5.17

UL1000 / UL1000 Fab

Helium Leak Detector



Besides maintaining the pressure in the mass spectrometer the pump system is used to evacuate the test parts. It is made sure that the pressure in the mass spectrometer is low enough under all circumstances. The valves V1a, V1b, V2, V4a, V4b control the gas flows when measuring. Valves V5 (only UL1000), V6, and V8 are used to vent the system and the Turbo pump. Valve V7 opens and closes the internal test leak during calibration.

With the pressure in the test part being lower than ambient pressure sprayed helium can penetrate into the part in case of a leakage. As soon as the pressure conditions allow it one of the valves to the TMP opens. Now Helium can penetrate into the mass spectrometer contrary to the pumping direction of the TMP.

See Chapter 4.3 Working Modes for details.

4.2.2 Control Panel

The Control Panel Fig. 4-2/7 contains a liquid crystal display (LC Display), the *START*, *STOP*, *ZERO* and *MENU* buttons and also eight Soft Keys for the different menus and inputs.

The control panel itself is rotatable.

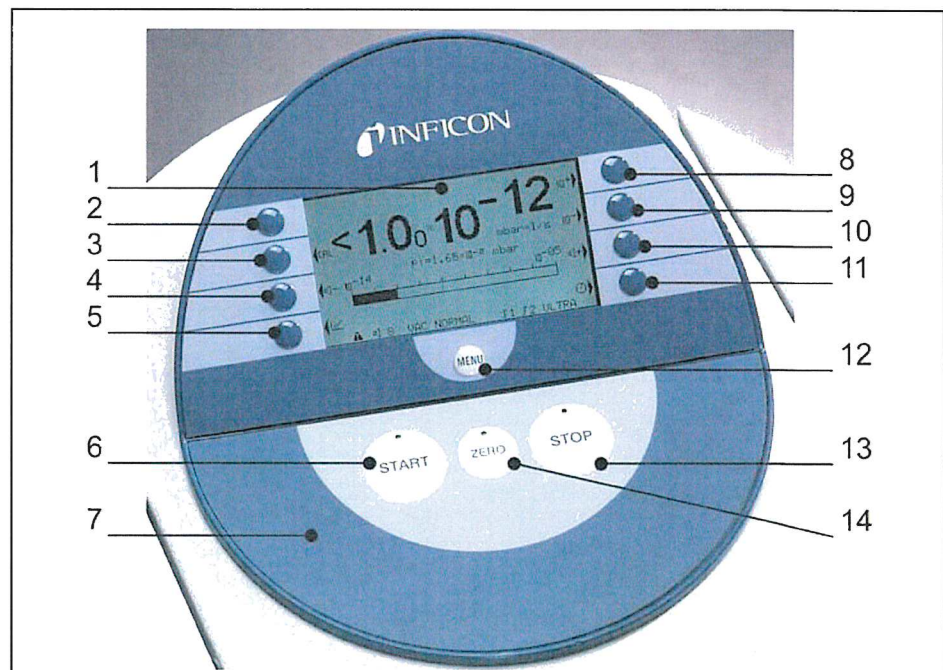


Fig. 4-2: Control Panel

Pos.	Description	Pos.	Description
1	LC Display	8	Soft Key no. 5
2	Soft Key no. 1	9	Soft Key no. 6
3	Soft Key no. 2	10	Soft Key no. 7
4	Soft Key no. 3	11	Soft Key no. 8
5	Soft Key no. 4	12	MENU Button
6	START Button	13	STOP Button
7	Control Panel	14	ZERO Button

4.2.1 Vacuum System

The vacuum diagram below shows the major components inside the UL1000 and UL1000 Fab:

