SLOVENSKI STANDARD
oSIST prEN ISO 4126-10:2021

01-september-2021

Varnostne naprave za zaščito pred prekomernim tlakom - 10. del: Velikosti varnostnih ventilov in varnostne membrane za dvofazni pretok plina/tekočine (ISO/DIS 4126-10:2021)

Safety devices for protection against excessive pressure - Part 10: Sizing of safety valves and bursting discs for gas/liquid two-phase flow (ISO/DIS 4126-10:2021)

Sicherheitseinrichtungen gegen unzulässigen Überdruck - Teil 10: Auslegung von Sicherheitsventilen und Berstscheiben bei Zweiphasenströmung (flüssig/gas) (ISO/DIS 4126 10:2021)

Dispositifs de sécurité pour protection contre les pressions excessives - Partie 10 : Dimensionnement des soupapes de sûreté et des disques de rupture pour les débits diphasiques gaz/liquide (ISO/DIS 4126-10:2021)

Ta slovenski standard je istoveten z: **prEN ISO 4126-10**

ICS:

13.240	Varstvo pred previsokim tlakom	Protection against excessive pressure

oSIST prEN ISO 4126-10:2021 **en,fr,de**

DRAFT INTERNATIONAL STANDARD
ISO/DIS 4126-10

ISO/TC **185** Secretariat: **ANSI**

Voting begins on: **2021-06-07**

Voting terminates on: **2021-08-30**

Safety devices for protection against excessive pressure —

Part 10: Sizing of safety valves and bursting discs for gas/liquid two-phase flow

ICS: 13.240

THIS DOCUMENT IS A DRAFT CIRCULATED FOR COMMENT AND APPROVAL. IT IS THEREFORE SUBJECT TO CHANGE AND MAY NOT BE REFERRED TO AS AN INTERNATIONAL STANDARD UNTIL PUBLISHED AS SUCH.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

This document is circulated as received from the committee secretariat.

ISO/CEN PARALLEL PROCESSING

Reference number
ISO/DIS 4126-10:2021(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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.

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 185, *Safety devices for protection against excessive pressure*.

ISO 4126 consists of the following parts, under the general title *Safety devices for protection against excessive pressure*:

— *Part 1: Safety valves*

— *Part 2: Bursting disc safety devices*

— *Part 3: Safety valves and bursting disc safety devices in combination*

— *Part 4: Pilot-operated safety valves*

— *Part 5: Controlled safety pressure-relief systems (CSPRS)*

— *Part 6: Application, selection and installation of bursting disc safety devices*

— *Part 7: Common data*

— *Part 9: Application and installation of safety devices excluding stand-alone bursting disc safety devices*

— *Part 10: Sizing of safety valves for gas/liquid two-phase flow*

In this standard, the unit bar for pressures is being used. 100 000 Pa = 1 bar:

Introduction

Well-established recommendations exist for the sizing of safety valves and bursting discs and the connected inlet and outlet lines for steady-state, single-phase gas/vapour or liquid flow. However, in the case of a two-phase vapour/liquid flow, the required relieving area to protect a system from overpressure is larger than that required for single-phase flow when the same vessel condition and heat release are considered. The requirement for a larger relief area results from the fact that, in two-phase flow, the liquid partially blocks the relieving area for the vapour flow, by which most of the energy is removed by evaporation from the vessel.

This part of ISO 4126 includes a widely usable engineering tool for the sizing of the most typical safety valves and bursting discs in fluid services encountered in various industrial fields. It is based on the omega parameter method, which is extended by a thermodynamic non-equilibrium parameter. A balance is attempted between the accuracy of the method and the unavoidable uncertainties in the input and property data under the actual sizing conditions.

In case of two-phase flow, the safety device size can influence the fluid state and, hence, the mass flow rate to be discharged. Furthermore, the two-phase mass flow rate through a safety device essentially depends on the mass flow quality (mass fraction of vapour) of the fluid at the inlet of the device. Because these parameters are, in most cases, not readily at hand during the design procedure of a relief device, this part of ISO 4126 also includes a comprehensive procedure that covers the determination of the fluid-phase composition at the safety device inlet. This fluid-phase composition depends on a scenario that leads to the pressure increase. Therefore, the recommended sizing procedure starts with the definition of the sizing case and includes a method for the prediction of the mass flow rate required to be discharged and the resulting mass flow quality at the inlet of the safety device.

