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Refrigerating systems and heat pumps — Valves — Requirements, testing and marking

Systèmes de réfrigération et pompes à chaleur — Robinetterie — Exigences, essais et marquage

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Foreword

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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 86, *Refrigeration and air-conditioning*, Subcomittee SC 1, *Safety and environmental requirements for refrigerating systems*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 182, *Refrigerating systems, safety and environmental requirements*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition is based on EN 12284:2003.

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.

Introduction

This document is intended to describe the safety requirements, safety factors, test methods, test pressures used, and marking of valves and other components with similar bodies for use in refrigerating systems.

Refrigerating systems and heat pumps — Valves — Requirements, testing and marking

1 Scope

This document specifies safety requirements, certain functional requirements, and marking of valves and other components with similar bodies, hereinafter called valves, for use in refrigerating systems including heat pumps.

This document includes requirements for valves with extension pipes.

This document describes the procedure to be followed when designing valve parts subjected to pressure as well as the criteria to be used in the selection of materials.

This document describes methods by which reduced impact values at low temperatures may be taken into account in a safe manner.

This document applies to the design of bodies and bonnets for pressure relief devices, including bursting disc devices, with respect to pressure containment but it does not apply to any other aspects of the design or application of pressure relief devices.

In addition, this document is applicable to valves with a maximum operating temperature not exceeding 200 °C and a maximum allowable pressure not exceeding 160 bar[1)].

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 148-1, *Metallic materials. Charpy pendulum impact test — Part 1: Test method*

ISO 5149-1, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 1: Definitions, classification and selection criteria*

ISO/TR 15608, *Welding — Guidelines for a metallic material grouping system*

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

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

EN 14276-2:2020, *Pressure equipment for refrigerating systems and heat pumps — Part 2: Piping — General requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5149-1 and the following 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/

1) 1 bar = 0,1 MPa.

3.1
valve
device with a pressure enclosure and an intended additional functionality, such as influencing the fluid flow by opening, closing or partially obstructing the passage of the flow or by diverting or mixing the fluid flow, indicating moisture content or filtering the fluid flow

Note 1 to entry: A device with a pressure enclosure and an intended additional functionality is designated as pressure accessory according to the European Pressure Equipment Directive 2014/68/EU.

3.2
extension pipe
piping connected to a valve by the valve manufacturer, which does not influence the pressure strength of the valve itself

Note 1 to entry: Extension pipes often have different diameters in two ends.

Note 2 to entry: The application of extension pipes is determined by the manufacturer and has the advantage that the pressure strength verification of the extension pipes becomes independent of the safety factors used for the verification of the valve.

3.3
valve assembly
combination of a valve and one or more extension pipes

EXAMPLE An example of a valve assembly is given in Clause H.6.

3.4
operating range
combination of temperature and pressure conditions at which the valve can safely be operated

3.5
nominal size
DN
alphanumeric designation of size for components of a pipework system, which is used for reference purposes comprising the letters *DN* followed by a dimensionless whole number which is indirectly related to the physical size, in millimetres, of the bore or outside diameter of the end connections

Note 1 to entry: The number following the letters *DN* does not represent a measurable value and should not be used for calculation purposes except where specified in this document.

Note 2 to entry: Where the nominal size is not specified, for the purpose of this document it is assumed to be the internal diameter of the pipe or component in mm (DN/ID).

Note 3 to entry: Nominal size is not the same as port size which is commonly used for the size of the valve seat opening.

Note 4 to entry: For additional information regarding the *DN* system, see Annex I.

[SOURCE: ISO 6708:1995, 2.1, modified — Notes to entry added.]

3.6
nominal pressure
PN
numerical designation which is a convenient rounded number for reference purposes

Note 1 to entry: All equipment of the same nominal size (DN) designated by the same PN number shall have compatible mating dimensions.

[SOURCE: ISO 7268:1983/Amd.1:1984, modified]

3.7
corrosion
all forms of material waste (e. g. oxidation, erosion, wear and abrasion)

3.8
maximum operating temperature
highest temperature that can occur during operation or standstill of the refrigerating system or during testing under test conditions

3.9
minimum operating temperature
lowest temperature that can occur during operation or standstill of the refrigerating system or during testing under test conditions

3.10
pressure bearing part
part, which is subject to stress due to internal pressure greater than 50 kPa (0,5 bar) gauge

3.11
main pressure bearing part
part, which constitute the envelope under pressure, essential for the integrity of the equipment

Note 1 to entry: Examples are bonnets, housings, end covers and flanges.