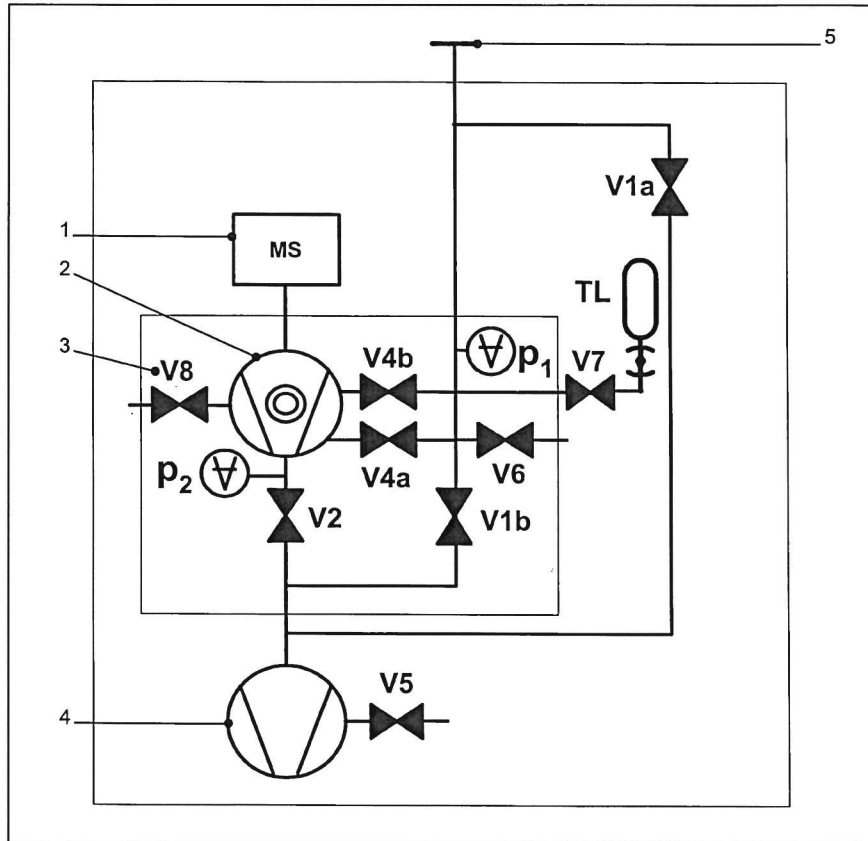


Fig. 4-1: Vacuum Diagram UL1000 and UL1000 Fab

Pos.	Description
1	MS: Mass Spectrometer, Helium sensor (180° magnetic field mass spectrometer)
2	Turbomolecular Pump (TMP, provides high vacuum conditions in the MS)
3	V1a ... V8: Electromagnetic Valves to control the gas flows
4	Scroll pump (provides the foreline pressure for the TMP und pumps down the parts under test)
5	Inlet Port

The mass spectrometer is mainly composed of the ion source, the magnetic separator and the ion collector.

Gas molecules getting into the mass spectrometer are ionized by the ion source. These positively charged particles are accelerated into the magnetic field following a circular path, the radius of which depends on the mass-to-charge ratio of the ions. Only helium ions can pass this filter and reach the ion collector where the stream of the ions is measured as a electrical current.

For operation the mass spectrometer requires a vacuum level in the range of 1×10^{-4} mbar and lower. This pressure is provided by the turbomolecular pump which in turn is backed up by a scroll pump.

4.3 Working Modes

4.3.1 Vacuum Mode

As mentioned (Please refer to Chapter 4.2.1 Vacuum System) the sample has to be evacuated to allow Helium which is sprayed on the outside to enter through any leaks due to the pressure difference.

When pressing the **START Button** Valves V1a and V1b open and the sample is pumped down by the roughing pump (UL1000) or scroll pump (UL1000 Fab). At the same time valve V2 is closed to avoid an unacceptable pressure increase in the turbo pump and the mass spectrometer. With valve V2 being closed the turbomolecular pump is operated without being backed up by the scroll pump. Since the mass spectrometer is already under vacuum no further gas is pumped. Thus the pressure p_2 remains constant or increases only slowly.

