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Industrial furnaces and associated processing equipment — Safety —

Part 2: Combustion and fuel handling systems

Fours industriels et équipements associés — Sécurité —

Partie 2: Équipement de combustion et de manutention des combustibles

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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 meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 244, *Industrial furnaces and associated processing equipment*.

ISO 13577 consists of the following parts, under the general title *Industrial furnaces and associated processing equipment — Safety*:

— *Part 1: General requirements*

— *Part 2: Combustion and fuel handling systems*

— *Part 3: Generation and use of protective and reactive atmosphere gases*

— *Part 4: Protective systems*

Introduction

This document is a type-C standard as defined in ISO 12100.

The machinery concerned and the extent to which hazards, hazardous situations or hazardous events are covered, is 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 -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.

This part of ISO 13577 assumes that the equipment is not creating any potentially explosive atmosphere and is located in a normally ventilated area.

Compliance with product standards e.g. ISO 22967 or ISO 22968 is not sufficient to ensure the minimum safety requirements for industrial furnaces and associated processing equipment (TPE). This part of ISO 13577 shall always have priority for TPE.

Industrial furnaces and associated 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.

ISO 13577-1 provides the general safety requirements common to TPE. This part of ISO 13577 details in addition specific safety requirements for combustion and fuel handling systems that are part of TPE as listed in the Scope.

NOTE As stated in its scope, ISO 13577-1 does not cover blast furnaces, converters (in steel plants), boilers and equipment not covered by ISO 12100.

The requirements for protective systems are specified in ISO 13577-4.

If a general requirement of ISO 13577-1 counters requirements in this part of ISO 13577, the requirements of this part of ISO 13577 take precedence.

The requirements for reducing hazards from noise are given in ISO 13577-1.

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

Industrial furnaces and associated processing equipment — Safety —

Part 2: Combustion and fuel handling systems

1 Scope

This part of ISO 13577 specifies the safety requirements for combustion and fuel handling systems that are part of industrial furnaces and associated processing equipment (TPE).

NOTE The general safety requirements common to TPE are provided in ISO 13577-1 (See introduction).

This part of ISO 13577 deals with significant hazards, hazardous situations and events relevant to combustion and fuel handling systems as listed in Annex A, when used as intended and under the conditions foreseen by the manufacturer.

This part of ISO 13577 covers:

— fuel pipework downstream of and including the manual isolating valve;

— combustion air supply (including oxygen and oxygen enriched combustion air) and flue gas system;

— burner(s), burner system and ignition device;

— functional requirements for safety related control system.

This part of ISO 13577 applies to any oxidation with air or other gases containing free oxygen of gaseous and liquid fuels or any combustion of them to release thermal energy in TPE.

For thermal or catalytic post combustion and waste incineration, this part of ISO 13577 applies only to auxiliary burners designed to start-up and/or support the process.

The pressure hazard of the piping and components covered by this part of ISO 13577 is within the maximum pressure/size relationship of category I as described in normative Annex E.

This part of ISO 13577 also gives the necessary requirements regarding information for use.

This part of ISO 13577 does not cover hazards from heating generated by electricity.

This part of ISO 13577 does not deal with the hazards created by the release of flammable substances from the products processed in the TPE.

This part of ISO 13577 is not applicable to combustion and fuel handling systems:

— of welding machines;

— up-stream of the TPE manual isolating valve.

This part of ISO 13577 is not applicable to electrical cabling and power cabling upstream of the TPE control panel/protective system.

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.

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

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

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

ISO 5817:2003, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections*

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*

ISO 7005-3:1988, *Metallic flanges — Part 3: Copper alloy and composite flanges*

ISO 8434-1:2007, *Metallic tube connections for fluid power and general use — Part 1: 24° cone connectors*

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

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

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

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

ISO 13577-1, *Industrial furnaces and associated processing equipment — Safety — Part 1: General requirements*

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

ISO 19879:2010, *Metallic tube connections for fluid power and general use — Test methods for hydraulic fluid power connections*

ISO 23551-1:2012, *Safety and control devices for gas burners and gas-burning appliances — Particular requirements — Part 1: Automatic and semi-automatic valves*

ISO 23551-2:2006, *Safety and control devices for gas burners and gas-burning appliances — Particular requirements — Part 2: Pressure regulators*

ISO 23551-3:2005, *Safety and control devices for gas burners and gas-burning appliances — Particular requirements — Part 3: Gas/air ratio controls, pneumatic type*

