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Guide for the selection, application and use of flame arresters

Richtlinie für die Auswahl, die Anwendung und den Einsatz von Flammendurchschlagssicherungen

Guide pour la sélection, l'application et l'utilisation des arrête-flammes

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23.060.40	Tlačni regulatorji	Pressure regulators

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Richtlinie für die Auswahl, die Anwendung und den Einsatz von Flammendurchschlagssicherungen

This Technical Report was approved by CEN on 22 December 2014. It has been drawn up by the Technical Committee CEN/TC 305.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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European foreword

This document (CEN/TR 16793:2016) has been prepared by Technical Committee CEN/TC 305 “Potentially explosive atmospheres - Explosion prevention and protection”, the secretariat of which is held by DIN.

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Introduction

The document provided is general in nature and for specific applications further expert advice should be sought.

In addition to the content of operating manuals from manufacturers, the local accident prevention regulations, environmental protection and general safety provisions for the devices' area of use, as well as relevant laws and national directives, this paper will support the user for a proper use of flame arresters.

In Europe, the "Directive 2014/34/EU on equipment and protective systems intended for use in potentially explosive atmospheres" (ATEX – Atmosphères Explosibles) is mandatory for the production and test intended for use of products in potentially explosive atmospheres. Flame arresters are defined as a Protective System.

Flame arresters should be tested according to EN ISO 16852, *Flame arresters – Performance requirements, test methods and limits for use,* to fulfill the health and safety requirements of this directive.

Flame arresters are subjected to an EC type examination and are designed for use in areas at risk from explosion.

The Directive 1999/92/EC of the European Parliament and of the Council of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres - gives the minimum requirements for the improvement of health protection and safety of employers who could be endangered by explosive atmospheres. The main issues are assessment of explosion risk, zone classification and the explosion protection documents (including requirements for personnel to do engineering, equipment selection, installation, maintenance, repair, etc.).

National regulations and/or codes relating to specific industries or applications may exist which have to followed.

Flame arresters are required to protect against many types of explosion events within equipment.

The safety obtained depends heavily upon correct choice, installation and maintenance of the flame arrester. This cannot be achieved without responsible, informed management.

1 Scope

This Technical Report is aimed primarily at persons who are responsible for the safe design and operation of installations and equipment using flammable liquids, vapours or gases.

This document applies to both industrial and mining applications

This document describes possible risks and gives proposals for the protection against these risks by the use of flame arresters.

This document gives some guidance to choice of flame arresters according to EN ISO 16852 for different common scenarios and it gives best practice for the installation and maintenance of these flame arresters.

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 60079-20-1, *Explosive atmospheres — Part 20-1: Material characteristics for gas and vapour classification — Test methods and data (IEC 60079-20-1)*

EN ISO 16852:2010, *Flame arresters — Performance requirements, test methods and limits for use (ISO 16852:2008, including Cor 1:2008 and Cor 2:2009)*

EN ISO 28300:2008, *Petroleum, petrochemical and natural gas industries — Venting of atmospheric and low-pressure storage tanks (ISO 28300:2008)*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

3.1.1
atmospheric condition
pressure ranging from 80 kPa to 110 kPa (0,8 bar to 1,1 bar); temperatures ranging from -20 °C to +60 °C

3.1.2
end-of-line flame arrester
flame arrester that is fitted with one pipe connection only

3.1.3
explosion
abrupt oxidation or decomposition reaction producing an increase in temperature, pressure, or in both simultaneously

3.1.4
explosion group
Ex.G
ranking of flammable gas-air mixtures with respect to the MESG

Note 1 to entry: See EN ISO 16852:2010, 3.12.2.