If the pressure p_2 even though increases (e.g because of a very long pumping down process), then the evacuation will be broken (V1a and V1b closed) at $p_2 > 10$ mbar and V2 will open shortly to restore an appropriate foreline ($p_2 < 1$ mbar).

The following diagrams show the gas flow during evacuation and during the modes GROSS, FINE and ULTRA.

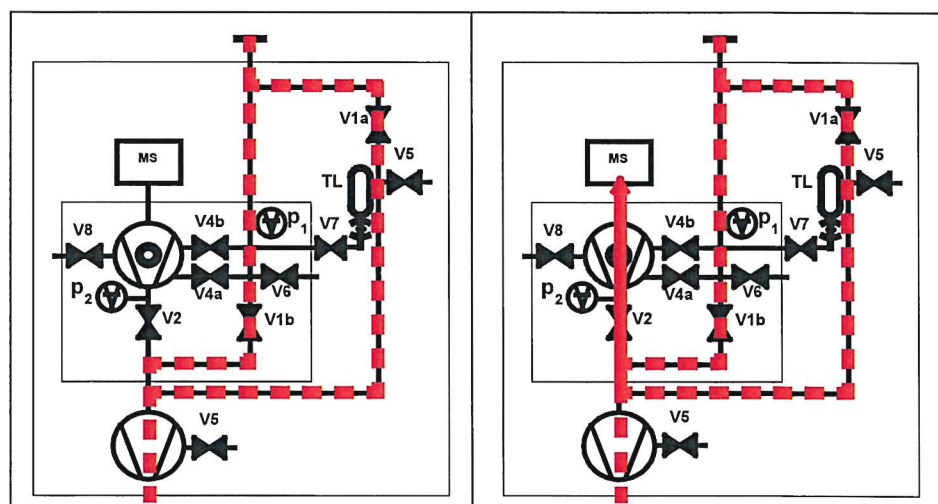


Fig. 4-6: left: Evacuation (no measurement), right: GROSS Mode

The condition for the evacuation process described is maintained until the inlet pressure p_1 has dropped below 15 mbar. Now valve V2 opens. Possibly present helium may now flow upstream against the pumping direction of the turbo molecular pump into the mass spectrometer where it is detected. This mode is called GROSS, the detection limit is 1×10^{-6} mbar l/s.

Since the scroll pump continues to evacuate the test sample the inlet pressure p_1 will continue to drop. Below 2 mbar the UL1000 and UL1000 Fab will switch to FINE mode, i.e. V4a will open and V1b will close. The gas stream enters the turbo pump at an intermediate level. The sensitivity of the system now is higher, the detection limit is 1×10^{-10} mbar l/s.

