SLOVENSKI STANDARD
oSIST prEN ISO 21011:2021

01-maj-2021

Kriogene posode - Ventili za kriogeno območje (ISO/DIS 21011:2021)

Cryogenic vessels - Valves for cryogenic service (ISO/DIS 21011:2021)

Kryo-Behälter - Ventile für den Kryo-Betrieb (ISO/DIS 21011:2021)

Récipients cryogéniques - Robinets pour usage cryogénique (ISO/DIS 21011:2021)

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ICS:

23.020.40	Proti mrazu odporne posode (kriogenske posode)	Cryogenic vessels
23.060.01	Ventili na splošno	Valves in general

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DRAFT INTERNATIONAL STANDARD

ISO/DIS 21011

ISO/TC **220**

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Cryogenic vessels — Valves for cryogenic service

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Contents

Page

iTeh STANDARD PREVIEW
(standards.iteh.ai)
oSIST prEN ISO 21011:2021
https://standards.iteh.ai/catalog/standards/sist/be18f37c-ada8-46e3-8ba3-
f29f83de760d/osist-pren-iso-21011-2021

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This document was prepared by Technical Committee ISO/TC *220*, *Cryogenic vessels*,

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This second edition cancels and replaces the first edition (ISO 21011:2008), which has been technically revised.

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The main changes compared to the previous edition are as follows:

— Update of the scope;

— Clarification of the use of pressure units;

— Revision of the type approval tests;

— Revision of Clause 7 Marking.

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Cryogenic vessels — Valves for cryogenic service

1 Scope

This document specifies the requirements for the design, manufacture and testing of valves for a rated temperature of −40 °C and below (cryogenic service), i.e. for operation with cryogenic fluids in addition to operation at temperatures from ambient to cryogenic.

It applies to all types of cryogenic valves, including vacuum jacketed cryogenic valves up to size DN 200. This document can be used as guidance for larger size valves. This document is not applicable to pressure relief valves covered by ISO 21013-1.

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 5208:2015, *Industrial valves — Pressure testing of metallic valves*

ISO 10434:2020, *Bolted bonnet steel gate valves for the petroleum, petrochemical and allied industries*

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ISO 10497:2010, *Testing of valves — Fire type-testing requirements*

ISO 15761:2020, *Steel gate, globe and check valves for sizes DN 100 and smaller, for the petroleum and natural gas industries*

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https://standards.iteh.ai/catalog/standards/sist/be18f37c-ada8-46e3-8ba3-

ISO 17292:2015, *Metal ball valves for petroleum, petrochemical and allied industries*

ISO 21010:2017, *Cryogenic vessels — Gas/material compatibility*

ISO 21028-1:2016, *Cryogenic vessels — Toughness requirements for materials at cryogenic temperature — Part 1: Temperatures below -80 degrees C*

ISO 21028-2:2018, *Cryogenic vessels — Toughness requirements for materials at cryogenic temperature — Part 2: Temperatures between -80 degrees C and -20 degrees C*

ISO 23208:2017, *Cryogenic vessels — Cleanliness for cryogenic service*

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/

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3.1
nominal size
DN or NPS
alphanumeric designation of size for components of a pipe work system, which is used for reference purposes.

Note 1 to entry: It comprises the letters “DN” or “NPS” followed by a dimensionless whole number or fractional number which is indirectly related to the physical size of the bore or outside diameter of the end connections.

3.2
rated pressure PR
maximum pressure difference between the inside and outside of any pressure retaining boundary for which the boundary is designed to be operated at 20 °C

Note 1 to entry: The PR of the valve is the lowest PR of any component of the valve.

3.3
PN or Class
numerical designation relating to pressure that is a convenient rounded number for reference purposes, and which comprises the letters PN or Class followed by the appropriate reference number

Note 1 to entry: It is desirable that all equipment of the same nominal size (DN or NPS) designated by the same PN or Class number has compatible mating dimensions.

Note 2 to entry: Tables of pressure/temperature ratings in the appropriate standards provide guidance on the maximum allowable pressure subject to materials, design and working temperature.

