SLOVENSKI STANDARD
SIST EN 12693:2008

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Hladilni sistemi in toplotne črpalke - Varnostnotehnične in okoljevarstvene zahteve - Kompresorji za hladilne tekočine z iztiskavanjem

Refrigerating systems and heat pumps - Safety and environmental requirements - Positive displacement refrigerant compressors

Kälteanlagen und Wärmepumpen - Sicherheitstechnische und umweltrelevante Anforderungen - Verdrängerverdichter für Kältemittel

Systèmes de réfrigération et pompes à chaleur - Exigences de sécurité et d'environnement - Compresseurs volumétriques pour fluides frigorigènes

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Refrigerating systems and heat pumps - Safety and environmental requirements - Positive displacement refrigerant compressors

Systèmes de réfrigération et pompes à chaleur - Exigences de sécurité et d'environnement - Compresseurs volumétriques pour fluides frigorigènes

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Foreword

This document (EN 12693:2008) has been prepared by Technical Committee CEN/TC 182 "Refrigerating systems, safety and environmental requirements", the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by November 2008, and conflicting national standards shall be withdrawn at the latest by November 2008.

This document 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 Directives 98/37/EC and 2006/42/EC.

For relationship with EU Directive(s) see informative Annexes ZA and ZB, which are an integral part of this document.

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Introduction

This standard 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 standard.

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.

1 Scope

This standard applies to positive displacement refrigerant compressors for stationary and mobile refrigerating systems and heat pumps defined in 3.1, hereafter called compressors.

It applies for compressors used in commercial and industrial appliances and with electrical energy supply including integral motors, up to 1 000 VAC and 1 500 VDC.

It applies to open drive, semi hermetic and hermetic motor compressors, which contain a positive compression function.

This standard is not applicable to:

— compressors used in household appliance for which EN 60335-2-34 applies;

— compressors using water or air as refrigerant.

This standard does not deal with requirements for vibration and noise.

NOTE 1 Compressors for automotive comfort air conditioning systems can be developed according e.g. SAE J 639.

NOTE 2 Noise emission depends on the complete installation of the built-in compressors and the corresponding operating conditions.

For semi-hermetic and open drive compressors which include moving parts and for which the external envelope is primarily designed for mechanical loads, thermal loads (to limit the possible deformation due to temperature), stiffness of the structure (external mechanical loads and weight of the equipment), taking into account established safe industrial practice, it is considered that pressure is not a significant design factor.

Attached parts covering other functions e.g. oil separators, oil coolers, suction accumulators shall comply to EN 14276-1 or EN 13445-6 (cast iron) or EN 13445-8 (aluminium) or showing compliance to the relevant European requirements. This applies also to shells for hermetic compressors either welded or with any kind of permanent joint.

Requirements for compressors used in explosive atmospheres are not covered by this standard.

NOTE 3 For further guidance see EN 13463-1.

This standard deals with all significant hazards, hazardous situations and events relevant to compressors, when they are used as intended and under conditions for misuse which are reasonably foreseeable by the manufacturer (see Clause 4).

This standard specifies safety requirements for the design, construction, manufacture and testing, documentation and marking of compressors, including integral accessories, e.g. shut-off valve, if necessary.

The requirements in this standard take account of the intended use, as defined in 3.12 of EN ISO 12100-1:2003.

This standard relates to the compressor itself which is to be incorporated in a refrigerating system.

This standard is not applicable to compressors as defined in the scope which are manufactured before the date of publication as EN.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 287-1, *Qualification test of welders — Fusion welding — Part 1: Steels*

EN 294, *Safety of machinery — Safety distance to prevent danger zones being reached by the upper limbs*

EN 378-1:2008, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 1: Basic requirements, definitions, classification and selection criteria*

EN 378-2:2008, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 2: Design, construction, testing, marking and documentation*

EN 378-3, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 3: Installation site and personal protection*

EN 378-4, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 4: Operation, maintenance, repair and recovery*

EN 837-1, *Pressure gauges — Part 1: Bourdon tube pressure gauges — Dimensions, metrology, requirements and testing*

EN 837-3, *Pressure gauges — Part 3: Diaphragm and capsule pressure gauges — Dimensions, metrology, requirements and testing*

EN 953, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*

EN 1050, *Safety of Machinery — Principles for risk assessment*

EN 1515 (all parts), *Flanges and their joints — Bolting*

EN 1561, *Founding — Grey cast irons*

EN 1563, *Founding — Spheroidal graphite cast irons*

EN 1779, *Non-destructive testing — Leak testing — Criteria for method and technique selection*