3.1.5
explosion-pressure-resistant
property of vessels and equipment designed to withstand the expected explosion pressure without becoming permanently deformed

3.1.6
explosion-pressure-shock resistant
property of vessels and equipment designed to withstand the expected explosion pressure without rupturing, but allowing permanent deformation

3.1.7
deflagration
explosion propagating at subsonic velocity

[SOURCE: EN ISO 16852:2010, 3.8]

3.1.8
detonation
explosion propagating at supersonic velocity and characterized by a shock wave

[SOURCE: EN ISO 16852:2010, 3.9]

3.1.9
stable detonation

detonation progressing through a confined system without significant variation of velocity and pressure characteristics

Note 1 to entry: For the atmospheric conditions, test mixtures and test procedures of this International Standard, typical velocities range between 1 600 m/s and 2 200 m/s.

[SOURCE: EN ISO 16852:2010, 3.10]

3.1.10
unstable detonation
detonation during the transition of a combustion process from a deflagration into a stable detonation

Note 1 to entry: The transition occurs in a limited spatial zone, where the velocity of the combustion wave is not constant and where the explosion pressure is significantly higher than in a stable detonation. The position of this transition zone depends, amongst other factors, on pipe diameter, pipe configuration, test gas and explosion group.

[SOURCE: EN ISO 16852:2010, 3.11]

3.1.11
flame arrester
device fitted to the opening of an enclosure, or to the connecting pipe work of a system of enclosures, and whose intended function is to allow flow but prevent the transmission of flame

[SOURCE: EN ISO 16852:2010, 3.1]

3.1.12
flame arrester element
part of a flame arrester whose principal function is to prevent flame transmission

[SOURCE: EN ISO 16852:2010, 3.3]

3.1.13
in-line flame arrester
flame arrester that is fitted with two pipe connections, one on each side of the flame arrester

[SOURCE: EN ISO 16852:2010, 3.22]

3.1.14
mixture
used to represent any mixtures of gas and/or product vapour/air

3.1.15
product
equipment, protective systems, safety devices, components and their combinations

3.1.16
protected side
side of the plant component to be protected

3.1.17
protective system
autonomous devices to stop an explosion immediately and/or limit the effects of explosion flames and pressures

3.1.18
stabilized burning
steady burning of a flame stabilized at, or close to, the flame arrester element [short time (max. 30 minutes) or endurance burning (for unlimited time)

3.1.19
unprotected side
ignition source side

3.1.20
restriction
reduction of the diameter of the pipe on the protected side of a flame arrester

Note 1 to entry: For example, a restriction can be a not fully opened valve.

3.2 Abbreviated terms

DN	nominal size of the connection of a device or pipe fitting
LEL	lower explosion limit of the explosion range
L_r	pipe length between flame arrester and restriction
L_u	pipe length on the unprotected side, maximum allowable run-up length for installation
p_0	maximum operational pressure
T_0	maximum operational temperature
MESG	maximum experimental safe gap – safe gap measured in accordance with EN 60079-20-1
p/v valve	pressure and vacuum relief vent valve
UEL	upper explosion limit of the explosion range
NPSH	net positive suction head

Z_{0min}	minimum operational water seal immersion depth when the mixture flow displaces the water from the immersion tubes, where $Z_{0min} > Z_{Rmin}$
Z_0	operational immersion depth, corresponding to Z_{0min} plus the manufacturer's recommended safety margin
Z_{Rmin}	minimum water seal immersion depth at rest above the outlet openings of the immersion tubes
Z_R	immersion depth at rest, corresponding to Z_{Rmin} plus the manufacturer's recommended safety margin
$\dot{V}_{max}$	safe volume flow rate
$\dot{V}_s$	safe volume flow rate including a safety margin

4 Explosion risks

The following content is a summary of the non-binding guide to good practice for implementing the European Parliament and Council Directive 1999/92/EC [1].

Three components are necessary at the same time for an explosion to occur. These are visualized in the so-called explosion triangle (see Figure 1).

1) Air (oxidizer)

2) Fuel (flammable gas)

3) Ignition Source (e.g. spark, hot surface, etc.)