ISO 23552-1:2007, *Safety and control devices for gas and/or oil burners and gas and/or oil appliances — Particular requirements — Part 1: Fuel/air ratio controls, electronic type*

ISO 23553-1:2007, *Safety and control devices for oil burners and oil-burning appliances — Particular requirements — Part 1: Shut-off devices for oil burners*

IEC 60204-1:2005, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 60730-2-5:2009, *Automatic electrical controls for household and similar use — Part 2-5: Particular requirements for automatic electrical burner control systems*

IEC 60730-2-6:2007, *Automatic electrical controls for household and similar use — Part 2-6: Particular requirements for automatic electrical pressure sensing controls including mechanical requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13574 apply.

4 Safety requirements, measures and verification means

4.1 General

The safety goals of this part of ISO 13577 shall include:

— choice of materials such that the construction and operation of the system are not detrimentally affected. In particular, all the components of the fuel pipework shall be capable of withstanding the mechanical, chemical and thermal loads to which they can be subjected during normal operation and foreseeable abnormal operation (e.g. identified during a safety assessment);

— reliable and correct time for ignition of the air/fuel-mixture at the burner(s);

— prevention of unintentional release of unburned fuels;

— shut-off fuel-supply in case of relevant fault;

— protection of pipeline to preclude the propagation of flame in reverse direction;

— prevent firing when the evacuation of flue gas/combustion products is not ensured;

— prevent firing when the process conditions are not in the safe state.

Electrical circuits shall be designed in accordance with IEC 60204-1.

A risk assessment according to ISO 12100 shall be carried out. Safety function shall be designed in accordance with ISO 13577-4, where the use of standards for functional safety IEC 62061, ISO 13849 (all parts), IEC 61511 (all parts) and IEC 61508 (all parts) is included. Informative Annex F provides information for the determination of the SIL or PL of safety-related functions covered in this part of ISO 13577.

Specific regional requirements are given in Annex G, Annex H and Annex I. The safety requirements of these annexes shall ensure at least the equivalent level of safety to the requirements given in this part of ISO 13577.

4.2 Gaseous fuels

4.2.1 Gas pipework

4.2.1.1 General

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

The pipework material shall comply with the relevant standards.

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).

4.2.1.2 Connections

Gas pipework connections shall be metallic and shall be of threaded, compression, flanged, welded or brazed types. The number of connections shall be kept to a minimum.

Threaded connections shall be used only for the following pressure/diameter combinations:

— pressures up to 15 kPa, and diameters up to DN 100

— pressures up to 200 kPa, and diameters up to DN 50

— pressures up to 500 kPa, and diameters up to DN 25

— pressures up to 1 MPa, and diameters up to DN 15

For fittings according to ISO 49, the following limitations shall be observed:

— fittings must be class “A”;

— maximum allowed pressure is 50 kPa;

— for dimensions DN 25 or less, the maximum pressure is 500 kPa.

Where the equipment has a threaded connection, this thread shall comply with ISO 228-1 or ISO 7-1 as appropriate. The use of threads complying with ISO 228-1 is limited to diameter up to DN 50. In case of threads according to ISO 228-1, the tightness shall be ensured by a ring gasket. In case of threads according to ISO 7-1 suitable sealants shall be used to ensure tightness. Hemp shall not be used in threaded connections unless reinforced with a suitable sealant.

Other threaded connections may only be used providing they ensure tight connections and are suitably identified.

The design of pipework shall be such as to avoid tensile loading of the joints.

Compression fittings shall comply with ISO 8434-1, ISO 8434–2 and ISO 8434–3 or ISO 19879. They shall only be used for pressures up to 500 kPa and diameters up to 42 mm.

Any pipe passing through an unventilated space shall not have a connection except welded joints.

Flanges shall comply with ISO 7005-1 and ISO 7005-2 as appropriate.

Arc welding shall comply with ISO 5817, quality level C.

4.2.1.3 Unconnected pipework

Any unconnected pipework shall be plugged, capped or blank flanged by means of metallic parts.

4.2.1.4 Galvanic cells

The formation of galvanic cells shall be avoided by suitable choice of materials.