The equations of ISO 4126-7 for single-phase flow up to the narrowest flow cross-section are included in this part of ISO 4126, modified to SI units, to calculate the flow rates at the limiting conditions of single-phase gas and liquid flow.

Safety devices for protection against excessive pressure —

Part 10:
Sizing of safety valves and bursting discs for gas/liquid two-phase flow

1 Scope

This part of ISO 4126 specifies the sizing of safety valves and bursting discs for gas/liquid two-phase flow in pressurized systems such as reactors, storage tanks, columns, heat exchangers, piping systems or transportation tanks/containers. The possible fluid states at the safety device inlet that can result in two-phase flow are given in Table 1.

NOTE The expression “safety valve” is a synonym for valves as described in ISO 4126-1, ISO 4126-4 and ISO 4126-5. The expression “bursting disc” is a synonym for bursting disc safety device as described in ISO 4126-2, ISO 4126-3 and ISO 4126-6.

Table 1 — Possible fluid state at the inlet of the safety valve or bursting disc that can result in two-phase flow

Fluid state at device inlet	Cases	Examples
liquid	subcooled (possibly flashing in the safety device)	cold water
	saturated	boiling water
	with dissolved gas	CO_2/water
gas/vapour	near saturated vapour (possibly condensing in the safety device)	steam
gas/liquid	vapour/liquid	steam/water
	non-evaporating liquid and non-condensable gas (constant quality)	air/water
	gas/liquid mixture, when gas is desorbed or produced	

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.

EN ISO 21013-3:2016, *Cryogenic vessels - Pressure-relief accessories for cryogenic service - Part 3: Sizing and capacity determination*

ISO 4126-1, *Safety devices for protection against excessive pressure — Part 1: Safety valves*

ISO 4126-7, *Safety devices for protection against excessive pressure — Part 7: Common data*

API Standard 521:2014-01, *Pressure-Relieving and Depressuring Systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4126-7 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1 General

3.1.1
pressurized system
equipment such as reactors, storage tanks, columns, heat exchangers, piping systems and transport tanks/containers being protected against impermissible pressure accumulation by a safety device

3.1.2
critical filling threshold
ϕ_{limit}
maximum initial liquid filling threshold (liquid hold-up) in the pressurized system at sizing conditions, up to where vapour disengagement occurs and single-phase gas or vapour flow can be expected

Note 1 to entry: The critical filling threshold is expressed as a ratio of the total volume of the system.

Note 2 to entry: For filling levels above the critical filling threshold, two-phase flow is assumed to occur.

3.1.3
initial liquid filling level
ϕ_0
liquid hold-up in the pressurized system at the sizing conditions

Note 1 to entry: The initial liquid filling level is expressed as a ratio of the total volume of the system.

3.1.4
inlet line
piping and associated fittings connecting the pressurized system to the safety device inlet

3.1.5
outlet line
piping and associated fittings connecting the safety valve outlet to a containment system or the atmosphere

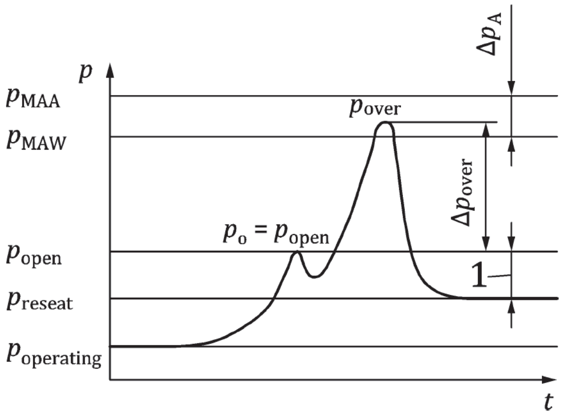
3.1.6
vent line system
combination of safety device, inlet line and outlet line

3.1.7
cryogenic vessel
vacuum jacketed vessel intended for application at low temperature involving liquefied gases

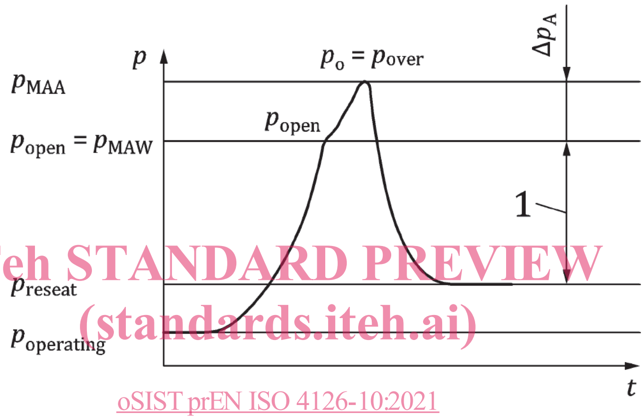
3.2 Pressure

See Figures 1 a) and 1 b) for an illustration of the relationship of the pressures defined in 3.2.