[SOURCE: EN 13445-1:2014]

3.12
seat tightness class
letter from A to G indicating the internal tightness of the valve across the valve seat(s)

3.13
competent body
third party organisation which has recognized competence in the assessment of quality systems for the manufacture of materials and in the technology of the materials concerned

Note 1 to entry: National legislation can place additional requirements on the competent body depending on the market for which the valve is intended.

3.14
type of valve connection
standard and size of the valve connection to other equipment directly fixed to the valves end

Note 1 to entry: Possible types of valve connection are e.g.

a) *NPS* 2, i.e. a butt-welding connection to ASME/ANSI B 36.10 2 inch steel pipe,

b) *NPT* ½ , i.e. a screwed connection with ½ inch male end according to ASME/ANSI B 1.20.1,

c) EN 1092-1/11/C/*DN* 200 x 6,3/*PN* 40, i.e. a flange type 11 with facing type C (tongue) of nominal size *DN* 200, wall thickness 6,3 mm, *PN* 40.

3.15
pressure sensitive part
part of a valve which will not have a reliable function after exposure to the greater of 1,5 times *PS* and 1,25 times PS_0

Note 1 to entry: Examples include bellows, diaphragms or float balls.

3.16
spindle
part of the valve which actuates the intended functionality, e.g. opening or closing for influencing the fluid flow

Note 1 to entry: A valve does not necessarily need to incorporate a spindle.

3.17
maximum allowable pressure
PS
maximum pressure for which the valve or valve assembly is designed, as specified by the manufacturer

3.18
maximum allowable pressure at ambient temperature (–10 °C to + 50 °C)
PS_0
maximum pressure for which the valve or valve assembly is designed, as specified by the manufacturer, at ambient temperature (–10 °C to + 50 °C)

4 List of symbols

Symbols used in this document are given in Table 1:

Table 1 — List of symbols

A_L	Elongation after fracture where the measured length is equal or greater than 0,4 times of diameter of the rod	mm
A_5	Elongation after fracture where the measured length is equal to 5 times of diameter of the rod	%
a	Lifetime in years for calculating effect of corrosion; typically 20 years	—
C_Q	Factor to compensate for the quality of a casting	—
D	Diameter of the hand-wheel	mm
δ_e	Negative wall thickness tolerance	mm
e_{act}	Actual wall thickness at given measuring points of the valve to be tested	mm
e_B	Reference thickness is the minimum material thickness needed to give adequate strength to pressure bearing parts	mm
e_c	Reduction in wall thickness caused by occurrence of corrosion	mm
e_{con}	Component wall thickness as specified in the design drawing	mm
F	Operating manual force to size the manual operating element	N
F_s	Maximum manual force to size the manual operating element	N
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
K_{VS}	Rate of flow of water in cubic metres per hour for a differential pressure Δp of 1 bar (0,1 MPa) at the rated full opening	m^3/h
L	Leakage in percent of K_{VS}	%
l	Length of the lever or radius of the crank circle	mm
P_F	Maximum allowable design test pressure	bar
PS	Maximum allowable pressure	bar
PS_0	Maximum allowable pressure at ambient temperature (–10 °C to + 50 °C)	bar
$PS_{TS\,max}$	Maximum allowable pressure at maximum operating temperature	bar
$PS_{TS\,min}$	Maximum allowable pressure at minimum operating temperature	bar
P_{Test}	Minimum burst test pressure (greater than P_F)	bar
p_1	Upstream pressure	bar
p_2	Downstream pressure	bar
Δp	Differential pressure	bar
NOTE 1 bar = 0,1 MPa.		

