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Industrijska termoprocesna oprema - 3. del: Varnostne zahteve za pridobivanje in uporabo atmosferskih plinov

Industrial thermoprocessing equipment - Part 3: Safety requirements for the generation and use of atmosphere gases

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Industrielle Thermoprozessanlagen - Teil 3: Sicherheitsanforderungen für die Erzeugung und Anwendung von Schutz- und Reaktionsgasen

Équipements thermiques industriels - Partie 3 : Prescription de sécurité pour la génération et l'utilisation des gaz d'atmosphère

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Industrial thermoprocessing equipment - Part 3: Safety requirements for the generation and use of atmosphere gases

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European foreword

This document (EN 746-3:2021) has been prepared by Technical Committee CEN/TC 186 “Industrial thermoprocessing - Safety”, the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by June 2022, and conflicting national standards shall be withdrawn at the latest by June 2022.

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

This document supersedes EN 746-3:1997+A1:2009.

Based on EN 746-3:1997+A1:2009, ISO 13577-3 was developed in 2016. This ISO standard differs considerably from the original EN 746-3:1997+A1:2009. The contents of this completely renewed EN 746-3:2021 are based on ISO 13577-3:2016.

This document has been prepared under a Standardization Request given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s) / Regulation(s).

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

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Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

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Introduction

This document is a type-C standard as stated in EN ISO 12100:2010.

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

— machine manufacturers (small, medium and large enterprises);

— health and safety bodies (regulators, accident prevention organizations, market surveillance etc.).

Others can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:

— machine users/employers (small, medium and large enterprises);

— machine users/employees (e.g. trade unions, organizations for people with special needs);

— service providers, e.g. for maintenance (small, medium and large enterprises);

— consumers (in case of machinery intended for use by consumers).

The above-mentioned stakeholder groups have been given the possibility to participate at the drafting process of this document.

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The machinery concerned and the extent to which hazards, hazardous situations or hazardous events are covered are indicated in the Scope of this document.

When requirements of this type-C standard are different from those which are stated in type-A or type-B standards, the requirements of this type-C standard take precedence over the requirements of the other standards for machines that have been designed and built according to the requirements of this type-C standard.

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Industrial furnaces and associated thermo-processing equipment (TPE) generally consists of the following components:

— processing chamber (e.g. steel construction with lining and/or refractory);

— heating systems;

— protective system;

— control and instrumentation system/operator-control level.

EN 746-1:1997+A1:2009 provides the general safety requirements common to TPE. This part of the EN 746 series details in addition specific safety requirements for generation and use of protective and reactive atmosphere gases that are part of TPE as listed in the scope. These requirements establish the minimum acceptable requirements for safety functions required for various processes. Where a process is not part of the TPE, the requirements do not apply.

For example, the minimum requirements for the opening and closing of doors on a TPE does not apply to TPE that do not have doors in their design.

NOTE As stated in its scope, EN 746-1:1997+A1:2009 does not cover blast furnaces, converters (in steel plants), boilers and equipment not covered under EN ISO 12100.

The requirements of protective system are specified in ISO 13577-4:2014.

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If a general provision of EN 746-1:1997+A1:2009 counters provisions in this part of the EN 746 series, the provisions of this part of EN 746 take precedence.

It is assumed that TPE will only be operated and maintained by trained personnel.

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1 Scope

This part of the EN 746 series specifies safety requirements for generation and use of protective and reactive atmosphere gases that are part of industrial thermo-processing equipment (TPE).

The general safety requirements common to TPE are provided in EN 746-1:1997+A1:2009 (see Introduction).

This part of the EN 746 series deals with significant hazards, hazardous situations and events relevant to the generation and use of protective and reactive atmosphere gases created by thermochemical reactions and their use in TPE that are part of TPE as listed in Clause 4 and Clause 5, when used as intended and under the conditions foreseen by the manufacturer.

This part of the EN 746 series covers:

— pipework downstream of and including the manual isolating valve,

— equipment for the generation of atmosphere gases,

— additional equipment for the use of atmosphere gases in TPE,

— safety devices, and

— functional requirements for safety related control system

for the generation and use of protective and reactive atmosphere gases.

