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Kompresorji in vakuumske črpalke - Varnostne zahteve - 2. del: Vakuumske črpalke

Compressors and vacuum pumps - Safety requirements - Part 2: Vacuum pumps

Kompressoren und Vakuumpumpen - Sicherheitsanforderungen - Teil 2: Vakuumpumpen

Compresseurs et pompes à vide - Prescriptions de sécurité - Partie 2: Pompes à vide

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Compressors and vacuum pumps - Safety requirements - Part 2: Vacuum pumps

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Kompressoren und Vakuumpumpen - Sicherheitsanforderungen - Teil 2: Vakuumpumpen

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Foreword

This document (EN 1012-2:1996+A1:2009) has been prepared by Technical Committee CEN/TC 232 “Compressors, vacuum pumps and their systems”, the secretariat of which is held by SIS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2010, and conflicting standards shall be withdrawn at the latest by March 2010.

This document includes Amendment 1, approved by CEN on 2009-08-06.

This document supersedes EN 1012-2:1996.

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1] ⟨A1⟩.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

[A1] For relationship with EU Directive(s), see informative Annexes ZA and ZB, which are integral parts of this document. ⟨A1⟩

The responsibility of CEN/TC 232 includes coordination of safety standards with CEN/TC 182 "Refrigerating systems, safety and environmental requirements" and CEN/TC 234 "Gas supply".

[A1] Annexes A, ZA and ZB to this draft European Standard are informative. ⟨A1⟩

This standard is divided in two parts:

— EN 1012-1 Compressors

— EN 1012-2 Vacuum Pumps

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

[A1] Introduction

This document is a type C standard as stated in EN ISO 12100.

The machinery concerned and the extent to which hazards, hazardous situations and hazardous events are covered are indicated in the scope of this document.

When provisions of this type C standard are different from those which are stated in type A or B standards, the provisions of this type C standard take precedence over the provisions of the other standards, for machines that have been designed and built according to the provisions of this type C standard. ⟨A1⟩

1 Scope

This standard is applicable to all vacuum pumps, vacuum pump combinations and vacuum pumping systems. The standard lists the significant hazards associated with vacuum pumps and specifies safety requirements applicable to the design, installation, operation, maintenance and dismantling of vacuum pumps during their foreseeable life and subsequent disposal.

The scope does not include pumps designed to pump continuously on open systems where the pump inlet pressure is above 75 kPA (750 mbar) absolute, i.e. vacuum cleaners, ventilation fans).

Vacuum pumps intended for use in special applications shall also comply with any specific standards relating to those applications.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when they are incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

〚A1〛 *deleted text* 〚A1〛

EN 294:1992, *Safety of machinery – Safety distances to prevent danger zones being reached by the upper limbs.*

EN 418, *Safety of machinery – Emergency stop equipment – Functional aspects*

EN 563, *Temperatures of touchable surfaces – Ergonomics data to establish temperature limit values for hot surfaces*

EN 953, *Safety of machinery – Guarding of machinery – Fixed and moveable guards.*

EN 1127-1, *Safety of machinery – Fires and explosions – Part 1: Explosion prevention*

〚A1〛 *deleted text* 〚A1〛

EN 50 014, *Electrical apparatus for potentially explosive atmospheres – General requirements*

EN 50 081-2, *Electro-magnetic compatibility – Generic emission – Part 2: Industrial environment*

EN 50 082-2, *Electro-magnetic compatibility – Generic immunity – Part 2: Industrial environment*

EN 61310-1, *Safety of machinery – Indication, marking and actuation – Part 1: Requirements for visual, auditory and tactile signal (IEC 1310-1:1995)*

EN 60204-1:1992, *Electrical equipment of industrial machines – Part 1: General requirements*

EN 60529, *Degrees of protection provided by enclosures*

ENV 1070, *Safety of machinery – Terminology*

〚A1〛 EN ISO 2151, *Acoustics – Noise test code for compressors and vacuum pumps – Engineering method (Grade 2) (ISO 2151:2004)* 〚A1〛

〚A1〛 EN ISO 12100-2:2003, *Safety of machinery – Basic concepts, general principles for design – Part 2: Technical principles (ISO 12100-2:2003)* 〚A1〛