4.2.1.5 Flexible tubing and couplings

Flexible tubing shall comply with the general requirements of 4.2.1.1, together with the following:

— shall be as short as practicable;

— shall be suitable for the maximum and minimum working (fuel and ambient) temperatures;

— shall be suitable for a pressure 1,5 times the working operating pressure (with a minimum of 15 kPa), at the maximum and minimum working temperatures;

— shall have a directly accessible, upstream manual shut-off valve;

— shall be mounted in such a way as to avoid distortion, whiplash and damage;

— shall have end fittings as integral parts of the tubing;

— shall be constructed from suitable material both metallic and/or non-metallic selected for the application duty and not be easily damaged.

Couplings for removable equipment shall ensure a gastight connection with the equipment connected and disconnected.

4.2.1.6 Marking

The pipework shall be identified as gas pipework.

NOTE Identification of gas pipework is dealt with by national regulations.

4.2.1.7 Soundness/tightness

The gas pipework shall be tight and shall be designed to withstand the internal pressure. After assembly, the gas pipework shall be submitted to its test pressure and tested for tightness. The test pressure shall be not less than 1,1 times the maximum working pressure at any point with a minimum of 5 kPa.

The external leakage rate shall not give rise to a dangerous condition, flammable and/or toxic, in the foreseen circumstances of the equipment installation. The frequency of testing to determine the external leakage shall be specified in the instruction handbook.

NOTE It is generally agreed that an external leak rate of ≈ 1 dm^3(n)/h will not give rise to a dangerous condition in typical ventilated industrial installations. The actual leak rate will depend upon the volume, number of connections, test gas, number of valves and component parts contained.

The external leak rate test method shall take into account the volume, number of connections, test gas, number of valves and component parts contained and temperature. Methods of testing shall include spray bubble leak identification and/or pressure decay test.

4.2.1.8 Condensate drains

In cases where condensates can create a hazard, means shall be provided at the lowest points of the equipment for draining any condensate. When moist gases are being used, condensate drains of a suitable type shall be installed. Any condensate drains, siphons, etc. shall be in a position such that they can be easily checked. Flammable condensates shall be collected by an appropriate means (e.g. piped into a container).

Valves in condensate drains shall be suitably plugged, capped or blank flanged by metallic parts.

4.2.1.9 Purge points

Means shall be provided to facilitate purging of the gas system during commissioning and maintenance to prevent the build-up of flammable substances.

4.2.1.10 Blow-off and breather pipes or conduits

Where blow-off or breather pipes or conduits are fitted on regulators or relief valves or vent valves, adequate means shall be provided to facilitate the venting of gas from the system to a safe discharge area.

In case breathers or blow-off pipes are gathered, the cross section of the collector shall be suitable to evacuate simultaneously total flow rates of the exhaust sources.

In case breathers are gathered with blow-off pipes, non-interaction of the collected lines, valves and instruments shall be verified.

4.2.1.11 Pressure relief devices and flame arrestors on pipework

For equipment designed for situations in which flashback can occur, flame arrestors and/or pressure relief devices shall be fitted.

Pressure relief devices shall be designed to yield at a pressure below the design pressure of the pipework and shall be positioned such that the discharge flow and the pressure relief device does not constitute a risk to the equipment, personnel or third parties.

A flashback at least shall trigger an alarm. The required measures after a flashback shall be described in the instruction handbook.

4.2.1.12 Pressure oscillations

The gas pipework shall be designed so as to avoid the possibility of gas velocities and pressure fluctuations causing oscillations which could cause damage to pipework, components or safety systems (e.g. by designing the correct sizing of pipe, using pressure regulator,).

4.2.1.13 Equipment supplied with different fuel gases

Where a burner is intended for alternating use with more than one gaseous fuel, means shall be provided to ensure that the supply pipework of the gas not being fired is positively isolated.

4.2.1.14 By-pass

By-passes shall not be fitted in parallel with any item of safety equipment.

This requirement shall not apply to valve proving systems (see ISO 23551-4) on automatic shut-off valves.

4.2.1.15 Isolation of required safety devices

Required safety devices (e.g. pressure switches, relief valves) shall not be isolated from the equipment they protect during start-up or operation of the burner. In case isolating valves cannot be avoided and are mounted between these required devices and the main lines, these isolating valves shall be locked in the open position during operation of the equipment by adequate means (e.g. manual lock).

4.2.2 Required safety devices

4.2.2.1 Manual isolating valve

A manually operated isolation valve shall be fitted upstream of the first control device in the gas circuit. Manual isolation valves shall be so designed or positioned as to prevent inadvertent operation but shall be easily accessible and capable of rapid operation when required.