Table 1 *(continued)*

p'	Testing pressure of each valve after production	bar
Q_{M}	Mass flow rate	kg/h
Q_{V}	Downstream volume flow rate	m^3/h
$R_{\mathrm{e}\,1,0}$	Yield strength, 1,0% offset	MPa, N/mm^2
$R_{\mathrm{e}\,1,0\,TS\,max}$	Yield strength, 1,0% offset at maximum operating temperature	MPa, N/mm^2
$R_{\mathrm{e}\,0,2}$	Yield strength, 0,2% offset at ambient temperature	MPa, N/mm^2
$R_{\mathrm{p}\,0,2}$	Proof strength, 0,2% offset at ambient temperature	MPa, N/mm^2
$R_{\mathrm{p}\,0,2\,TS\,min}$	Proof strength, 0,2% offset at minimum operating temperature	MPa, N/mm^2
$R_{\mathrm{p}\,0,2/t}$	Proof strength, 0,2% offset at temperature t	MPa, N/mm^2
$R_{\mathrm{p}\,0,2\,TS\,max}$	Proof strength, 0,2% offset at maximum operating temperature	MPa, N/mm^2
$R_{\mathrm{p}\,1,0}$	Proof strength, 1,0% offset at ambient temperature	MPa, N/mm^2
R_{eH}	Upper yield strength	MPa, N/mm^2
$R_{\mathrm{eH}\,TS\,max}$	Upper yield strength at maximum operating temperature	MPa, N/mm^2
R_m	Tensile strength	MPa, N/mm^2
$R_{\mathrm{m}\,TS\,max}$	Tensile strength at maximum operating temperature	MPa, N/mm^2
$R_{\mathrm{m\,act}}$	Actual tensile strength of the material of the valve to be tested	MPa, N/mm^2
$R_{\mathrm{m\,con}}$	Tensile strength used for the design	MPa, N/mm^2
ρ	Density of the actual fluid	kg/m^3
ρ_0	Density of water at 15,5 °C	kg/m^3
ρ_1	Upstream density	kg/m^3
ρ_2	Downstream density	kg/m^3
S_{C}	Factor to compensate effects of corrosion	—
S_{con}	Factor for the calculation of the burst test pressure taking into account the tensile strength according to Table A.1	—
S_{F}	Factor to allow for forming	—
$S_{\mathrm{TS\,min}}$	Factor taking into consideration the impact rupture energy reduction due to minimum operating temperature	—
$S_{\mathrm{TS\,max}}$	Factor to allow for the reduction in strength due to the maximum operating temperature	—
S_{σ}	Factor to allow for the test pressure	—
σ_{con}	Initial design stress	MPa, N/mm^2
σ_{corr}	Allowable stress values derived from σ_{con}	MPa, N/mm^2
$t_{\mathrm{min\,25}}$	Lowest temperature at which pressure bearing parts can be used, if their load amounts to 25 % of the allowable design stress at 20 °C, taking the safety factors according to Table A.1 into account	°C
$t_{\mathrm{min\,75}}$	Lowest temperature at which pressure bearing parts can be used, if their load amounts to 75 % of the allowable design stress at 20 °C, taking the safety factors according to Table A.1 into account	°C
$t_{\mathrm{min\,100}}$	Lowest temperature at which pressure bearing parts can be used, if their load amounts to 100 % of the allowable design stress at 20 °C, taking the safety factors according to Table A.1 into account	°C
T_{R}	Design reference temperature is the minimum operating temperature TS_{min} adjusted. Used when determining TS_{min} based on reference thickness e_{B}	
T_{S}	Temperature adjustment of the design reference temperature T_{R}	
T_{KV}	Impact test temperature	
TS	Operating temperature	°C
TS_{min}	Lowest operating temperature	°C
NOTE 1 bar = 0,1 MPa.		

Table 1 *(continued)*

TS_{max}	Maximum operating temperature	°C
τ	Torque, under specified conditions, to operate the valve	Nm
τ_s	Maximum torque, under specified conditions, to seat or unseat the obturator or to overcome temporary intermediate dynamic conditions	Nm
V	Inner volume of a valve	l
X	Correction of the actual wall thickness relative to the wall thickness of the design	—
K	assigns the value $\frac{\Delta p}{P_1}$	—
Y	Correction on the basis of current strength values of the test sample relative to the strength parameters for the design of valves	—
Z	Factor to allow for the quality of a joint (e.g. welded joint)	—
∂	Wall thickness reduction per year	mm
NOTE 1 bar = 0,1 MPa.		

5 General requirements

5.1 Installation and operation

Valves and valve assemblies shall be designed for the operational loads and conditions as specified in the relevant refrigerating system safety standard.

Relevant refrigerating system safety standards include:

a) ISO 5149-1, ISO 5149-2 and ISO 5149-4,

b) IEC 60335-2-40,

c) ANSI/ASHRAE Standard 15,

d) EN 378-1, EN 378-2 and EN 378-4.

The application of extension pipes is determined by the manufacturer.

NOTE 1 When extension pipes are applied, the finished device is a valve assembly (see. 3.3) consisting of a valve (see 3.1) and extension pipes (see 3.2).

NOTE 2 The application of extension pipes has the advantage that the pressure strength verification of the pipes becomes independent of the safety factors used in the verification of the valve body.

The lowest operating temperature (TS_{min}), maximum operating temperature (TS_{max}), and the maximum allowable pressure (PS) shall be the same for extension pipes and valve assemblies as for the valve incorporated in the valve assembly.

The manufacturer shall classify the category of the valve, extension pipe, and valve assembly according to Annex H as appropriate.

