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Vacuum technology — Vocabulary —

Part 1: General terms

Technique du vide — Vocabulaire —

Partie 1: Termes généraux

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Contents

Page

Introduction

If difficulties arise in the use of the definitions in connection with measurement of some quantities, it is recommended that reference be made to the International Standards related to the measurement of those quantities for the practical interpretation of the terms.

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 112, *Vacuum technology*.

This second edition cancels and replaces the first edition (ISO 3529-1:1981), which has been technically revised. The main changes compared to the previous edition are as follows:

— standard conditions which are defined elsewhere were removed;

— ranges of vacuum were newly defined and reasons given;

— new term ultra clean vacuum was defined;

— knudsen number and rarefaction parameter were included;

— slip flow was defined;

— specific desorption, outgassing, and evaporation rate were newly defined;

— accommodation factor distinguished in energy and momentum accommodation factor.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Vacuum technology — Vocabulary —

Part 1:
General terms

1 Scope

This document defines general terms used in vacuum technology. It gives theoretical definitions as precise as possible, bearing in mind the need for use of the concept in practice.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 General terms

3.1.1
vacuum
commonly used term to describe the state of a rarefied gas or the environment corresponding to such a state, associated with a pressure or a molecular density below the prevailing atmospheric level

3.1.2
ranges of vacuum
various ranges of vacuum according to certain pressure intervals

Note 1 to entry: While there has been some variation in the selection of the limits of these intervals, the following list gives typical ranges for which the limits are to be considered as approximations.

Note 2 to entry: The prevailing atmospheric pressure on ground depends on weather conditions and altitude and ranges from 31 kPa (altitude of the Mount Everest, weather condition "low") up to 110 kPa (altitude Dead Sea, weather condition "high").

Pressure range	**Definition**	**The reasoning for the definition of the ranges is as follows (typical circumstances):**
Prevailing atmospheric pressure (31 kPa to 110 kPa) to 100 Pa	low (rough) vacuum	Pressure can be achieved by simple materials (e.g. regular steel) and positive displacement vacuum pumps; viscous flow regime for gases
<100 Pa to 0,1 Pa	medium (fine) vacuum	Pressure can be achieved by elaborate materials (e.g. stainless steel) and positive displacement vacuum pumps; transitional flow regime for gases

Pressure range	Definition	The reasoning for the definition of the ranges is as follows (typical circumstances):
<0,1 Pa to 1×10^{-6} Pa	high vacuum (HV)	Pressure can be achieved by elaborate materials (e.g. stainless steel), elastomer sealings and high vacuum pumps; molecular flow regime for gases
<$1x10^{-6}$ Pa to 1×10^{-9} Pa	ultra-high vacuum (UHV)	Pressure can be achieved by elaborate materials (e.g. low-carbon stainless steel), metal sealings, special surface preparations and cleaning, bake-out and high vacuum pumps; molecular flow regime for gases
below 1×10^{-9} Pa	extreme-high vacuum (XHV)	Pressure can be achieved by sophisticated materials (e.g. vacuum fired low-carbon stainless steel, aluminium, copper-beryllium, titanium), metal sealings, special surface preparations and cleaning, bake-out and additional getter pumps; molecular flow regime for gases

3.1.3
ultra clean vacuum
medium or high vacuum that requires special conditions for some gas species equivalent to UHV conditions

Note 1 to entry: The requirements for the particular gas species (impurity) depend on the application.

Note 2 to entry: Hydrocarbons, CO, CO_2 and H_2O are typical impurity gases.

Note 3 to entry: The particular requirements may also include specifications for low particle density.

3.1.4.1
pressure of a vacuum
p
<on a boundary surface> normal component of the force exerted by a gas on an area of a real surface divided by that area

Note 1 to entry: The orientation of the surface relative to the mass flow vector being specified if there is a net mass flow of gas);

3.1.4.2
pressure of a vacuum
p
<at a specified point in a bulk of gas> state of a gas according to the ideal gas law with corrections for real gases if necessary

Note 1 to entry: When the ideal gas law is applied, the pressure p in a small infinitesimal volume is given by the product of number density n of gas molecules in this volume, Boltzmann constant k and temperature T.

Note 2 to entry: For most practical applications in vacuum, the ideal gas law without corrections for real gases (volume and interaction of gas molecules) is sufficient.

3.1.5
partial pressure
pressure due to a specified component of a gaseous mixture

3.1.6
total pressure
term used to denote the sum of all the partial pressures of the constituents of a gas mixture in contexts where the shorter term "pressure" might not clearly distinguish between the individual partial pressure and their sum

3.2 Terms to define gases and vapours and their parameters

3.2.1
gas
matter in a state such that the molecules are virtually unrestricted by intermolecular forces so that the matter is free to occupy any available space

Note 1 to entry: In vacuum technology the word "gas" has been loosely applied to both the non-condensable gas and the vapour.

3.2.2
non-condensable gas
gas whose temperature is above the critical temperature of the substance considered, i.e. one which cannot be changed into the condensed phase by increase of pressure alone

3.2.3
vapour
gas whose temperature is below the critical temperature of the substance considered, i.e. one which can be changed into the condensed phase by increase of pressure alone

3.2.4
saturation vapour pressure
p_L
pressure exerted by a vapour which is in thermodynamic equilibrium with one of its condensed phases at the prevailing temperature

3.2.5
degree of saturation
ratio of the pressure exerted by a vapour to its saturation vapour pressure

3.2.6
saturated vapour
vapour which exerts a pressure equal to the saturation vapour pressure at a given temperature

Note 1 to entry: The vapour is always saturated when it is in thermodynamic equilibrium with one of the condensed phases of the substance considered.

3.2.7
unsaturated vapour
vapour which exerts a pressure less than the saturation vapour pressure of the substance considered for a given temperature

3.2.8
number density of molecules
n
<at a specified point in a gas and at a certain instant> number of molecules contained at time t in an adequately chosen volume surrounding that point, divided by that volume

Note 1 to entry: The word "time" is used for brevity. More exactly, an average is to be taken over a short time interval, centred about the time, of sufficient duration so that an adequate statistical average may be obtained.

3.2.9
unitary mass density
ρ_u
mass density of a gas divided by its pressure