SLOVENSKI STANDARD
SIST EN 13648-3:2003

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Kriogene posode - Varnostna oprema proti prekoračitvi tlaka - 3. del: Določanje potrebne izpustne količine - Količina izpusta in načrtovanje

Cryogenic vessels - Safety devices for protection against excessive pressure - Part 3: Determination of required discharge - Capacity and sizing

Kryo-Behälter - Sicherheitseinrichtungen gegen Drucküberschreitung - Teil 3: Ermittlung des erforderlichen Ausflusses - Ausflussmassenstrom und Auslegung

Récipients cryogéniques - Dispositifs de protection contre les surpressions - Partie 3: Détermination du débit a évacuer - Capacité et dimensionnement

Ta slovenski standard je istoveten z: EN 13648-3:2002

ICS:

13.240	Varstvo pred previsokim tlakom	Protection against excessive pressure
23.020.40	Proti mrazu odporne posode (kriogenske posode)	Cryogenic vessels

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Cryogenic vessels - Safety devices for protection against excessive pressure - Part 3: Determination of required discharge - Capacity and sizing

Récipients cryogéniques - Dispositifs de protection contre les surpressions - Partie 3: Détermination du débit à évacuer - Capacité et dimensionnement

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This European Standard was approved by CEN on 19 August 2002.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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Contents

Foreword

This document (EN 13648-3:2002) has been prepared by Technical Committee CEN/TC 268 "Cryogenic vessels", the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by April 2003, and conflicting national standards shall be withdrawn at the latest by April 2003.

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 Directive(s).

For relationship with EU Directive(s), see informative annex ZA, which is an integral part of this document.

EN 13648 consists of the following parts:

EN 13648-1, *Cryogenic vessels - Safety devices for protection against excessive pressure - Part 1: Safety valves for cryogenic service.*

EN 13648-2, *Cryogenic vessels - Safety devices for protection against excessive pressure - Part 2: Bursting discs safety devices for cryogenic service.*

EN 13648-3, Cryogenic vessels - Safety devices for protection against excessive pressure - Part 3: Determination of required discharge - Capacity and sizing.

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

Introduction

The capacity of each of the pressure relief devices is established by considering all of the probable conditions contributing to internal excess pressure. The applicable conditions are specified in the product standard of each type of cryogenic vessel.

This European Standard provides a separate calculation method for determining the contributing mass flow to be relieved for each of the specified conditions. Conformity of the pressure protection system with the requirement for each condition is assumed if the applicable method of this standard is adopted.

This European Standard is based on CGA pamphlet, S-1.2 and S-1.3 and standards prepared by CEN/TC 69.

1 Scope

This standard provides a separate calculation method for determining the contributing mass flow to be relieved resulting from each of the following specified conditions:

- vacuum insulated vessels with insulation system (outer jacket + insulating material) intact under normal vacuum. Outer jacket at ambient temperature. Inner vessel at temperature of the contents at the relieving pressure;
- vacuum insulated vessels with insulation system remaining in place but with loss of vacuum, or non vacuum insulated vessels with insulation system intact. Outer jacket at ambient temperature. Inner vessel at temperature of the contents at the relieving pressure;
- vacuum or non vacuum insulated vessels with insulation system remaining fully or partially in place, but with loss of vacuum in the case of vacuum insulated vessels, and fire engulfment. Inner vessel at temperature of the contents at the relieving pressure;
- vessels with insulation system totally lost and fire engulfment.

Good engineering practice based on well established theoretical physical science shall be adopted to determine the contributing mass flow where an appropriate calculation method is not provided for an applicable condition.

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 these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

prEN ISO 4126-1, *Safety devices for protection against excessive pressure - Part 1: Safety valves (identical to ISO 4126-1).*

prEN ISO 4126-6:2000, *Safety devices for protection against excessive pressure - Part 6: Application, selection and installation of bursting disc safety devices (ISO/DIS 4126-6:2000).*

3 Calculation of the total quantity of heat transferred per unit time from the hot wall (outer jacket) to the cold wall (inner vessel)

3.1 General

p (bar abs) is the actual relieving pressure which is used for the sizing of a safety valve. This shall not be greater than 1,1 PS, where PS is the maximum allowable pressure for which the vessel is designed.

T_a (K) is the maximum ambient temperature for conditions other than fire (as specified e.g.by regulation/standard)

T_f (K) is the external environment temperature under fire conditions (in any case T_f = 922 K, i.e. 649°C or 1200 F)

T (K) is the relieving temperature to be taken into account:

1) for subcritical fluids, T is the saturation temperature of the liquid at pressure p;

2) for critical or supercritical fluids, T is calculated from 4.3.

