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Vacuum technology — Vocabulary —

Part 3: Total and partial pressure vacuum gauges

Technique du vide — Vocabulaire —

Partie 3: Manomètres de pression totale et analyseurs de pressions partielles

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Foreword

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The committee responsible for this document is ISO/TC 112, *Vacuum technology*.

This second edition cancels and replaces the first edition (ISO 3529-3:1981), which has been technically revised in order to include terms of now common vacuum gauges and to adapt terms to new developments and general use of terms in publications.

ISO 3529 consists of the following parts, under the general title *Vacuum technology — Vocabulary*:

— *Part 1: General terms*

— *Part 2: Vacuum pumps and related terms*

— *Part 3: Total and partial pressure vacuum gauges*

Vacuum technology — Vocabulary —

Part 3: Total and partial pressure vacuum gauges

1 Scope

This part of ISO 3529 gives definitions of total and partial pressure vacuum gauges. lt is a continuation of ISO 3529-1, which defines general terms used in vacuum technology, and of ISO 3529-2, which gives definitions of vacuum pumps and related terms.

The terms for those gauges are defined, which had been either very important in the past or are important today and normally commercially available or which physical principle is important still today.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE A tree diagram of total pressure vacuum gauges is illustrated in Figure A.1.

2.1 General terms

2.1.1
pressure gauge
instrument for measuring gas or vapour pressures, greater, equal to or less than the prevailing atmospheric pressure

2.1.2
vacuum gauge
instrument for measuring gas or vapour pressures less than the prevailing atmospheric pressure

Note 1 to entry: A vacuum gauge is a subset of a pressure gauge.

Note 2 to entry: Some types of vacuum gauges commonly in use do not actually measure a pressure (as expressed in terms of a force acting on a surface), but some other physical quantity related to pressure, under specific conditions.

2.1.2.1
gauge head
<of certain types of gauge> part of the gauge which contains the pressure-sensitive element and which is directly connected to the vacuum system

2.1.2.1.1
nude gauge
gauge head without an envelope

Note 1 to entry: In this case, the sensitive element is inserted directly into the vacuum system.

2.1.2.2
control unit
controller
<of certain types of gauge> part of the gauge containing the power supply and all electrical circuitry necessary for the operation of the gauge

2.1.2.2.1
indicator
indicating unit
<of certain types of gauge> part of the gauge which indicates the output signal, usually scaled in units of pressure

2.2 General categories of vacuum gauges

2.2.1
differential vacuum gauge
vacuum gauge which measures the difference of pressures existing simultaneously on either side of a sensitive partition element, for example a flexible diaphragm or a movable separating liquid

2.2.2
absolute vacuum gauge
vacuum gauge by means of which pressure may be determined in terms of measured physical quantities alone

2.2.3
total pressure vacuum gauge
vacuum gauge for measuring the total pressure of a gas or a gaseous mixture

2.2.4
partial pressure vacuum gauge
partial pressure analyser
vacuum gauge for measuring currents derived from the ionized constituents of a gaseous mixture

Note 1 to entry: These currents represent partial pressures with different proportionality constants for different components.

Note 2 to entry: Sometimes this gauge is denoted as a "residual gas analyser". Since this term characterizes only one of several possible applications of partial pressure analysers, it should be avoided.

2.3 Characteristics of vacuum gauges

2.3.1
measurement range
<of a vacuum gauge> range between minimum and maximum pressure where the reading of the gauge is within the specified measurement uncertainty limits

Note 1 to entry: For certain types of gauge, this range depends on the nature of the gas. In such a case, the pressure range for nitrogen shall always be specified.

2.3.2
sensitivity
sensitivity coefficient
<for a given pressure> change in the signal indicated by the vacuum gauge, divided by the corresponding change in pressure and, where appropriate, divided by parameters not depending on pressure

Note 1 to entry: For certain types of gauge, the sensitivity depends on the nature of the gas. In such a case, the sensitivity for nitrogen shall always be specified.

2.3.3
relative sensitivity factor
<of a vacuum gauge for a specified gas> sensitivity of the gauge for that gas divided by the sensitivity of the gauge for nitrogen, at the same pressure and under the same operating conditions

2.3.4
ionization sensitivity
<for a given gas> change of ion current divided by the corresponding change in pressure

2.3.5
equivalent nitrogen pressure
<of a gas acting on a vacuum gauge> that pressure of nitrogen which would produce the same gauge reading

2.3.6
X-ray limit
<of an ionization gauge> that pressure of pure nitrogen which would give the same gauge reading, without a X-ray effect, as is produced by the residual current caused by photo-electrons mainly emitted at the ion collector

Note 1 to entry: For ionization gauges with a discharge by crossed electromagnetic fields, the X-ray limit is normally not significant.

2.4 Total pressure vacuum gauges

2.4.1 Vacuum gauges based on mechanical phenomena

2.4.1.1
liquid level manometer
absolute differential manometer, commonly a U-tube, in which the sensitive element is a movable separating liquid (for example mercury)

Note 1 to entry: The pressure difference is obtained by measuring the difference in the liquid levels.

2.4.1.2
elastic element gauge
differential vacuum gauge in which the flexible partition is an elastic element

EXAMPLE Bourdon gauge, diaphragm gauge, capacitance diaphragm gauge, etc.