EN 10045-1, *Metallic materials — Charpy impact test — Part 1: Test method*

EN 10204, *Metallic products — Types of inspection documents*

EN 12178, *Refrigerating systems and heat pumps — Liquid level indicating devices — Requirements, testing and marking*

EN 12516-2, *Industrial valves — Shell design strength — Part 2: Calculation method for steel valve shells*

EN 13136:2001, *Refrigerating systems and heat pumps — Pressure relief devices and their associated piping — Methods for calculation*

EN 13445-2:2002, *Unfired pressure vessels — Part 2: Materials*

EN 13445-3, *Unfired pressure vessels — Part 3: Design*

EN 20898 (all parts), *Mechanical properties of fasteners*

EN 60034-1:2004, *Electrical rotating machinery — Part 1: Rating and performance (IEC 60034-1:2004)*

EN 60204-1:2006, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:2005, modified)*

EN 60335-2-34, *Household and similar electrical appliances — Safety — Part 2-34: Particular requirements for motor-compressors (IEC 60335-2-34:2002)*

EN 60529, *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989)*

EN 60947-4-1, *Low-voltage switchgear and controlgear — Part 4-1: Contactors and motor-starters — Electromechanical contactors and motor-starters (IEC 60947-4-1:2000)*

EN 60999 (all parts), *Connecting Devices — Electrical copper conductors — Safety requirements for srew-type and screwless-type clamping units*

EN 61010-1, *Safety requirements for electrical equipment for measurement, control and laboratory use — Part 1: General requirements (IEC 61010-1:2001)*

EN ISO 898 (all parts), *Mechanical properties of fasteners made of carbon steel and alloy steel*

EN ISO 4126-2, *Safety devices for protection against excessive pressure — Part 2: Bursting disc safety devices (ISO 4126-2:2003)*

EN ISO 9606-2, *Qualification test of welders — Fusion welding — Part 2: Aluminium and aluminium alloys (ISO 9606-2:2004)*

EN ISO 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology (ISO 12100-1:2003)*

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

EN ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules (ISO 15607:2003)*

EN ISO 15614-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2004)*

EN ISO 15614-2, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 2: Arc welding of aluminium and its alloys (ISO 15614-2:2005)*

CR ISO 15608:2000, *Welding — Guidelines for a metallic material grouping system (ISO/TR 15608:2000)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 378-1:2008, EN ISO 12100-1:2003 and the following apply.

NOTE All pressures are gauge pressures unless otherwise specified.

3.1
positive displacement compressor
compressor in which compression is obtained by changing the internal volume of the compression chamber

3.2
specified maximum allowable pressure, PS
maximum allowable pressure as stated by the compressor manufacturer

3.3
specified maximum allowable standstill pressure, PSs
maximum allowable value for the equalisation pressure in the compressor as stated by the compressor manufacturer

NOTE 1 This pressure corresponds to different maximum permissible ambient temperatures for different refrigerants (see 6.5.2).

NOTE 2 $PS_S \leq PS$

3.4
compressor overflow device
device specifically intended to protect the compressor against bursting caused by abnormal conditions, e.g. the discharge valve shut. The device relieves from the high pressure/intermediate side of the compressor to a lower pressure side

NOTE The device may be a bursting disc or may be a spring loaded overflow valve. Spring loaded overflow valves can be either back pressure compensating or back pressure dependent type.

3.5
Temperature load cases

3.5.1
min $t_{0\,100}$
lowest temperature at which component material can be used at a load of up to 100 % of the allowable design stress at 20 °C, taking the safety factors according to Table B.2 into account

3.5.2
min $t_{0\,75}$
lowest temperature at which component material can be used, at a load of up to 75 % maximum of the allowable design stress at 20 °C, taking the safety factors according to Table B.2 into account

3.5.3
min $t_{0\,25}$
lowest temperature at which component material can be used, at a load of up to 25 % maximum of the allowable design stress at 20 °C, taking the safety factors according to Table B.2 into account

3.5.4
fasteners
screws, double end studs, reduced shank bolts, studs and nuts with designation system according to EN ISO 898 and EN 20898 or EN 1515 (property classes)

3.6 Symbols

For the purposes of this document, the following symbols apply.