They shall be so designed that the “OPEN” and “CLOSED” positions are readily distinguishable (e.g. a 90° turn valve if applicable and available).

4.2.2.2 Filter/strainer

Special care shall be taken to prevent the ingress of particles, either from the pipework or from the gas, which would be detrimental to the operation of the equipment by the incorporation of a suitable filter or strainer immediately downstream of the first manual isolating valve of the TPE. Additional filters/strainers may be required (e.g. immediately upstream of the automatic shut-off valve). The filter and/or the strainer shall be positioned in such a way that periodic servicing remains easy. The filtering capacity of the filter/strainer has to be chosen according to the requirements of downstream equipment.

NOTE Normally safety and control devices for gas burners and gas-burning appliances require upstream filters with filtering capacity ≤ 50 µm. Strainers with larger mesh size are only suitable for primary cleaning.

In case of the installation of a by-pass to the filter/strainer, an identical filtering device shall be installed on the by-pass line.

The intervals for checking the filter and/or the strainer shall be specified in the instruction handbook.

4.2.2.3 Gas pressure regulator

A gas pressure regulator shall be incorporated where this is necessary for control of the pressure and the flow rate.

Gas pressure regulators when fitted shall comply with ISO 23551-2 as appropriate.

If the outlet side of the gas pressure regulator and/or the following line section with equipment up to the burner is/are not designed for the maximum supply pressure (inlet pressure upstream to the gas pressure regulator under fault conditions) an over pressure cut-off device shall be installed upstream of the gas pressure regulator shutting off the gas supply before an excessively high pressure occurs.

The over pressure cut-off device shall be:

— a mechanical valve which measures the gas pressure downstream of the gas pressure regulator by means of an impulse line and closes by spring force in case the pressure exceeds the set response pressure, or

— an automatic shut-off valve according to ISO 23551-1 actuated by an overpressure detector installed downstream of the gas pressure regulator. The overpressure detector shall comply with IEC 60730-2-6 or be evaluated to ensure appropriate reaction time and accuracy. In this case, signal processing has to fulfil the requirements of a protective system according to ISO 13577-4.

A small capacity relief valve (token relief valve) shall always be applied downstream of the gas pressure regulator, if an over pressure cut-off device is installed to vent small leakages of the high pressure cut-off.

Pressure adjustment on the gas pressure regulator shall only be possible with a special tool provided for the task.

Where the gas for the pilot burner is taken from upstream of the gas pressure regulator to the main burner(s), the pilot burner shall be equipped with a separate gas pressure regulator.

4.2.2.4 Low gas protection

Low gas pressure protection shall be fitted. The low gas pressure protection device has to provide satisfactory and reliable proof of the pressure for all operation conditions.

The system shall prevent start-up or cause safety shut-down and lock-out in the event of pressure falling below a pre-determined value. This function shall meet a requirement of the protective system according to ISO 13577-4.

Gas pressure detectors shall comply with IEC 60730-2-6 or shall be evaluated to ensure appropriate reaction time and accuracy.

4.2.2.5 High gas protection

High gas pressure protection shall be fitted in all circumstances except when:

— the equipment supply pressure does not exceed 10 kPa, and

— regulator failure does not result in an unsafe start-gas rate being obtained.

Where high gas pressure protection is required, the system shall prevent start-up or cause safety shut-down and lock-out in the event of a pre-determined pressure being exceeded. This function shall meet the requirements of a protective system according to ISO 13577-4.

Gas pressure detectors shall comply with IEC 60730-2-6 or shall be evaluated to ensure appropriate reaction time and accuracy.

4.2.2.6 Automatic shut-off valves

The gas supply to each burner or group of burners shall be under the control of two automatic shut-off valves in series in the gas pipework in accordance with the following subclauses of ISO 23551-1:2012:

— for general requirements: subclause 7.1;

— for leak tightness: subclause 7.2;

— for durability: subclause 7.5;

— for the closing function: subclause 7.6.101;

— for the closing force: subclause 7.6.104;

— for the closing time: subclause 7.6.106.

The sealing force for automatic shut-off valves shall be equal to or greater than 15 kPa.

For natural draught burner with a controlled capacity below 70 kW the sealing force for automatic shut-off valves shall be at least 5 kPa.

The automatic shut-off valve shall endure the intended number of cycles in the TPE.

Valves construction and materials shall be suitable for the used gas composition.