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3.4
rated minimum temperature
lowest temperature for which the valve is rated by the manufacturer

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3.5
valve category A
valves intended to be operated with normal frequency (above 20 cycles a year)

Note 1 to entry: See 5.1.3.3.

3.6
valve category B
valves intended to be operated only occasionally i.e. with a frequency below 20 cycles a year

Note 1 to entry: See 5.1.3.3.

3.7
flow coefficient
basic coefficient used to state the flow capacity of a valve under specified conditions

Note 1 to entry: Flow coefficients in current use are *Kv* and *Cv* depending upon the system of units.

Note 2 to entry: Even though the dimensions and units used with flow coefficient *Kv* differ from those used with flow coefficient *Cv*, it is possible to relate the two flow coefficients numerically by means of the relationship.

$$K_v = 0,865 C_v$$

Note 3 to entry: The flow coefficient definitions given in 3.7.1 (for *Kv*) and in 3.7.2 (for *Cv*) include certain units, nomenclature and temperature values which are not consistent with the parts of IEC 60534 other than IEC 60534-1. These inconsistencies are limited to 3.7.1 and 3.7.2 of this document, and their sole purpose is to illustrate the unique relationships traditionally used in the valve industry. These inconsistencies do not concern any parts of IEC 60534 other than IEC 60534-1.

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3.7.1
flow coefficient
K_v
special volumetric flow rate calculated in cubic metres per hour (capacity) through a valve, with the valve 100% fully open, where the static pressure loss across the valve is 1 bar (0.1 MPa)[1)], and the fluid is water within a temperature range 5 °C to 40 °C (278 K to 313 K)

Note 1 to entry: The value of *Kv* can be obtained from test results by means of the following formula:

$$K_v = Q\sqrt{\left(\frac{\Delta p_{K_v}}{\Delta p}\right)\left(\frac{\rho}{\rho_w}\right)}$$

where

Q is the measured volumetric flow rate, in m^3/h;

Δp_{K_v} is the static pressure loss of 1 bar (0,1 MPa);

Δp is the measured static pressure loss across the valve, in bar (MPa);

ρ is the density of the fluid, in kg/m3;

ρ_w is the density of water, in kg/m3 (1 000 kg/m3).

This formula is valid when the flow is turbulent and no cavitation or flashing occurs.

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3.7.2
flow coefficient C_v
Cv
non-SI valve coefficient which is in widespread use worldwide

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Note 1 to entry: Numerically, *Cv* is represented as the number of US gallons of water, within a temperature range of 40 °F to 100 °F, that will flow through a valve in 1 min, with the valve 100% fully open, when a pressure drop of 0,068 948 bar (0,006 894 8 MPa)[1)] occurs. For conditions other than these, *Cv* can be obtained using the following formula:

$$C_v = Q\sqrt{\left(\frac{\Delta p_{C_v}}{\Delta p}\right)\left(\frac{\rho}{\rho_w}\right)}$$

where

Q is the measured volumetric flow rate, in US gallons per minute<?>
1 gal (US)/min = 309 x 10-5 m3/s.

ρ is the density of the fluid, in pounds per cubic foot<?>
1 lb/ft3 = 16,018 kg/m3.

ρ_w is the density of water within a temperature range of 4 °C to 38 °C (40 °F to 100 °F), in pounds per cubic foot;

Δp is the measurement state pressure loss across the valve, in psi;

$\Delta p_{C_v} = 1\text{psi}$.

This formula is valid when the flow is turbulent and no cavitation or flashing occurs.

1) 1 psi = 0,068 948 bar = 0,006 894 8 MPa.

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3.8
bonnet
part connecting the valve body to the seal packing chamber

4 Requirements

4.1 Materials

4.1.1 General

Materials shall be in conformance with an internationally recognized standard and compatible with the fluid. Galling, frictional heating and galvanic corrosion shall be considered in the selection of materials. Materials shall also be oxygen compatible, if relevant (see 4.1.5.1).

Materials not listed in an internationally recognized standard shall be controlled by the manufacturer of the valve by a specification ensuring control of chemical content and physical properties, and ensuring quality at least equivalent to an internally recognized standard. A test certificate providing the chemical content and physical property test results shall be provided with the valve.