5.2 Components under pressure

All parts of the valve or valve assembly shall be designed and manufactured to remain leak proof and to withstand the pressures which may occur during operation, standstill and transportation, taking into account the thermal, physical and chemical stresses to be expected.

5.3 Excessive mechanical stress

After installation, valves and valve assemblies, especially valves for hot gas defrosting, shall not be under excessive mechanical stress from fitting of the pipe or from temperature variations during operation.

NOTE Hot gas defrosting can produce hydraulic shocks resulting in transient pressures in excess of *PS*.

5.4 Tightness

The valve or valve assembly shall not leak to the outside when tested as described in 9.2. Valve seats shall seal to a degree specified in 9.3.

5.5 Functioning of hand-operated valves

Proper functioning of hand-operated valves shall be ensured for the entire operating range up to the allowable pressure *PS* and the associated allowable temperature *TS*.

5.6 Functioning of actuator-operated valves

Proper functioning of actuator-operated valves operated by the fluid or by energy from an external source, shall be ensured for the entire operating range, which is to be specified by the manufacturer.

6 Materials

6.1 General

6.1.1 Using metallic materials

Metallic materials, included welding filler metals, solders, brazing metals and sealants, shall allow for the thermal, chemical and mechanical stresses arising in system operation. Materials shall be resistant to the refrigerants, solvents (in absorption systems) and refrigerant-oil mixtures used in each particular case.

NOTE A list of suitable materials is found in Annex E of this document. Steel information can also be found in EN 13445-2 or ASME B 31.5, along with other useful information.

If material properties are changed during the method of manufacture (e.g. through welding or deep drawing) to such an extent that the strength and/or Charpy notch energies, according to ISO 148-1, are reduced, these reduced values shall be taken into consideration by corrections or shall be subject to suitable compensatory material treatment (e.g. heat treatment).

Residual stress can e.g. decrease impact strength and increase stress corrosion (see Annex L). Where relevant, it shall be verified that the residual stress does not impose adverse implications.

Materials with a deformation higher than 2 % shall be heat treated with the respective material specifications. Alternatively, the proof against inner pressure shall be verified by test, if no heat treatment is used.

6.1.2 Using non-metallic materials

It is permitted to use non-metallic materials, e.g. for gaskets, coatings, insulating materials, and sightglasses, provided that they are compatible with other materials, refrigerants and lubricants.

The compatibility of rubber and thermoplastic sealing materials and flat gaskets shall be evaluated according to Annex K.

6.2 Requirements for materials to be used for pressure bearing parts

Materials listed in this document (see Annex E) have been identified for use in valves.

Lamellar cast iron shall not be used but nodular cast iron can be used down to temperatures at which it can be proved to achieve overall levels of safety equivalent to alternative materials.

NOTE EN 1563 contains information on nodular cast iron.

Free-cutting steel generally does not have the impact strength, KV_0, required for pressure bearing parts. It may be used for pressure bearing parts where pressure is not a significant design factor.

Where new materials are proposed, the design shall be carried out using Annexes A to D provided the yield strength or proof strength, as applicable, at the maximum operating temperature and the impact rupture energy at the lowest operating temperature are known. If these properties are not known the material shall not be used.

6.3 Compatibility of connections

Materials which are to be physically joined shall be suitable for an effective connection, depending on the particular materials used and on the dimensions of the piping specified.

6.4 Ductility

Materials which are to be considerably deformed shall be sufficiently ductile and capable of being heat treated where necessary.

6.5 Ageing

Materials for pressurized parts shall not be significantly affected by ageing.

6.6 Castings

Castings shall exhibit a low stress level. If they are not subjected to stress relief heat treatment, controlled cooling shall be ensured after the casting process and after any heat treatment which may have been applied.

6.7 Forged and welded components

Forged and welded components shall be fabricated from suitable materials (e.g. weldable close grain low carbon steel) and shall be heat treated where the combination of operating temperature, operating pressure and wall thickness indicates by calculation that heat treatment is necessary.

Free-cutting steel is not qualified for welding.

6.8 Nuts, bolts and screws

Materials for nuts, bolts and screws for joining housing parts subject to pressure loads shall exhibit the correct characteristics for the material over the full range of the application limits for the nuts, bolts and screws defined by the operating temperature, whereby the following minimum values for the elongation at fracture and notched impact rupture energy shall be achieved. The test piece for impact rupture energy measurements shall be taken parallel to the drawing or rolling direction, and the notch orientation shall be perpendicular to the drawing or rolling direction.

a) for ferritic materials an elongation at fracture $A_5 \geq 14$ %;

b) for cold formed austenitic materials an elongation at fracture $A_L \geq 0,4 \times d$;