Automatic shut-off valve shall be capable of withstanding all upstream pressures, backpressure and differential pressure under all process circumstances.

High cycling applications over 100 000 cycles/year, (e.g. pulse firing, regenerative burners) shall use only valves that are declared capable of the intended number of cycles and on/off cycling rate.

The instruction handbook shall specify the need to check automatic shut-off valves for correct operation, the procedure to be adopted and the intervals at which this should be carried out and the requirements for replacement. Means to permit the operator to determine when automatic shut-off valves require replacement shall be supplied.

NOTE It is commonly agreed that valves are to be tested annually unless longer testing intervals can be justified by the risk analysis.

All systems shall have the ability for manual leak testing of the automatic shut-off valve.

Control valves may be used as safety shut-off valves provided they are designed as both safety shut-off and modulation valves and tested for concurrent use.

The automatic shut-off valves shall not open or shall shut off the fuel to the burner when the limit of any safety condition is reached. In this case, the relevant automatic shut-off valves shall be de-energised by a protective system according to ISO 13577-4.

NOTE Examples for safety related conditions to be considered are (but not limited to): minimum and/or maximum gas flow, minimum and/or maximum gas pressure, minimum and/or maximum air flow, minimum and/or maximum air pressure, failure of power supply and/or other utilities (e.g. compressed air, steam), failure of heat transfer fluid, fume extraction malfunction, minimum and/or maximum operation temperature, minimum and/or maximum combustion chamber pressure, flame failure, failure of valve proving as referred in 4.2.2.7, incorrect air gas ratio as referred in 4.3.3.3.

It shall only be possible to manually reset (locally or remotely) the lock out of a closed automatic shut-off valve.

Flame failure or process control shut down shall cause the closing of two automatic shut-off valves piped in series except in the following cases where closing a single individual burner shut off valve is sufficient:

— in case of high-temperature equipment;

— in case of low-temperature equipment where the individual burner automatic shut-off valve is fitted with proof of closure according to ISO 23551-1, and the protective system closes an upstream automatic shut-off valve (header valve) if one of the individual burner valve is not proven closed by the prove of closure switch.

Flame failure or process control shut down of radiant tube burner system shall cause the closing of two automatic shut-off valves piped in series except in the following cases where the closing of a single individual burner shut off valve is sufficient:

— each radiant tube burner system is explosion resistance and the exhaust system dilutes the ignitable fuel-air-mixture from leaking gas valves inside the exhaust system below 25 % of the LFL.

For typical examples of piping and components see informative Annex C.

4.2.2.7 Valve proving

Automatic shut-off valves controlling capacities higher than 1 200 kW shall be proved closed at each start-up of the TPE. In case where the valve is not proved closed, the current start-up shall be stopped and the system shall go to lock-out. The valve proving procedure and the action after such failure shall be specified in the instruction handbook (e.g. replacement of valve).

NOTE It is generally agreed that a leak rate of the valve(s) below 0,1 % of the maximum gas flow into the combustion chamber during operation is considered as proved close valve. In case of preheated gas and/or oxygen or oxygen enriched combustion this value has to be readjusted accordingly.

For a TPE intended to be started up more than two times a year, the automatic shut-off valve(s) shall be proved closed by an automatic system.

Automatic valve proving shall fulfil the requirements of a protective system according to ISO 13577-4.

In multiple burner systems with two automatic shut-off valves for each burner, automatic testing does not have to prove each burner valve individually (see Figure C2b). The testing of the individual burner valves shall be specified in the instruction handbook.

4.2.2.8 Individual manual shut-off valves for burners

For burners which are independently ignited, each individual burner shall be fitted with a manual shut-off valve suitable for the type of gas.

However, if the installation of such a manual valve affects the mixing characteristics of mixing devices (e.g. venturi mixers), then the shut-off valve shall be installed upstream of any such device.

For multiple burners in which cross-ignition from burner to burner occurs by design, the complete group of burners shall be fitted with at least one manual shut-off valve.

4.2.3 Combustion air and air/fuel ratio

4.2.3.1 Combustion air system

The pipework design shall take into account the properties of combustion air (e.g. pressure, temperature).

The location of the combustion air intake shall be such as to prevent entry of impurities (e.g. dust) and flue products, unless provided for by the design (e.g. for reduction of emission of nitrogen oxides NO_x).

The ventilation of TPE shall be such as to allow an adequate supply of process air and combustion air to reach the burner(s) under all conditions.