SLOVENSKI STANDARD
oSIST prEN ISO 21028-2:2015

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Kriogene posode - Zahtevana žilavost za materiale pri kriogeni temperaturi - 2. del: Temperature med –80 °C in –20 °C (ISO/DIS 21028-2:2014)

Cryogenic vessels - Toughness requirements for materials at cryogenic temperature - Part 2: Temperatures between -80 degrees C and -20 degrees C (ISO/DIS 21028-2:2014)

Kryo-Behälter - Anforderungen an die Zähigkeit von Werkstoffen bei tiefen Temperaturen - Teil 2: Temperaturen zwischen -80 °C und -20 °C (ISO/DIS 21028-2:2014)

Récipients cryogéniques - Exigences de ténacité pour les matériaux à température cryogénique - Partie 2: Températures comprises entre -80 degrés C et -20 degrés C (ISO/DIS 21028-2:2014)

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ICS:

23.020.40	Proti mrazu odporne posode (kriogenske posode)	Cryogenic vessels

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Cryogenic vessels — Toughness requirements for materials at cryogenic temperature —

Part 2:
Temperatures between -80 degrees C and -20 degrees C

Récipients cryogéniques — Exigences de ténacité pour les matériaux à température cryogénique —

Partie 2: Températures comprises entre -80 degrés C et -20 degrés C

ICS: 23.020.40

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 21028-2 was prepared by Technical Committee ISO/TC 220, *Cryogenic vessels*, Subcommittee SC , and by Technical Committee CEN/TC 268, *Cryogenic vessels* in collaboration.

This second edition cancels and replaces the first edition (ISO 21028-2:2004 and EN 1252-2:2001), which have been technically revised.

ISO 21028 consists of the following parts, under the general title *Cryogenic vessels — Toughness requirements for materials at cryogenic temperature*:

— *Part 1: Temperature below -80 °C*

— *Part 2: Temperature between -80 °C and -20 °C*

Introduction

The use of materials at low temperatures entails special problems which have to be addressed. Consideration has to be given, in particular, to changes in mechanical characteristics, expansion and contraction phenomena and the thermal conduction of the various materials. The most important property to be considered is the material toughness at low temperature.

Cryogenic vessels — Toughness requirements for materials at cryogenic temperature — Part 2: Temperature between -80 °C and -20 °C

1 Scope

This part of ISO 21028 specifies the toughness requirements of metallic materials for use at temperatures between – 20 °C and – 80 °C to ensure their suitability for cryogenic vessels. It is applicable to fine-grain and low-alloyed steels with specified yield strength $\leqslant$ 460 N/mm^2, aluminium and aluminium alloys, copper and copper alloys and austenitic stainless steels.

2 Normative references

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

EN ISO 148 (all parts), *Metallic materials — Charpy pendulum impact test.*

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*.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
minimum metal temperature
T_M
lowest temperature defined for each of the conditions

— temperature during normal operation,

— temperature during start-up and shut down procedures,

— temperature which may occur during possible process upsets,

— temperature which may occur during pressure or leak testing, and

— ambient conditions

NOTE See also 3.2 and 3.3.

3.2
temperature adjustment term
T_S
term relevant to the calculation of the **design reference temperature** T_R (3.3) and dependent on the pressure-induced principal membrane stress at the appropriate minimum metal temperature

3.3
design reference temperature
T_R
temperature used for determining the impact energy requirements, themselves determined by adding the **temperature adjustment term** T_S (3.2) to the **minimum metal temperature** T_M (3.1):

$$T_R = T_M + T_S$$

NOTE All applicable combinations of the temperatures T_M and T_S are to be considered, and the lowest possible T_R value used for the determination of the required material **impact test temperature** (3.4).

3.4
impact test temperature
T_{KV}
temperature at which the required impact energy has to be achieved

NOTE See Clause 5.

3.5
impact energy
KV
energy determined from Charpy V-notch tests performed in accordance with EN ISO 148.

3.6
reference thickness
e_B
thickness of a component used to relate the **design reference temperature** T_R (3.3) of the component with its required **impact test temperature** T_{KV} (3.4)

See Figures 1 to 5.

NOTE The reference thickness is based on the nominal thickness (including corrosion allowance) and can be as defined in Table 6. For butt-welded components, it is the nominal wall thickness of the component at the edge of the weld preparation

4 Requirements for steels with specified yield strength $\leqslant$ 460 N/mm^2

4.1 General

This method, based on fracture mechanics, may be used to determine the requirements to avoid brittle fracture in C, CMn, fine-grain and low-alloy steels with a specified minimum yield strength $\leqslant$ 460 N/mm^2.

In this procedure, the impact test temperature T_{KV} is not equal to the design reference temperature T_R.

Parent material, welds and HAZ shall meet the impact energy (KV) and impact test temperature T_{KV} requirements given in Table 1 for design reference temperatures T_R and reference thicknesses. Values of T_R shall be calculated from T_M using the values of T_S given in 4.2.

For materials with a specified minimum yield strength $>$ 310 N/mm^2, the impact energy at T_{KV} given in Figure 1 and Figure 2 shall be 40 J.

Where 27 J is specified in the product standard, Figure 3 for the post-weld heat-treated condition applies.

For the as-welded case with minimum yield strength in the range $>$ 310 N/mm^2 and $\leqslant$ 360 N/mm^2, Figure 4 applies.

For minimum yield strength $>$ 360 N/mm^2, Figure 5 applies.

Table 1 — Impact energy requirements

Specified min. yield strength of base material	Required impact energy KV (on 10 mm × 10 mm test pieces)	Figure defining required T_{KV}	
		Non-welded/ Post-weld heat-treated (PWHT)	As-welded (A-W)
N/mm^2	J		
$<$ 310	27	1	2
$>$ 310, $\leqslant$ 360	40	1	2
	27	3	4
$>$ 360	40	1	2
	27	3	5

4.2 Temperature adjustments

T_S is a temperature adjustment which may be used if the pressure-induced principal membrane stress does not exceed the percentage of the maximum allowable design stress or 50 N/mm^2 given in Table 2.

Table 2 — Temperature adjustments

Condition	Percentage of maximum allowable design stress			Membrane stress [b]
	$>$ 75 % ; $\leqslant$ 100 %	$\leqslant$ 75 %	$\leqslant$ 50 %	$\leqslant$ 50 N/mm^2
Non-welded, post-weld heat treated [a]	0 °C	+ 10 °C	+ 25 °C	+ 50 °C
As-welded and reference thickness $<$ 30 mm	0 °C	0 °C	0 °C	+ 40 °C

[a] Also applicable for equipment where all nozzles and non-temporary welded attachments are first welded to vessel components and these sub-assemblies are post-weld heat-treated before being assembled into the equipment by butt-welding, but the main seams are not subsequently post-weld heat-treated.

[b] In this case, the membrane stress should take account of internal and external pressure and dead weight.

4.3 Procedure for base material $<$ 10 mm thick

Minimum T_R values are given in Table 3 which shall be used when the base material is less than 10 mm thick and the testing temperature T_{KV} is 20 °C. The impact energy requirements are as specified in the relevant materials standards.

If these materials are to be used below the T_R values given in Table 3, the testing shall be performed in accordance with the relevant curve for 10 mm in Figure 1 to Figure 5. The required energies for the sub-sized specimens are given in Table 4.