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

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 a vide

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English version

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

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

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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Contents

Foreword

This European Standardhas been prepared by the Technical Committee CEN/TC 232 "Compessors - Safety" 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publication of an identical text or by endorsement, at the latest by October 1996, and conflicting standards shall be withdrawn at the latest by October 1996.

This European Standards 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).

For relationship with EU Directiv(e), see informative Annex ZA, which is an integral part of this standard.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

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".

Annexes A and ZA to this draft European Standard are informative.

The standard is divided in two parts:

- EN 1012-1 Compressors
- EN 1012-2 Vacuum Pumps

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, (ie 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 the publications apply to this European standard only when they are incorporated in this standard by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 292-1:1991	Safety of machinery - Basic concepts, general principles for design Part 1 : Basic terminology, methodology
EN 292-2 :1991	Safety of machinery - Basic concepts, general principles for design Part 2 : Technical principles and specifications
EN 294	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
EN 12076	Acoustics - Noise test code for compressors and vacuum pumps (Grade 2)
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 60 204-1	Electrical equipment of industrial machines Part 1 : General requirements
EN 60 529	Degrees of protection provided by enclosures
ENV 1070	Safety of machinery - Terminology
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
IEC 1010-7	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=100Pa.

3.2 vacuum pump: Device for creating, improving and/or maintaininga 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 120K) 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 120K

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	5.1.1

the pump or pumping system.	
e) Ejection of parts caused by bursting of the vacuum system due to excess pressure caused by - 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	5.1.1 and 7.3.1
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	
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.	5.1.2
4.1.3 Applicable to cryogenic entrapment pumps	
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.	5.1.3
4.1.4 Applicable to getter pumps	
Trapping of fingers when handling strong magnets.	7.3.1
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

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

Hearing losses caused by high noise level. 5.4.1

4.5 Hazards Generated by Radiation

Exposure to ionising radiation produced by a getter pump. 5.5.1

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

4.6.2 Applicable to vapour pumps

Hazards resulting from contact or inhalation of toxic chemical breakdown products of pump fluids exposed to excessive temperature.	5.6.2

4.6.3 Applicable to cryogenic entrapment pumps

Hazards resulting from contact or inhalation of toxic materials released by a cryogenic entrapment pump during warm up or maintenance.	5.6.3

4.7 Hazards Generated by Neglecting Ergonomic Principles in Design

a) Neglected use of personal protection equipment	5.7
b) Human errors resulting from poor positioning of controls and instruments	5.7
c) Hazards caused by incorrectly connecting a pump to the system to be pumped.	6.3 7.3.1

4.8 Hazards Caused by Failure of Energy Supply, Breaking Down of Parts or other Functional Disorders	5.8.1
a) Failure of energy supply	

b) Failure or disorder of central control system (unexpected start up)

c) Errors of fitting.

4.9 Hazards Caused by Missing or Incorrectly Positioned Safety Related Measures and Means 5.9 5.10

a) Hazards that may occur should a pump restart of its own accord after being shut down due to a fault condition

b) Hazard resulting from error in programming a process sequence

c) Hazard resulting from a software error

d) Hazard resulting from a computer component failure.

5 Safety Requirements and Measures

5.1 Mechanical safety

5.1.1 General requirements

a) Contact with moving parts shall be prevented by the use of guards in accordance with EN 953.

A guard shall be considered adequate if it prevents contact with the moving part using the Test Finger of EN 60 529, (see EN 294).

b) All accessible edges and corners shall be radiused to avoid injury.

c) If final guarding is only achievable on installation to the vacuum system, temporary guards shall be provided (eg. where the pump mechanism is accessible through the pump inlet, the inlet shall be covered).

d) Evacuated parts shall be strong enough to prevent implosion during the life of the equipment.

Where the risk of such damage cannot be eliminated, implosion guards shall be provided to contain any ejected material.

e) The design shall be such that blockage or restriction due to any accumulation of debris from the pumped media shall not cause a hazard.

Exhaust filters shall have sufficient capacity to allow the pump to operate safely at maximum throughput.

Means shall be provided to ensure that saturation or blockage of the filter element cannot result in the maximum allowable working pressure being exceeded.

Where the process is such that accumulation of debris in the outlet of a pump or pumping system is unavoidable, outlet pressure monitoring devices or a pressure relief valve shall be provided.

f) Vacuum pumping systems shall be designed to be stable. The test for stability is described in