ISO 3266, *Eyebolts for lifting purposes*

ISO 3529, *Vacuum Technology – Vocabulary*

ISO 4126-1, *Safety valves – Part 1: General Requirements*

ISO 4871, *Acoustics – Declaration and verification of noise emission values of machinery and equipment*

ISO 7000, *Graphical symbols for use on equipment – Index and synopsis*

ISO/TR 11688-1, *Acoustics – Recommended practice for the design of low-noise machinery and equipment – Part 1: Planning*

IEC 417, *Graphical symbols for use on equipment*

〉A1〈 IEC 61010-1 〉A1〈, *Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements*

3 Definitions

For the purposes of this standard the definitions given in ENV 1070 and ISO 3529 apply. Definitions specifically needed for this standard are added below.

3.1
vacuum
an environment where the total pressure is below the prevailing atmospheric level.

NOTE Vacuum is usually measured as the absolute pressure of the residual gas expressed as Pascals (Pa) or millibar (mbar). 1 mbar = 100 Pa.

3.2
vacuum pump
device for creating, improving and/or maintaining a vacuum.

NOTE Terms "vacuum pump" and "pump" have the same meaning throughout this standard.

3.3
pump inlet
port by which gas to be pumped enters the pump

3.4
pump outlet
outlet or discharge port of a pump

3.5
maximum starting pressure
maximum inlet pressure at which the vacuum pump may be started

3.6
maximum outlet pressure
maximum pressure at the vacuum pump outlet specified by the manufacturer

3.7
throughput of a vacuum pump
quantity of gas flowing through the inlet of the vacuum pump, usually expressed as a pressure quantity product per unit time interval

3.8
pumped media
all the substances which enter the vacuum pump i.e. gases, vapours, liquid mists and entrained solid particles

3.9
pump fluid
fluid essential for the operation of a vacuum pump

3.10
primary pump
pump that has a maximum outlet pressure equal or greater than ambient pressure

3.11
secondary pump
pump which has a maximum starting pressure or a maximum outlet pressure which is less than atmospheric pressure or is only efficient at lower pressures and is intended to operate in conjunction with a primary pump to produce pressures lower than could be achieved by the primary pump alone

3.12
pumping system
pump or a combination of pumps fitted with accessories for the sole purpose of producing a vacuum. The accessories could include pipework, valves, filters, coolers, control devices and any other equipment required to meet performance requirements

3.13
positive displacement pump
vacuum pump in which a volume filled with gas is cyclically isolated from the inlet, the gas being then transferred to an outlet

3.14
vapour pump
vacuum pump in which gases are pumped by molecular collision with and/or entrainment by a high speed directional vapour stream and driven to the pump outlet (e.g. Vapour Diffusion Pumps and Vapour Diffusion Ejector Pumps)

3.15
cryogenic entrapment pump
vacuum pump in which the pumped media is either condensed on a surface refrigerated to a very low temperature (less than 120 K) or is retained by adsorption using a porous medium of large effective area maintained at cryogenic temperature (e.g. Cryopumps and Adsorption Pumps). The term "cryogenic temperature" is used in the text for temperatures less than 120 K.

3.16
getter pump
pumps in which the gas is retained principally by chemical combination with a getter. The getter is usually a metal or metal alloy either in bulk (volume getter pump) or is sublimated (sublimation pump) or is dispersed by cathodic sputtering (sputter ion pump)

3.17
molecular pump
vacuum pumps in which the pumping action is achieved by a high speed rotor imparting momentum to gas molecules causing them to move towards the outlet of the pump (e.g. Molecular Drag Pumps and Turbomolecular Pumps)

3.18
maximum allowable working pressure
maximum operating pressure which the manufacturer specifies

3.19
minimum allowable working pressure
minimum operating pressure which the manufacturer specifies

3.20
baking
process of heating a vacuum system to accelerate, for instance, the removal of unwanted substances from the surfaces within the system and enable a low pressure to be achieved

3.21
methane drain pump
positive displacement pump used for the extraction of methane from mines, landfill sites and environments where the presence of methane is a hazard

