



Vacuum technology — Mass-spectrometer-type leak-detector calibration

Technique du vide — Étalonnage des spectromètres de masse détecteurs de fuites

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3530 was developed by Technical Committee ISO/TC 112, *Vacuum technology*, and was circulated to the member bodies in December 1978.

It has been approved by the member bodies of the following countries :

Australia	Italy	South Africa, Rep. of
Belgium	Japan	Spain
Chile	Korea, Rep. of	United Kingdom
Czechoslovakia	Mexico	USA
France	Netherlands	USSR
Germany, F.R.	Poland	
India	Romania	

No member body expressed disapproval of the document.

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0 Introduction

This International Standard specifies procedures to be used for calibrating leak detectors of the mass-spectrometer type; that is, for determining a sensitivity figure for such leak detectors. The procedures require the use of a calibrated leak and a standard gas mixture; the preparation and standardization of these are outside the scope of this International Standard. Hereafter, the designation "leak detector" will be used to refer to a detector of the mass-spectrometer type.

A leak detector permits detection of leakage due to mechanical openings, such as pinholes, and of leakage due to permeation, such as occurs through many polymeric materials. Virtual leaks, such as those due to surface desorption, vaporization, and gas pockets, cannot, in general, be detected by a leak detector.

The range of leakage-rate calibration is limited to a specified level since factors that are unimportant for larger leaks may become significant for leak rates that are substantially smaller than $10^{-12} \text{ Pa}\cdot\text{m}^3\cdot\text{s}^{-1}$.

Objects being tested by a leak detector may be under high vacuum, or, at the other extreme, under pressure greater than atmospheric. The leak-detection techniques will, in general, differ in the two situations. In the first case, the leak detector usually will be operating near its ultimate low pressure; in the second case, the detector is frequently used at or near its maximum operating pressure. Corresponding to these two conditions of operation, two sensitivity terms are defined, "minimum detectable leak rate" and "minimum detectable concentration ratio" (see clause 2).

The two quantities thus defined are related, but in practice it is not feasible to obtain either figure from the other by calculation. Methods are therefore specified for determining both.

This International Standard is one of a series standardizing leak-testing procedures and apparatus, prepared for use in the field of vacuum technology.

Applications fall into the categories: leak tightness, leak-detector calibration, calibration of leaks, gas mixtures, acceptance specifications for leak-detection instruments and general procedures for tightness-proving of vacuum plant.

The above-mentioned requirements will form the subjects of future International Standards.

1 Scope and field of application

This International Standard specifies procedures to be used for the calibration of mass-spectrometer-type leak detectors.

It deals only with leak detectors which have an integral high vacuum system to maintain the sensing element (mass spectrometer tube) at a low pressure. Specifically excepted from treatment are sensing elements without such a vacuum system. It is also to be understood that the procedures are not intended to constitute a complete acceptance test; such tests will be the subject of a future International Standard.

This International Standard concerns the use of helium-4. Nevertheless, the procedures described may be used for other search gases such as argon-40, subject to appropriate precautions.

The application of this International Standard is restricted to leak detectors not capable of detecting leaks smaller than $10^{-12} \text{ Pa}\cdot\text{m}^3\cdot\text{s}^{-1}$.

Two procedures are outlined, one for determining the minimum detectable leak rate and the other for determining the minimum detectable concentration ratio. These are applicable to the use of the leak detector for high vacuum and for pressures greater than atmospheric, respectively.

2 Definitions

NOTES

1 An ISO glossary of terms used in vacuum technology is not yet available. In view of this, the following list of definitions has been prepared; usage in this International Standard will conform to these definitions.

2 Where a word may be either a noun or a verb, the letters "n" or "v", in parentheses, indicate which usage is involved.

2.1 Background (or residual signal)

2.1.1 background: In general, the total spurious indication given by the leak detector without injected search gas. Background can originate in either the mass spectrometer tube (see below) or the associated electric and electronic circuitry, or both. (Frequently, the term is used to refer specifically to the indication due to ions other than those produced from injected search gas.)