In contrast to the definition used in other parts of this International Standard (e.g. ISO 4126-7) all pressures are absolute pressures and not gauge pressures.



a) Pressure history of a typical tempered reaction system that is adequately sized



b) Typical pressure history for an externally heated gas vented system

Key

p_{MAA}	maximum allowable accumulated pressure	p_0	sizing pressure equal to p_{open} as shown in Figure 1 a) and equal to p_{over} as shown in Figure 1 b)
p_{MAW}	maximum allowable working absolute pressure	p_{over}	overpressure
p_{open}	opening pressure	Δp_{MAA}	maximum allowable accumulation
p_{reseat}	reseating pressure	Δp_{over}	change in overpressure
$p_{operating}$	operating pressure		
1	Δp_{BD} blowdown		

Figure 1 — Relationship of the defined pressures

3.2.1
maximum allowable working absolute pressure

p_{MAW}

maximum pressure permissible at the top of a pressurized system in its operating position for designated temperature

Note 1 to entry: This pressure is an absolute pressure, not a gauge pressure.

3.2.2
maximum allowable accumulated pressure

p_{MAA}

sum of the maximum allowable working pressure and the maximum allowable accumulation

Note 1 to entry: The maximum allowable accumulation is established by applicable code for operating and fire contingencies.

Note 2 to entry: This pressure is an absolute pressure, not a gauge pressure.

3.2.3
maximum allowable accumulation

Δp_{MAA}

pressure increase over the maximum allowable working pressure of a pressurized system during discharge through the safety device

Note 1 to entry: The maximum allowable accumulation is expressed in pressure units or as a percentage of the maximum allowable working pressure.

Note 2 to entry: This pressure is an absolute pressure, not a gauge pressure.

3.2.4
opening pressure

p_{open}

predetermined absolute pressure at which a safety valve under operating conditions at the latest commences to open

Note 1 to entry: This pressure is an absolute pressure, not a gauge pressure.

3.2.6
absolute overpressure

Δp_{over}

pressure increase over the opening pressure of the safety device, p_{open}

Note 1 to entry: The maximum absolute overpressure is the same as the maximum accumulation, Δp_{MAA}, when the opening pressure of the safety valve is set at the maximum allowable working pressure of the pressurized system.

Note 2 to entry: The absolute overpressure is expressed in pressure units or as a percentage of the opening pressure.

Note 3 to entry: This pressure is an absolute pressure, not a gauge pressure.

3.2.7
overpressure

p_{over}

maximum pressure in the pressurized system during relief, i.e. pressure less or equal to the maximum accumulated pressure

Note 1 to entry: This pressure is an absolute pressure, not a gauge pressure.

3.2.8
sizing pressure

p_0

pressure at which all property data, especially the compressibility coefficient, ω, are calculated for sizing the safety device

Note 1 to entry: In the case of tempered and hybrid reactive systems, the sizing pressure shall be as low as reasonable possible, but should not affect the normal operation. In the case of non-reactive and gassy systems, the designer may choose a higher value for the sizing pressure, but it shall not exceed the maximum allowable accumulated pressure.

Note 2 to entry: This pressure is an absolute pressure, not a gauge pressure.

3.2.9
critical pressure
p_{crit}
fluid-dynamic critical pressure occurring in the narrowest flow cross-section of the safety valve and/or at an area enlargement in the outlet line

Note 1 to entry: At this pressure, the mass flow rate approaches a maximum at a given sizing condition in the pressurized system. Any further decrease of the downstream pressure does not increase the flow rate further. Usually, the critical pressure occurs in the safety valve, either in the valve seat, inlet nozzle and/or valve body. In the bursting disc, critical pressure can occur downstream of the device at a minimum flow area, at the exit of the vessel or a change in pipe diameter. In long safety device outlet lines, multiple critical pressures can also occur.

Note 2 to entry: This pressure is an absolute pressure, not a gauge pressure.

3.2.10
critical pressure ratio
η_{crit}
ratio of critical pressure to the sizing pressure

3.2.11
thermodynamic critical pressure
p_c
state property, together with thermodynamic critical temperature, at the thermodynamic critical point

Note 1 to entry: This pressure is an absolute pressure, not a gauge pressure.