Note 1 to entry: The pressure difference can be determined by measuring either the displacement of the elastic element (direct method) or the force required to compensate its displacement (zero method).

2.4.1.2.1
Bourdon gauge
elastic element gauge where the elastic element is a tube formed into a spiral or a helix.

2.4.1.2.2
diaphragm gauge
membrane gauge
elastic element gauge where the elastic element is a membrane that changes the shape under a pressure difference across it

EXAMPLE An example is a piezoresistive gauge where the force onto the membrane is measured by a piezo element. Another example is the *capacitance diaphragm gauge* (2.4.1.2.3) and the resonant silicon gauge.

2.4.1.2.3
capacitance diaphragm gauge
diaphragm gauge where the membrane is part of a capacitor

Note 1 to entry: A capacitance diaphragm gauge is sometimes also termed a “capacitance manometer”.

2.4.1.3
compression gauge
McLeod gauge
vacuum gauge in which a known volume of the gas at the pressure to be measured is compressed (for example by the movement of a column of liquid – e.g. mercury) in a known ratio and the resulting higher pressure then measured

Note 1 to entry: If the higher pressure is measured by a liquid level manometer, such a gauge is absolute for a gas which satisfies the ideal gas law.

2.4.1.4
pressure balance
piston gauge
absolute vacuum gauge in which the pressure to be measured is suitably applied to an accurately matched piston-cylinder assembly of known cross-sectional area, the resulting force being compared with the gravitational force acting on a group of known masses or being measured by a force meter

Note 1 to entry: A piston gauge where the piston and surrounding cylinder rotate against each other is called a "rotating piston gauge" or "rotating pressure balance".

2.4.2 Vacuum gauges based on transport phenomena in gases

2.4.2.1
viscosity gauge
vacuum gauge in which the pressure is determined in relation to the viscous forces acting on a surface

EXAMPLE Quartz friction gauges, tuning fork gauges, decrement gauge, molecular drag gauge.

Note 1 to entry: This gauge is based on the viscosity of a gas being pressure dependent.

2.4.2.1.1
spinning rotor gauge

viscosity gauge in which the surface is a spinning rotor magnetically suspended in a vacuum thimble and the relative deceleration rate of the rotor is measured

Note 1 to entry: The deceleration of the rotor is caused by momentum transfer from the rotor to the gas molecules in high vacuum and additionally by gas friction (viscous forces) at higher pressures.

2.4.2.1.2
quartz friction vacuum gauge
viscosity gauge in which resonant frequency of the quartz tuning fork depends on the pressure

2.4.2.2
thermal conductivity gauge
vacuum gauge in which the pressure is determined in relation to the transfer of thermal energy between the surfaces of two fixed elements maintained at different temperatures

EXAMPLE Pirani gauge, thermocouple gauge, thermistor gauge, bimetal gauge.

Note 1 to entry: This gauge is based on the thermal conductivity of a gas being pressure dependent.

2.4.2.2.1
thermocouple gauge
thermal conductivity gauge in which the temperature of the heated element is measured by a thermocouple attached to it

2.4.2.2.2
Pirani gauge
thermal conductivity gauge in which the heated element is part of a Wheatstone bridge that supplies the energy to the element and by which the electrical resistance or the dissipated power of the element is being measured

Note 1 to entry: The heated element, often a wire, may be maintained at a constant temperature and the required heating power in dependence of pressure is measured. This is the most accurate measuring principle of a Pirani gauge. Alternatively, the heating power (as in the original design of Pirani) or the current is kept constant and the compensation current in the bridge is used as a measure of pressure.

2.4.2.2.3
thermistor gauge
thermal conductivity gauge in which the heated element is a semiconductor with a high specific resistance coefficient

2.4.2.2.4
thermo-molecular gauge
vacuum gauge in which the pressure is determined by measuring the net rate of transfer of momentum by gas molecules striking fixed surfaces maintained at different temperatures

EXAMPLE Knudsen gauge, diamagnetic levitation.

Note 1 to entry: The dimensions shall be very small compared to the mean free path of the gas molecules.

2.4.3 Vacuum gauges on ionization phenomena in gases

2.4.3.1
ionization vacuum gauge
vacuum gauge in which the molecular density is determined by measuring the ion current produced in the gas by ionization under controlled conditions

Note 1 to entry: The pressure is directly related to gas density.

2.4.3.2
crossed field ionization gauge
ionization vacuum gauge in which the ions are produced by a cold cathode discharge in crossed electrical and magnetic fields

Note 1 to entry: This kind of gauge was formerly defined as a “cold cathode gauge”. Due to the availability of cold cathodes like field emission cathodes or carbon nano tubes as emitting cathodes, the new term was introduced.

2.4.3.2.1
Penning gauge
crossed field ionization gauge with a magnet and which has a particular electrode geometry

Note 1 to entry: One of the electrodes consists of two linked parallel discs. The other electrode (normally the anode) is usually annular and placed between the discs, parallel to them. The magnetic field is perpendicular to the discs.

2.4.3.2.2
magnetron gauge
crossed field ionization gauge having electrodes arranged as coaxial cylinders, the cathode being the inner one, and an axial magnetic field perpendicular to the electric field

2.4.3.2.3
inverted magnetron gauge
crossed field ionization gauge having electrodes arranged as coaxial cylinders, the anode being the inner one, and an axial magnetic field perpendicular to the electric field