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It applies to the supply of atmosphere gas, source gas, inert gas and process liquids to TPE and their removal from TPE, confined to equipment integrated in the TPE.

This part of the EN 746 series also details the anticipated significant hazards associated with atmosphere gas systems and their use in TPE and specifies the appropriate preventative measures for the reduction or elimination of these hazards.

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The pressure hazard of the piping and components covered by this standard is within the maximum pressure/size relationship of group 1 as described in Annex C.

This part of the EN 746 series:

— specifies the requirements to be met to ensure the safety of persons and property during installation, commissioning, start up, operation, shutdown and maintenance,

— does not cover the relevant risks involved in the flue gas ducting system when it is not considered a part of TPE,

— is not applicable to utility supply upstream of the TPE main disconnects,

— does not apply to TPE for semi-conductor devices,

— does not apply to TPE with atmosphere, such as air and flue gas from an over stoichiometric combustion,

— does not cover the decommissioning of the TPE,

— does not cover vacuum furnaces,

— does not cover blast furnaces, converters (in steel plants), boilers and equipment not covered under EN ISO 12100:2010.

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— does not deal with the hazard of noise which is covered in EN 746-1:1997+A1:2009,

— is not applicable to generation and use of atmosphere gas in TPE and associated plant which is manufactured before the date of its publication, and

— gives the necessary requirements for the information for use.

A TPE designed according to this part of EN 746 series does not create any potentially explosive atmosphere in the area around the TPE and is not designed to be located in an area with a potentially explosive or hazardous atmosphere.

This part of the EN 746 series deals with significant hazards which are described in Annex A.

A table of typical protective and reactive gases is given in Annex B.

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 7-1:1994, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

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ISO 49:1994, *Malleable cast iron fittings threaded to ISO 7-1*

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EN 88-1:2011+A1:2016, *Pressure regulators and associated safety devices for gas appliances - Part 1: Pressure regulators for inlet pressures up to and including 50 kPa*

EN 88-2:2007, *Pressure regulators and associated safety devices for gas appliances - Part 2: Pressure regulators for inlet pressures above 500 mbar up to and including 5 bar*

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EN 161:2011+A3:2013, *Automatic shut-off valves for gas burners and gas appliances*

EN ISO 228-1:2003, *Pipe threads where pressure-tight joints are not made on the threads - Part 1: Dimensions, tolerances and designation (ISO 228-1:2000)*

EN 331:2015, *Manually operated ball valves and closed bottom taper plug valves for gas installations for buildings*

EN 334:2019, *Gas pressure regulators for inlet pressure up to 10 MPa (100 bar)*

EN 746-1:1997+A1:2009, *Industrial thermoprocessing equipment - Part 1: Common safety requirements for industrial thermoprocessing equipment*

EN 746-2:2010, *Industrial thermoprocessing equipment - Part 2: Safety requirements for combustion and fuel handling systems*

EN 751-1:1996, *Sealing materials for metallic threaded joints in contact with 1st, 2nd and 3rd family gases and hot water - Part 1: Anaerobic jointing compounds*

EN 751-2:1996, *Sealing materials for metallic threaded joints in contact with 1st, 2nd and 3rd family gases and hot water - Part 2: Non-hardening jointing compounds*

EN 1643:2014, *Safety and control devices for gas burners and gas burning appliances - Valve proving systems for automatic shut-off valves*

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EN 1854:2010, *Pressure sensing devices for gas burners and gas burning appliances*

EN 10241:2000, *Steel threaded pipe fittings*

EN 10242:1994,[1] *Threaded pipe fittings in malleable cast iron*

EN ISO 5817:2014, *Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections (ISO 5817:2014)*

ISO 7005-1:2011, *Pipe flanges — Part 1: Steel flanges for industrial and general service piping systems*

ISO 7005-2:1988, *Metallic flanges — Part 2: Cast iron flanges*

EN ISO 8434-1:2018, *Metallic tube connections for fluid power and general use - Part 1: 24° cone connectors (ISO 8434-1:2018, Corrected version 2018-10)*