3.2 For conditions other than fire

3.2.1 Vacuum insulated vessels under normal vacuum : quantity of heat transferred per unit time (Watt) by heat leak through the insulation system:

$$W_1 = (T_a - T)\, U_1 \Sigma$$

where

U_1 is the overall heat transfer coefficient of the insulating material under normal vacuum, in $Wm^{-2}K^{-1}$

$$U_1 = \frac{\lambda_1}{e_1}$$

λ_1 is the thermal conductivity coefficient of the insulating material under normal vacuum, between T and T_a, in $W.m^{-1}K^{-1}$;

e_1 is the nominal insulating material thickness, in m;

Σ is the arithmetic mean of the inner and outer surface areas of the vessel insulating material, in m².

3.2.2 Vacuum insulated vessels in case of loss of vacuum or non vacuum insulated vessels; quantity of heat transferred per unit time (Watt) by heat leak through the insulating material:

$$W_2 = (T_a - T)\, U_2 \Sigma$$

where

U_2 is the overall heat transfer coefficient of the insulating material at atmospheric pressure, in $Wm^{-2}K^{-1}$

$$U_2 = \frac{\lambda_2}{e_2}$$

λ_2 is the thermal conductivity coefficient of the insulating material saturated with gaseous lading or air at atmospheric pressure, whichever provides the greater coefficient, between T and T_a, in $Wm^{-1}K^{-1}$.

e_2 is the minimum insulating material thickness taking into account the manufacturing tolerancies or effects of sudden loss of vacuum, in m.

NOTE This formula cannot apply to application at very low temperatures with small thickness of insulating material, as the maximum heat transfer coefficient would be given by air condensation. This phenomena has been studied for helium in W. Lehmann, Sicherheitstechnische Aspekte bei Auslegung and Betrieb von Lhe-badgekühlten-SL-Badkyokasten."

3.2.3 Quantity of heat transferred per unit time (Watt) by supports and piping located in the interspace

$$W_3 = (T_a - T)(w_1 + w_2 + \dots + w_n + \dots)$$

where

w_n is the heat leak per degree K contributed by one of the supports or the pipes, in WK^{-1}

$$w_n = \lambda_n \frac{S_n}{l_n}$$

λ_n is the thermal conductivity coefficient of the support or pipe material between T and T_a, in $Wm^{-1}K^{-1}$;

S_n is the support or pipe section area, in m²;

l_n is the support or pipe length in the vacuum interspace, in m.

3.2.4 Quantity of heat transferred per unit time (Watt) by the pressure built up device circuit with the regulator fully open :

W_4 determined from the type (ambient air, water or steam, electrical …) and the design of the pressure built up device circuit. For example, in the case of ambient air vaporiser:

$$W_4 = U_4 A (T_a - T)$$

where

U_4 is the overall convective heat transfer coefficient of the ambient air vaporiser, in $Wm^{-2}K^{-1}$;

A is the external heat transfer surface area of the vaporiser, in m².

3.3 Under fire conditions

3.3.1 Quantity of heat transferred per unit time (Watt) by heat leak through the vessel walls

3.3.1.1 Insulation system remains fully or partially in place during fire conditions

$$W_5 = 2{,}6\,(922 - T)\,U_5 \Sigma^{0{,}82}$$

where

$$U_5 = \frac{\lambda_5}{e}, \text{ in } Wm^{-2}K^{-1};$$

λ_5 is the thermal conductivity coefficient of the insulating material saturated with gaseous lading or air at atmosphere pressure whichever provides the greater coefficient between T and 922 K, in $Wm^{-1}K^{-1}$;

e is the thickness of the insulating material remaining in place during fire conditions, in m;

Σ is the mean surface area of the insulating material remaining in place during fire conditions, in m².

If outer jacket remains in place during fire conditions, but if insulating material is entirely destroyed, U_5 is equal to the overall heat transfer coefficient with gaseous lading or air at atmospheric pressure in the space between outer jacket and inner vessel, whichever provides the greater coefficient between T and 922 K. Σ is equal to the mean surface area of the interspace.

3.3.1.2 Insulation system does not remain in place during fire conditions

$$W_6 = 7{,}1 \cdot 10^4 \sigma^{0{,}82}$$

where

σ is the total outside surface area of the inner vessel, in m².

3.3.2 Quantity of heat transferred by supports and piping located in the interspace: can be neglected in this case