2.1.2 drift : The relatively slow change in the background. The significant parameter is the maximum drift measured in a specified period of time.

2.1.3 noise : The relatively rapid changes in the background. The significant parameter is the noise measured in a specified period of time.

2.1.4 helium background : Background due to helium released from the walls of the leak detector or leak-detection system.

2.2 Components

2.2.1 inlet line or sample inlet line : The line through which the search gas passes from the object under test to the leak detector.

2.2.2 inlet valve : A valve which is placed at the end of the sample inlet line and adjacent to the leak detector. (See figure 1.) Almost invariably the inlet valve is an integral part of the leak detector.

2.2.3 leak isolation valve : A valve placed between a leak which is to be used for testing the leak detector and the sample inlet line. (See figure 1.)

2.2.4 pump valve : A valve placed between the roughing pump used for evacuating the sample inlet line and that line. (See figure 1.)

2.2.5 vent valve : A valve used to admit air or other gas into an evacuated space so as to increase the pressure therein to atmospheric pressure. (See figure 1.)

2.2.6 backing-off control; zero control : An electrical control, present on most leak detectors, which may be used to shift the output indication of the device. Frequently, the backing-off control is used to return the output indication to zero of the scale, whence the alternative name.

2.2.7 filament : The source of the (thermal) electrons which ionize the gases in the mass spectrometer tube; the filament is located in this tube.

2.2.8 mass spectrometer tube : That element of a leak detector in which the search gas is ionized and detected.

2.3 Search gas

search gas : A gas applied to the outer surface of equipment under leak test and detected, after entry into the equipment through the leak, in a vacuum test, or introduced into the

equipment under test and detected after it is emitted from the leak, in a pressure test.

2.4 Leaks

2.4.1 leak (*n*) : In vacuum technology, a hole, porosity, permeable element, or other structure in the wall of an enclosure capable of passing gas from one side of the wall to the other under action of a pressure or concentration difference existing across the wall.

Also, a device which can be used to introduce gas into an evacuated system.

2.4.2 channel leak : A leak which consists of one or more discrete passages that may be ideally treated as long capillaries.

2.4.3 membrane leak : A leak which permits gas flow by permeation of the gas through a non-porous wall. For helium, this wall may be of glass, quartz, or other suitable material.

2.4.4 molecular leak : A leak through which the mass rate of flow is substantially proportional to the reciprocal of the square root of the molecular mass of the flowing gas.

2.4.5 viscous leak : A leak through which the mass rate of flow is substantially proportional to the reciprocal of the viscosity of the flowing gas.

2.4.6 calibrated leak : A leak device which provides a known mass rate of flow for a specific gas under specific conditions.

2.4.7 standard leak : A calibrated leak for which the rate of leakage is known under standard conditions; namely, $23 \pm 7^\circ\text{C}$, a pressure of $100\text{ kPa} \pm 5\%$ at one end of the leak, and a pressure at the other end so low as to have a negligible effect on the leak rate.

2.4.8 virtual leak : The semblance of a leak due to evolution of gas or vapour within a system.

2.5 Leak rates

2.5.1 leak rate : The throughput¹⁾, in $\text{Pa}\cdot\text{m}^3\cdot\text{s}^{-1}$, of a specific gas which passes through a leak under specific conditions.

2.5.2 standard air leak rate : The throughput, through a leak, of atmospheric air of dewpoint less than -25°C under standard conditions specified as follows : the inlet pressure shall be $100\text{ kPa} \pm 5\%$, the outlet pressure shall be less than 1 kPa , and the temperature shall be $23 \pm 7^\circ\text{C}$.

1) Differentiated from volume rate of flow, which is also called "pumping speed". Throughput is equivalent to mass rate of flow when the temperature and molecular mass of the gas are specified.