3.2.12
back pressure
p_b
pressure that exists at the outlet of a safety device as a result of pressure in the discharge system

Note 1 to entry: Back pressure can be either constant or variable; it is the sum of superimposed and built-up back pressure.

Note 2 to entry: This pressure is an absolute pressure, not a gauge pressure.

3.2.13
built-up back pressure
pressure existing at the outlet of the safety device caused by flow through the valve or bursting disc and discharge system

Note 1 to entry: This pressure is an absolute pressure, not a gauge pressure.

3.2.14
superimposed back pressure
pressure existing at the outlet of the safety device at the time when the device is required to operate

Note 1 to entry: Superimposed back pressure is the result of pressure in the discharge system from other sources.

Note 2 to entry: This pressure is an absolute pressure, not a gauge pressure.

3.2.15
inlet pressure loss
Δp_{loss}
irrecoverable pressure decrease due to flow in the piping from the equipment that is protected to the inlet of the safety device

Note 1 to entry: This pressure is an absolute pressure, not a gauge pressure.

3.2.16
blowdown
Δp_{BD}
difference between opening pressure and reseating pressure of a safety valve

Note 1 to entry: Blowdown is normally stated as a percentage of the opening pressure.

Note 2 to entry: This pressure is an absolute pressure, not a gauge pressure.

3.2.17
dimensionless reduced pressure
p_{red}
local pressure divided by the thermodynamic critical pressure of the substance

3.3 Flow rate

3.3.1
mass flow rate required to be discharged from a pressurized system
$Q_{m,out}$
mass flow rate required to be discharged from a pressurized system, such that the pressure does not exceed maximum allowable accumulated pressure in the pressurized system during relief

3.3.2
feed mass flow rate into the pressurized system
$Q_{m,feed}$
maximum mass flow rate through a feed line or control valve fed into the pressurized system being protected

3.3.3
dischargeable mass flux through the safety device
$\dot{m}_{SD}$
mass flow rate per area through a safety device at the sizing conditions calculated by means of the certified discharge coefficients for gas and liquid flow

Note 1 to entry: See Equation (49).

3.3.4
discharge coefficient for gas and liquid flow
$K_{dr,g}$ ⟨for gas⟩
$K_{dr,l}$ ⟨for liquid⟩
correction factor defined by the ratio of the theoretically dischargeable mass flux through the safety device to an experimentally determined mass flux through a device of the same manufacturer's type

Note 1 to entry: The discharge coefficient of a safety valve is related to the valve seat cross-section and accounts for the imperfection of flow through the device compared to that through a reference model (ideal nozzle). Certified values for gas and liquid flow, K_d, are usually supplied by valve manufacturers or determined by experiment. Rated discharge coefficients K_{dr}, equal to 0,9 K_d, are used to calculate the safety valve sizing area.

Note 2 to entry: The discharge coefficient of a bursting disc is related to the disc cross-section and accounts for the imperfection of flow through the device compared to that through a reference model.

3.4 Flow area

3.4.1
safety device sizing area
A_0
most essential result of the sizing procedure in accordance with this part of ISO 4126 required to select an adequately sized safety device and defined as the minimum cross-section of flow area

Note 1 to entry: It is important that the dischargeable mass flux through the safety device be related to this specific area.

3.4.2
effective flow area of the feed line or the control valve
A_{feed}
discharge flow area of a feed line or control valve in the line to the pressurized system

3.5 Fluid state

3.5.1
gas/liquid mixture
fluid mixture composed of both a liquid part and a gas part, in which the gas is not necessarily of the same chemical composition as the liquid

3.5.2
tempered system
fluid system in which some energy is removed from the liquid phase by evaporation or flashing

3.5.3
gassy system
fluid system in which permanent gas is generated (e.g. by chemical reaction or by evolution from solution) and in which no significant amount of energy is removed from the liquid by evaporation at the sizing conditions

3.5.4
hybrid system
fluid system that exhibits characteristics of both tempered and gassy systems to a significant extent at the sizing conditions

3.5.5
thermal runaway reaction
uncontrolled or undesired exothermic chemical reaction

3.6 Temperature

3.6.1
thermodynamic critical temperature
T_c
state property, together with thermodynamic critical pressure, at the thermodynamic critical point

3.6.2
sizing temperature
T_0
temperature of the pressurized system at the sizing conditions

3.6.3
overtemperature
T_{over}
maximum temperature in the pressurized system during relief