4.1.2 Metallic materials

Metallic materials to be used in the construction of cryogenic valves shall meet the toughness requirements of ISO 21028-1 or ISO 21028-2 as appropriate for the rated minimum temperature.

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These requirements apply only to the valve parts exposed to low temperatures in normal service. Metallic materials which do not exhibit ductile/brittle transition and non-ferrous materials which can be shown to have no ductile/brittle transition do not require additional impact tests.

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Forged, rolled, wrought and fabricated valve components from raw materials from these processes need not be impact tested if the rated minimum temperature is higher than the ductile/brittle transition range temperatures of the material. Castings meeting the requirements of one of the applicable mandatory Appendices I and IV or II and III of ASME B16.34 for forgings and rolled or wrought material, or conforming to equivalent standards, need not be impact tested if the rated minimum temperature is higher than the ductile/brittle transition range temperatures of the material. When impact testing is required, at least one randomly selected valve body (including bonnet, if applicable) material from each production lot castings shall be impact tested at the rated minimum temperature.

4.1.3 Non-metallic materials

Non-metallic materials are well established only for use in packing and glands and for use for inserts within the plug/stem assembly to provide leak tightness across the seat when the valve is closed. If such materials are to be used for structural parts, they shall have the properties appropriate to the application and conform to ISO 21028-1 or ISO 21028-2, as appropriate to the rated minimum temperature.

Non-metallic materials shall also:

— have mechanical properties that will allow the valve to pass the type approval test for category A valves defined in 5.1.3.3;

— be resistant to sunlight, weather and ageing.

— be oxygen compatible, if applicable, see 4.1.5.1.

4.1.4 Corrosion resistance

In addition to resistance to normal atmospheric corrosion, particular care shall be taken to ensure that the valve cannot be rendered inoperative by accumulation of corrosion products. Some copper alloys

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are susceptible to stress corrosion cracking; consequently, careful consideration shall be given before selection of these materials for components under stress. Careful consideration shall be given to the leak detection fluid that is used for leak checking copper alloys to ensure that the fluid does not cause stress corrosion cracking in copper alloys (e.g. ASTM G186).

4.1.5 Gas material compatibility

4.1.5.1 Oxygen

If the rated minimum temperature is equal to or less than the boiling point of air (approximately – 190 °C at atmospheric pressure), or if the valve is intended for service with oxygen or oxidizing products, the materials in contact with liquid air or oxidizing products shall be oxygen compatible, in accordance with ISO 21010.

4.1.5.2 Hydrogen

For hydrogen service, see ISO 11114-1 and ISO 11114-2.

4.1.5.3 Acetylene

Metallic materials shall contain less than 70 % copper if specified for use with mixtures containing acetylene.

4.1.5.4 LNG (Liquefied Natural Gas)

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The valve shall be designed to take into account the thermal stresses in transient state occurring during the cool down operation.

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NOTE Thermal stresses in transient state present the following characteristics:

— They are often much larger than static pressure stresses

— They increase with an increase in thickness of the valve body

The valve design with respect to thermal stresses in transient state shall be accepted provided that the valve passes the thermal shock test

The optional thermal shock test defined in annex B may be performed on agreement with purchaser/customer.

4.2 Design

4.2.1 General

The valves shall fulfil their function in a safe manner within the temperature range from +65 °C to their rated minimum temperature and the pressure range intended for use. Valves shall be designed to satisfy a pressure rating PR, PN, or Class. Valves shall be selected with a PR (PN or Class) equal to or greater than the maximum allowable pressure (PS) of the equipment with which it is to be used.

Minimum wall thickness values for valve bodies shall be from the appropriate valve standards ISO 10434, ISO 15761, ISO 17292 or ASME B16.34. Alternatively, the minimum wall thickness may be determined using recognized calculation methods (e.g. EN 16668, AD2000 Merkblatt, or ASME B31.3) for calculating the minimum shell thickness of an equivalent diameter pipe. Bonnet thickness of extended bonnet (extended stem) valves are exempted from meeting the minimum wall thickness requirements of these standards. These standards may be used as informative references for design not specifically covered in this document.

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