4 List of Hazards Specific to Vacuum Pumps

4.1 Mechanical Hazards

		Reference to safety requirement
4.1.1	**Generally applicable**	
a)	Cutting and severing due to contact with moving parts such as drive belts, cooling fans, couplings, shafts and rotors;	5.1.1
b)	Cutting and severing due to sharp edges such as sheet metal parts, crimped tubes and turbine blades;	5.1.1 and 5.1.4
c)	Drawing in to a vacuum system;	5.1.1
d)	Ejection of parts caused by implosion of any part of the pump or pumping system;	5.1.1
e)	Ejection of parts caused by bursting of the vacuum system due to excess pressure caused by:	5.1.1 and 7.3.1
—	the incorrect direction rotation of the vacuum pump,	
—	a blocked or restricted exhaust,	
—	the faulty operation of a gas input to the vacuum system,	
—	mechanical failure of components,	
—	the reverse rotation of a pump when switched off under vacuum;	
f)	Loss of stability when adding or removing accessories;	5.1.1
g)	Loss of stability during transportation;	5.1.1
h)	Loss of stability during lifting due to lack of lifting facilities;	5.1.1

i) Slip, trip or fall resulting from oil leakage; 5.1.1

4.1.2 Applicable to vapour pumps 5.1.2

Ejection of parts due to a pressure rise caused by operating a vapour pump at atmospheric pressure, without cooling and with its inlet and outlet valves closed.

4.1.3 Applicable to cryogenic entrapment pumps 5.1.3

Ejection of parts due to the bursting of a cryogenic entrapment pump caused by:

- release of entrapped pumped media into a sealed system;
- excessive pressure generated when cold high pressure refrigerant is allowed to warm up in a sealed system;
- excessive pressure generated when a container of refrigerant at high pressure is exposed to fire;
- the cryogenic failure of materials used in its construction.

4.1.4 Applicable to getter pumps 7.3.1

Trapping of fingers when handling strong magnets.

4.1.5 Applicable to Molecular Pumps 5.1.5

a) Ejection of the moving rotor assembly from a turbomolecular pump;

b) Ejection of high energy fragments resulting from disintegration of the high speed rotor of a turbomolecular pump;

c) Loss of stability of a molecular pump caused by the rotor becoming unbalanced or decelerating suddenly.

4.2 Electrical Hazards 5.2.1

4.2.1 Generally applicable 5.2.1

- electrical contact direct or indirect,
- electrostatic phenomena,
- external influences on electrical equipment.

4.2.2 Applicable to vapour pumps 5.2.2

High electrical leakage current caused by the absorption of moisture by mineral insulated heater elements.

4.2.3 Applicable to getter pumps 5.2.3

Contact with Extra High Voltage supply to a getter pump due to:

— disconnecting the pump from its power supply before switching off the supply and, if appropriate, without discharging stored energy;

— failure of insulation caused by excessive baking temperatures or mechanical damage.

4.3 Thermal hazards

5.3.1, 5.3.2

a) Burns due to contact with hot surfaces.

b) Burns due to contact with very cold surfaces, cold pumped media or cold refrigerant gas.

c) Scalds due to contact with hot pump fluids or lubricants.

4.4 Hazards generated by noise

5.4.1

Hearing losses caused by high noise level.

4.5 Hazards generated by radiation

5.5.1

Exposure to ionising radiation produced by a getter pump.

4.6 Hazards generated by material and substances processed, used or exhausted by vacuum pumps

4.6.1 Generally applicable

a) Hazards resulting from exhausting of toxic gases or vapours being processed; 5.6.1

b) Hazards resulting from inhalation of concentrations of oil mist from the exhaust of an oil sealed pump; 5.6.1

c) Hazards resulting from any contact during pump maintenance with toxic breakdown/reaction products of lubricants, pump fluids or pumped media; 7.6.2

d) Fire or explosion resulting from processing or exhausting flammable gases and vapours; 5.6.1

e) Fire or explosion resulting from processing or exhausting oxidants; 5.6.1

f) Fire or explosion resulting from processing pyrophoric gases; 5.6.1

g) Fire resulting from the degradation of lubricating oil at high temperatures; 5.6.1

h) Hazard resulting from a violent increase in pressure due to the decomposition of a pumped gas. 5.6.1