Table 1 — Symbols

Symbol	Term	Unit
A	Elongation after fracture	%
KV	Impact rupture energy	J
KV_0	Threshold value of impact rupture energy, where the impact rupture energy is defined as independent of the temperature	J
KV_0^t	Standard value of impact rupture energy at standard temperature of the material	J
$KV_{TS\ min.}$	Impact rupture energy at minimum operating temperature $TS_{min.}$	J
P_{burst}	Burst pressure	MPa
min $t_{0\ 100}$	The lowest temperature according to the European Standards of the respective materials at which the compressor can be used at a load of up to 100 % of the allowable design stress at 20 °C, taking into account the safety factors	
min $t_{0\ 75}$	The lowest temperature at which the compressor can be used, if its load amounts to 75 % maximum of the allowable design stress at 20 °C, taking into account the safety factors	
min $t_{0\ 25}$	The lowest temperature at which pressure parts can be used, if their load amounts to 25 % maximum of the allowable design stress at 20 °C, taking into account the safety factors	
P_F	Maximum allowable design test pressure	MPa
PS	Maximum allowable pressure in common sense, without regarding any influence of temperature	MPa or bar [a]
PS_S	Maximum allowable standstill pressure	MPa or bar [a]
PS_0	Maximum allowable pressure at ambient temperature (– 10 °C to + 50 °C) according to strength design (without temperature correction)	MPa or bar [a]
$PS_{TS\ max.}$	Maximum allowable pressure at maximum operating temperature	MPa or bar [a]
$PS_{TS\ min.}$	Maximum allowable pressure at minimum operating temperature	MPa or bar [a]
$R_{p\ 0,2}$	Proof strength, 0,2 % offset at room temperature	MPa, N/mm^2
$R_{p\ 1,0}$	Proof strength, 1,0 % offset at room temperature	MPa, N/mm^2
$R_{p\ 0,2\ TS\ max.}$	Proof strength, 0,2 % offset at highest operating temperature	MPa, N/mm^2
$R_{p\ 1,0\ TS\ max.}$	Proof strength, 1,0 % offset at highest operating temperature	MPa, N/mm^2
R_{eH}	Upper yield strength	MPa, N/mm^2
$R_{eH\ TS\ max.}$	Upper yield strength at highest operating temperature	MPa, N/mm^2

Table 1 (*continued*)

Symbol	Term	Unit
R_m	Tensile strength	MPa, N/mm^2
$R_{m\ TS\ max.}$	Tensile strength at highest operating temperature	MPa, N/mm^2
S_{con}	Safety factor	—
$S_{TS\ min.}$	Factor taking into consideration the impact strength reduction due to the minimum operating temperature	—
$S_{TS\ max.}$	Factor to allow for the reduction in strength due to the highest operating temperature	—
σ_{con}	Initial design stress	MPa, N/mm^2
TS	Operating temperature	°C
$TS_{min.}$	Lowest operating temperature	°C
$TS_{max.}$	Highest operating temperature	°C
[a]	1 MPa = 10 bar.	
NOTE	1 bar = 0,1 MPa = 100 kPA = 100 000 PA = 14,5 PSI.	

4 List of significant hazards

See Table 2.

This clause contains all significant hazards, hazardous situations and events, as far as they are dealt with in this standard, identified by risk assessment as significant for type of compressors and which requires action to eliminate or reduce the risk. The risk assessment shall be made according to EN 1050. The compressors shall be manufactured in accordance with the principle listed in EN ISO 12100-2 to eliminate or reduce the foreseeable risk.

Table 2 — List of significant hazards, hazardous situations, safety requirements and/or measures

Significant hazard according to EN 1050	Hazardous situation	Safety requirements and/or measures	Reference	Verification
Mechanical				
Moving parts	Possible injuries to human body	Guards	5.2	V
Loss of stability	Possible injuries at transport and operation	Fixing points Lifting points Lifting points	5.3 5.4, 7.3.1 6.2.5	V D / V T
Rupture or bursting	Possible injuries from ejected parts or fluid	Design criteria Strength test Tightness test	5.5 6.2.2, 6.2.3, 6.3.2 6.3.3	D T T V
Electrical				
Contact live parts	Possible injuries from electrocution	Design criteria Earthing Internal wiring High potential test Protection devices	5.6.1, 5.6.2, 5.6.3, 5.6.4, 5.6.5, 5.6.9 5.6.6 5.6.7 5.6.8,6.2.4, 6.3.4 5.6.10	D D D T V
Electrostatic phenomena	Possible injuries from electric shock	Earthing	5.6.6	D
Thermal				
Contact with hot or cold objects	Possible injuries to the skin	Warning	8.2	

Table 2 (*continued*)

Significant hazard according to EN 12100-1	Hazardous situation	Safety requirements and/or measures	Reference	Verification
Materials and substances				
Contact or inhaling gasses	Possible injuries from aggressive media at draining	Means and instructions Warning	5.7 7.3.2	V V

NOTE Verification methods:

V Visual inspection, verifies the required features of the components

T A test or check verifies that the features provided perform their function in such a way that the requirement is met

M Measurement verifies that requirements are met to the specified limits

D Drawing and / or calculations verify that the design characteristics meet the requirements

5 Safety requirements and/or protective measures

5.1 General

Compressors shall comply with the safety requirements and/or measures of this clause.

