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Safety devices for protection against excessive pressure —

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

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

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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 document 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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This document was prepared by Technical Committee ISO/TC 185, *Safety devices for protection against excessive pressure,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 69, *Industrial valves*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 4126-10:2010), which has been technically revised.

The main changes are as follows:

— opening of the method for sizing of bursting discs;

— more thorough iteration for the calculation of the flow rate;

— allowing for slip;

— allowing for velocity in the outlet line and pressure losses in front and after the safety device;

— added an example for flow rate to be discharged (Annex B);

— added an example for dischargeable mass flow rate added and method to estimate pressure drop in pipe flow (Annex C);

— various correction.

A list of all parts in the ISO 4126 series can be found on the ISO website.

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

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 document includes a widely applicable method for the sizing of the most typical safety valves and bursting discs in fluid services encountered in various industrial fields (see Table 1). 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 document 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 formulae of ISO 4126-7:2013/Amd 1:2016 for single-phase flow up to the narrowest flow cross-section are included in this document, modified to SI units, to calculate the flow rates at the limiting conditions of single-phase gas and liquid flow.

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

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

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 document 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, see Figure 2. The possible fluid states at the safety device inlet that can result in two-phase flow are given in Table 1.

NOTE The pressures used in this document are absolute pressures, not gauge pressures.

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 4126-7:2013/Amd 1:2016, *Safety devices for protection against excessive pressure — Part 7: Common data*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4126-7:2013/Amd 1:2016 and the following apply.

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

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

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

3.1 General

3.1.1
pressurized system
equipment being protected against excessive pressure accumulation by a safety device

EXAMPLE Equipment can be reactors, storage tanks, columns, heat exchangers, piping systems and transport tanks/containers, etc.

3.1.2
critical filling threshold
ϕ_{limit}
maximum initial liquid filling threshold (liquid hold-up) in the *pressurized system* (3.1.1) 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.