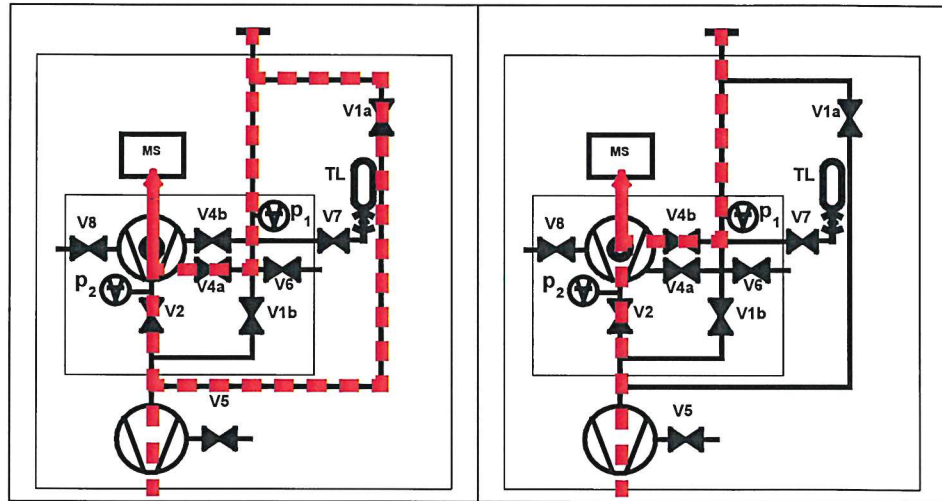


Fig. 4-7: left: FINE Mode, right: ULTRA Mode

Now the lower part of the turbo pump further evacuates the sample and after the pressure p_1 has reduced below 0.4 mbar the UL1000 and UL1000 Fab switches into ULTRA mode, i.e. V1a and V4a close and V4b opens. The entrance into the turbo pump is on a higher level now. The pumping speed at the inlet port is now 2.5 l/s, the detection limit is 5×10^{-12} mbar l/s.

Tip A special set up of the UL1000 and UL1000 Fab stops the autoranging procedure as described above. With the mode *FINE ONLY* (Please refer to Chapter 6.3 Mode) the unit will stay in FINE Mode Fig. 4-7 (left) regardless the inlet pressure. The valve V1a is closed.

4.3.2 Sniffer Mode

In sniff mode a sniffer line (preferably the INFICON standard sniffer line 14005) is connected to the inlet port. When pressing the **START Button** the system starts to pump air through the sniffer line. Due to the constant gas flow through the sniffer line the software will range directly into FINE mode and stay there. The inlet pressure will not drop further down. By measuring the inlet pressure the system software makes sure that the flow through the sniffer line is at the right level. Otherwise warning messages are generated. The detection limit in sniff mode is $< 1 \times 10^{-7}$ mbar l/s.

INFICON's sniffersystem QT100 may also be used to sniff. Since the QT100 provides a lower inlet pressure it is recommended to keep the system in vacuum mode to avoid a wrong generation of pressure warnings. The machine factor has to be adjusted to value 400.

4.3.3 Auto Leak Test Mode

In this mode the test of hermetically sealed testing objects can be performed automatically. By use of the optional test chamber TC1000 this test mode starts automatically when closing the chamber lid. Fast test results within seconds are achieved by using the internal test leak of the UL1000 or UL1000 Fab for a dynamic calibration, matched to the required test cycle. Leak rates in the 10^{-9} mbar l/s range can be detected within 5 seconds.

Auto zero

Measurement and automatic adaptation to the helium background.

This function determines the internal ZERO level of the unit which is then deducted from the currently measured leak rate signal. This function is enabled by pressing the Start key provided the UL1000 or UL1000 Fab have run at least 20 s in "Standby" mode or in "Ventilation" mode.

If the before suppressed helium background further decreases and only the display limit appears, the ZERO-level will be adjusted automatically

Menu

The menu allows the user to program the UL1000 and UL1000 Fab according to his requirements. The menu has a tree architecture.

Default

Status of the UL1000 and UL1000 Fab when supplied by the factory.

GROSS

GROSS is a measurement mode which allows high inlet pressure (1 to 15 mbar). The smallest detectable leak rate is 1×10^{-6} mbar l/s.

FINE

FINE is the medium measurement mode with inlet pressure between 2 and 0,4 mbar. Detection limit is 1×10^{-10} mbar l/s.

ULTRA

ULTRA is the most sensitive measuring range with inlet pressures below 0,4 mbar. The minimum detectable leak rate is 5×10^{-12} mbar l/s.

Foreline pressure

Pressure in the foreline between Turbo pump and scroll pump.

Minimum detectable leak rate

The smallest leak rate the UL1000 and UL1000 Fab is able to detect ($\leq 5 \times 10^{-12}$ mbar l/s).

Internal helium background

The existing helium partial pressure in the measurement system. The level of the internal helium background is measured in the Standby mode and subtracted from the measured signal.

Measure Measurement mode

The UL1000 and UL1000 Fab measures the leak rate of the test sample.