ISO 8434-2:2007, *Metallic tube connections for fluid power and general use — Part 2: 37 degree flared connectors*

ISO 8434-3:2005, *Metallic tube connections for fluid power and general use — Part 3: O-ring face seal connectors*

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EN ISO 10352:2020, *Fibre-reinforced plastics - Moulding compounds and prepregs - Determination of mass per unit area and fibre mass per unit area (ISO 10352:2020)*

EN ISO 12100:2010, *Safety of machinery - General principles for design - Risk assessment and risk reduction (ISO 12100:2010)*

EN 14382:2019, *Gas safety shut-off devices for inlet pressure up to 10 MPa (100 bar)*

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ISO 13574:2015, *Industrial furnaces and associated processing equipment — Vocabulary*

ISO 13577-4:2014, *Industrial furnace and associated processing equipment — Safety — Part 4: Protective systems*

EN ISO 13849-1:2015, *Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2015)*

EN ISO 19879:2021, *Metallic tube connections for fluid power and general use - Test methods for hydraulic fluid power connections (ISO 19879:2021)*

EN 60204-1:2018, *Safety of machinery - Electrical equipment of machines - Part 1: General requirements*

EN 60730-2-5:2015, *Automatic electrical controls - Part 2-5: Particular requirements for automatic electrical burner control systems*

EN 61508-1:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements*

[1] This document is impacted by the amendments EN 10242:1994/A1:1999 and EN 10242:1994/A2:2003.

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EN 61508-2:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems*

EN 61508-3:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 3: Software requirements*

EN 61508-4:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 4: Definitions and abbreviations*

EN 61508-5:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 5: Examples of methods for the determination of safety integrity levels*

EN 61508-6:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3*

EN 61508-7:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 7: Overview of techniques and measures*

EN 61511-1:2017, *Functional safety - Safety instrumented systems for the process industry sector - Part 1: Framework, definitions, system, hardware and application programming Requirements*

EN 61511-1:2017/A1:2017, *Functional safety - Safety instrumented systems for the process industry sector - Part 1: Framework, definitions, system, hardware and application programming Requirements*

EN 61511-2:2017, *Functional safety - Safety instrumented systems for the process industry sector - Part 2: Guidelines for the application of IEC 61511-1*

EN 61511-3:2017, *Functional safety - Safety instrumented systems for the process industry sector - Part 3: Guidance for the determination of the required safety integrity levels*

EN 62061:2005,[2] *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems (IEC 62061:2005)*

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3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13574:2015 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

NOTE See Annex G for the list of terms specified in ISO 13574:2015.

[2] This document is impacted by the amendments EN 62061:2005/A1:2013 and EN 62061:2005/A2:2015.

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3.1
safety shutdown
function that takes the TPE out of operation and brings it in a defined safe state

Note 1 to entry: The definition is different from safety shutdown according ISO 13574:2015, 2.166 which is applicable to ISO 13577-2:2014 and EN 746-2:2010.

3.2
flame failure
loss of flame from the normally detected position by any cause other than the action of de-energising the automatic shut-off valves system

Note 1 to entry: The term is used in ISO 13577-2 and EN 746-2:2010.

3.3
gas generator
equipment that converts or modifies a fluid or a mixture of fluids (gaseous or liquid) into a gas which can be utilized as the controlled atmosphere within the thermo-processing equipment

3.4
endothermic generator
gas generator that produces atmosphere gas by an endothermic reaction

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3.5
exothermic generator
gas generator that produces atmosphere gas by an exothermic reaction

3.6
combustible atmosphere gas
any gas mixture that is capable of forming ignitable mixtures with air or oxygen under the conditions of temperature and pressure used in the process, according to the lower explosion level (LEL) of the actual gas mixture

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3.7
inert gas
non-combustible gas which will not support combustion and does not react at all

Note 1 to entry: Nitrogen, helium and argon are typical inert gases.

3.8
purge gas
gas which can be used to purge a TPE

Note 1 to entry: A purge gas can safely be used for pre- and post-purging of cold and hot enclosures of TPE.

Note 2 to entry: Typically, purge gases are nitrogen, argon, helium and lean exothermic gas.