In addition, the compressors shall be designed according to the principles of EN ISO 12100 for relevant but not significant hazard, which are not dealt with by this standard.

Furthermore, the refrigerating system which the compressor is part of, shall be in accordance with the requirements of the EN 378 series.

As surface temperatures on a refrigerant compressor and the attached parts and piping depend on operating conditions and properties of specific refrigerants, protection shall be provided considering the requirements in EN ISO 13732-1.

5.2 Protection of moving parts

Protection shall be provided for moving parts such as automatic drives, fans or indicators of capacity controls by fixed guards according to EN 953. Openings such as slots, holes, etc. shall comply with EN 294.

5.3 Safety to prevent loss of stability

Compressors shall be equipped with fixing points to ensure that they shall not tip or fall over during transport and operation.

5.4 Safety during handling

Compressors above 25 kg weight shall be equipped with lifting points or arrangement to enable safe lifting, installation and maintenance. Lifting points or arrangements shall be designed for to carry 1,25 times the weight of the compressor allocated to the individual lifting point.

NOTE For design it is sufficient to use a factor 2 against deformation and a factor 3 against fracture correlated to vertical lifting.

5.5 Safety to prevent rupture or bursting

5.5.1 General

Compressors and associated components shall be designed and manufactured to withstand the pressure and temperatures which can occur during operation, standstill and transportation taking into account the thermal, chemical and mechanical stresses to be expected.

The materials shall be selected based upon suitability for the application. The choice of materials and selection of dimensions shall be based on the need for sufficient strength, rigidity and stability to cope with dynamic effects. The ability of the compressor to withstand internal pressure shall be demonstrated by type test (see 6.2) or by individual test (see 6.3).

5.5.2 Pressure requirements

The compressor design pressure for standard applications shall be in accordance with the refrigerant saturation pressures corresponding to the temperatures given in EN 378-2 or as specified by the compressor manufacturer.

For refrigerants and applications not covered by EN 378-2, the maximum allowable pressure PS and the specified maximum allowable standstill pressure PS_S shall be specified by the manufacturer in the Instructions for use under consideration of the required application ranges. For further requirements, see 6.2 and 6.3.

5.5.3 Materials

5.5.3.1 General

The materials shall be selected to allow for the thermal, chemical and mechanical stresses expected during operation, standstill and transportation throughout the foreseeable life of the compressor parts.

Compressor and compressor parts shall comply with the requirements of Annexes B, C, D and E.

NOTE Basic design criteria for refrigerant compressors are described in Annex A.

5.5.3.2 Requirements to avoid brittle fracture

For compressor and compressor parts with reduced ductility at low temperatures below – 10 °C, the allowable temperature should be reduced according Annex F.

Examples are given in Annex E.

5.5.4 Sight glasses

If sight glasses are used, safety requirements according to EN 12178 shall apply.

5.5.5 Application of pressure relief devices

5.5.5.1 Protection against discharge shut off valve closed

The manufacturer shall protect compressor stages fitted with a shut-off valve between stages and compressors with a nominal swept volume > 90 m^3/h (25 l/s) against rupture by incorporating either a compressor overflow device or an external relief device or safety valve. In case of multiple stage compressors, the swept volume of the high pressure stage shall be considered as the 'nominal swept volume' for the purposes of this clause.

NOTE Internal damage of the compressor from overloading and overheating may result if the overflow device operates.

The compressor overflow device shall be sized to relieve the refrigerant flow produced by the compressor at a suction pressure corresponding to 10 °C saturated. If the maximum allowable evaporation temperature differs from the value of 10 °C by more than 5 K then the overflow device shall be sized to the pressure corresponding to that temperature.

The compressor overflow device shall relieve to a lower pressure part of the compressor/system or to a special container.

Relief devices discharging to atmosphere or external safety valves discharging to the compressor/system shall be in accordance to EN 13136.

Bursting discs shall be in accordance with EN 13136:2003, 7.3 and EN ISO 4126-2.

The dimensions of the compressor overflow device shall be verified by testing according to 6.2.3.

It shall not be possible to isolate compressor overflow devices, relief devices or safety valves.

The compressor overflow device shall not be used for system pressure protection.