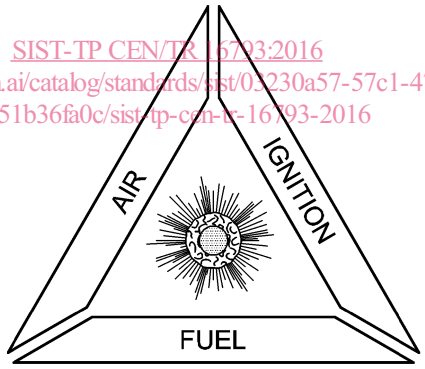


Figure 1 — Explosion triangle

Fuel mixed with air in a suitable ratio (above LEL and below UEL) is called explosive atmosphere.

Assessment of explosion risks is focused on:

— the likelihood that an explosive atmosphere will occur,

and subsequently on

— the likelihood that sources of ignition will be present and become effective.

Suitable methods for assessing the explosion risks associated with work processes or plant are those which lend themselves to a systematic approach to checking plant and process safety. An analysis is made of the existing sources of hazardous explosive atmospheres and the effective sources of ignition which could occur at the same time. Explosion risks can in practice be assessed by means of seven questions:

1) Are flammable substances present?

2) Can sufficient dispersal in air give rise to an explosive atmosphere?

3) Where can explosive atmospheres occur?

4) Is the formation of a hazardous explosive atmosphere possible?

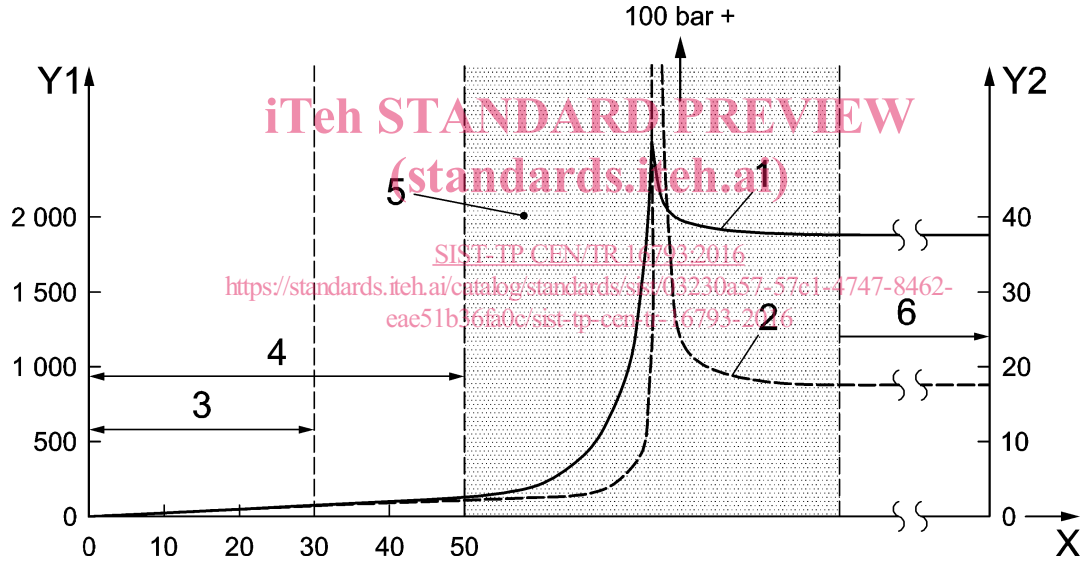
5) Is the formation of hazardous explosive atmospheres reliably prevented?

6) To what zones can the places with hazardous explosive atmospheres be assigned?

7) Is the ignition of hazardous explosive atmospheres reliably prevented?

Depending on the answers of these questions, it could be necessary to apply adequate explosion protection measures. "Explosion protection measures" mean all measures that prevent the formation of hazardous explosive atmospheres, avoid the ignition of hazardous explosive atmospheres or mitigate the effects of explosions. One of the possible measures is to use flame arresters.

An idealized representation of the flame acceleration process is presented in Figure 2.



Key

X	pipe L/D	3	deflagration IIB - IIC
Y1	flame speed in $m \cdot s^{-1}$	4	deflagration IIA – IIB3
Y2	pressure in bar	5	deflagration to detonation transition
1	flame speed	6	stable detonation
2	pressure		

Figure 2 — Development of an explosion in a pipeline