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3.9
safety purge volume
volume of purge gas needed to displace either air or a combustible gas from a furnace chamber/enclosure to achieve a volume fraction of 1 % or less oxygen and/or a non-combustible atmosphere gas and/or 25 % of the lower flammability limit

Note 1 to entry: Typically, this will be a volume equal to five times the volume of the thermo-processing equipment chamber to be purged, if the purging gas is an inert gas.

Note 2 to entry: Non-combustible atmosphere gas as defined in 3.6.

3.10
multi-turn valve
valve which, in order to operate from the fully closed to the fully open position, requires a number of revolutions of the operating key or handwheel to be completed

3.11
safe ignition temperature
<MAC> minimum temperature at which spontaneous, safe auto-ignition of combustible gases occurs

Note 1 to entry: The safe ignition temperature has been established at 750 °C.

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3.12
toxic atmosphere gas
gas which, in addition to having asphyxiating properties, also acts as a poison

3.13
internal gas generator
gas generator integrated into or directly connected to a TPE

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3.14
gas control equipment
centralized mounting of components such as: pipework, safety components, pressure and flow accessories, assembled in a functional unit

3.15
atmosphere gas
gas that is supplied into or formed in TPE in accordance with a defined specification for thermo-processes

Note 1 to entry: Atmosphere gas is used to react with the material processed or to avoid a reaction with the material processed.

3.16
process liquids
liquids that are supplied to TPE to create an atmosphere gas

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4 Safety requirements and/or protective/risk reduction measures

4.1 General

Protective and reactive atmosphere gases in TPE are used to react with the material processed or to avoid a reaction with the material processed. Protective and reactive atmosphere gases are fed into the TPE at determined points and are discharged out of the TPE at determined points too.

Protective and reactive atmosphere gases shall only be used in TPE that has been constructed to avoid leakage of the protective and reactive atmosphere gases out of the TPE or ambient air into the TPE.

Machinery shall comply with the safety requirements and/or protective/risk reduction measures of this clause. In addition, the machine shall be designed according to the principles of EN ISO 12100:2010 for relevant but not significant hazards which are not dealt with by this document.

Electrical circuits shall be designed in accordance with EN 60204-1:2018.

A risk assessment according to EN ISO 12100:2010 shall be carried out. Safety functions shall be designed in accordance with ISO 13577-4:2014, where the use of standards for functional safety EN 62061:2005, EN ISO 13849-1:2015, EN 61511-1:2017, EN 61511-1:2017/A1:2017, EN 61511-2:2017, EN 61511-3:2017, EN 61508-1:2010, EN 61508-2:2010, EN 61508-3:2010, EN 61508-4:2010, EN 61508-5:2010, EN 61508-6:2010 and EN 61508-7:2010 is included. Annex E provides information for the determination of the SIL or PL of safety-related functions covered in this part of EN 746 series.

CAUTION — Toxic hazards for persons occur at lower concentrations than hazards by generation of ignitable atmospheres.

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NOTE Requirements for maximum allowable concentrations values are identified by national regulations.

The choice of materials shall consider the specific properties of the engaged gas and liquids (e.g. non-ferrous metals are not suitable for NH_3 and natural rubber is not suitable for natural gas).

For basic configuration of piping system of TPE using atmosphere gas, see Annex F.

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4.2 Pipework

4.2.1 General

The pipework design shall take into account the composition and properties (e.g. pressure, temperature, corrosiveness, specific gravity, velocity) of gas and liquids and the need for venting, purging and cleaning.

Due to durability, steel is the preferred material for pipes and components but where appropriate and the same safety levels can be achieved, then other materials may be utilized. Such materials and conditions of service shall be specified in the instruction handbook.

Oscillations which may cause damage to pipework, components or safety systems shall be prevented (by firm anchoring and/or use of flexible couplings).

Pipework shall be arranged so that safe isolation of atmosphere gas and process liquids to all parts of the TPE can be guaranteed

NOTE An example is shown in Figure F.1.

The isolation method shall be clearly identified (e.g. by removable spool piece painted in red, blanking plate), and provision for blanking opened pipes shall be provided secured against loss (e.g. by an attached chain).