



SLOVENSKI STANDARD
SIST EN 1539:2002
01-september-2002

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Dryers and ovens, in which flammable substances are released - Safety requirements

Trockner und Öfen, in denen brennbare Stoffe freigesetzt werden -
Sicherheitsanforderungen

Séchoirs et fours dans lesquels se dégagent des substances inflammables -
Prescriptions de sécurité

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EUROPEAN STANDARD

EN 1539

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Dryers and ovens, in which flammable substances are released - Safety requirements

Séchoirs et fours dans lesquels se dégagent des
substances inflammables - Prescriptions de sécurité

Trockner und Öfen, in denen brennbare Stoffe freigesetzt
werden - Sicherheitsanforderungen

This European Standard was approved by CEN on 16 April 1999.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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FOREWORD

This European Standard has been prepared by Technical Committee CEN/TC 271 "Surface treatment equipment - 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of an identical text or by endorsement, at the latest by July 2000, and conflicting national standards shall be withdrawn at the latest by July 2000.

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

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

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

The following TCs participated in this joint-working group:

TC 186 Thermoprocessing equipment,
TC 198 Printing and paper machinery,
TC 200 Tannery machines,
TC 202 Foundry machinery.

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0 INTRODUCTION

This standard is a type C standard as defined in EN 1070.

The machinery concerned and the extent to which hazards are covered are indicated in the scope of this standard.

1 SCOPE

This standard deals with all significant hazards relevant to dryers and ovens, in which flammable substances are released, when they are used as intended and under the conditions foreseen by the manufacturer (see clause 4).

1.1 This standard is applicable to dryers, ovens and other evaporating equipment used in the pre-treatment, printing, coating and/or impregnating processes of surfaces and/or materials.

This standard gives the requirements for the design of such equipment which in the course of drying and/or curing release flammable substances, predominantly volatile organic compounds (V.O.C's).

This standard details all anticipated significant hazards associated with the equipment (listed in clause 4) and specifies the appropriate safety requirements (listed in clause 5) to be met by the manufacturer to ensure the safety of persons and property during commissioning, start-up, operation, shut-down and maintenance.

1.2 This standard is not applicable to

- portable heaters used for drying,
- pharmaceutical and food drying processes,
- combined booths (see prEN 13355),
- solvent recovery systems.

1.3 For dryers, ovens and other evaporating equipment which do not in any circumstances have a concentration of flammable substances (VOC) exceeding 3 % LEL compliance with EN 746-1 and EN 746-2 can be used as an alternative to this standard.

1.4 This standard applies to dryers, ovens and other evaporating equipment in which flammable substances are released, which are manufactured after the date of issue of this standard.

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2 NORMATIVE REFERENCES

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

2.1 Basic standards (A-type standards)

EN 292-1:1991	Safety of machinery - Basic concepts, general principles for design - Part 1: Basic terminology, methodology
EN 292-2:1991+A1:1995	Safety of machinery - Basic concepts, general principles for design - Part 2: Technical principles and specifications
EN 1050	Safety of machinery - Principles for risk assessment
EN 1070	Safety of machinery - Terminology
EN 1127-1:1997	Explosive atmospheres - Explosion prevention and protection - Part 1: Basic concepts and methodology

2.2 Group safety standards (B-type standards)

EN 349	Safety of machinery - Minimum gaps to avoid crushing of parts of the human body
EN 418	Safety of machinery - Emergency stop equipment, functional aspects - Principles for design
EN 563	Safety of machinery - Temperatures of touchable surfaces - Ergonomics data to establish temperature limit values for hot surfaces
EN 574	Safety of machinery - Two-hand control devices - Functional aspects - Principles for design
EN 626-1	Safety of machinery - Reduction of risks to health from hazardous substances emitted by machinery - Part 1: Principles and specifications for machinery manufacturers
EN 953	Safety of machinery - Guards - General requirements for the design and construction of fixed and movable guards
EN 954-1:1996	Safety of machinery - Safety related parts of control systems Part 1: General principles for design
CR 954-100 Revision 3	Safety of machinery - Safety related parts of control systems - Part 100: Guide on the use and application of EN 954-1:1996
EN 981	Safety of machinery - System of auditory and visual danger and information systems
EN 982	Safety of machinery - Safety requirements for fluid power systems and components - Hydraulics
EN 983	Safety of machinery - Safety requirements for fluid power systems and their components - Pneumatics
EN 1037	Safety of machinery - Prevention of unexpected start-up

2.3 Product safety standards (C-type standards)

EN 746-1	1997	Industrial thermoprocessing equipment - Part 1: Common safety requirements for industrial thermoprocessing equipment
EN 746-2	1997	Industrial thermoprocessing equipment - Part 2: Safety requirements for combustion and fuel handling systems

prEN 1010	Technical safety requirements for the design and construction of printing and paper converting machines - Part 1: Common requirements
EN ISO 11546-1	Acoustics - Determination of sound insulation performances of enclosures - Part 1: Measurements under laboratory conditions (for declaration purposes)
EN ISO 11688-1	Acoustics - Recommended practice for the design of low-noise machinery and equipment - Part 1: Planning
EN ISO 11821	Acoustics - Measurement of the in situ sound attenuation of a removable screen
prEN 50073	Guide for the selection, installation, use and maintenance of apparatus for the detection and measurement of combustible gases
IEC 60405	Nuclear instruments: Constructional requirements to afford personal protection against ionizing radiation
IEC 60519-1	Safety in electroheat installations - Part 1: General requirements
IEC 60519-6	Safety in electroheat installations - Part 6: Specifications for safety in industrial microwave heating equipment
IEC 60519-7	Safety in electroheat installations - Part 7: Particular requirements for installations with electron guns
IEC 61508-1	Functional safety of electrical/electronic/programmable electronic – safety related systems - Part 1: General requirements

2.4 Safety standards – electrical

EN 50054	Electrical apparatus for the detection and measurement of combustible gases - General requirements and test methods
EN 50057	Electrical apparatus for the detection and measurement of combustible gases - Performance requirements for group II apparatus indicating up to 100 % lower explosive limit.
EN 50104	Electrical apparatus for the detection and measurement of oxygen - Performance requirements and test methods
prEN 50154	Electrical installations in potentially explosive gas atmospheres (other than mines)
EN 60204-1	1997 Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN 60947-1	Low-voltage switchgear and controlgear - Part 1: General rules

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3 DEFINITIONS

For the purpose of this standard the definitions given in EN 1070 apply.

Additional definitions specifically needed for this standard are added below:

3.1 dryers, sometimes called ovens: Equipment in which drying and/or curing processes take place and flammable substances are released.

Dryers are forced ventilated and normally fitted with heating or other energy systems.

Other equipment, where evaporating takes place, such as flash-off zones and/or vestibules arranged before the dryer shall be considered in the same way as the dryer.

NOTE : The heat or other energy can be transmitted for example by:

- convection
- radiation (e.g. IR, UV, micro waves, electron beam)

or

- by a combination of both.

Both direct and indirect heating are employed utilising electrical devices or heat exchangers supplied with steam, hot water, hot oil or hot gases (produced by the combustion of gas or oil).

3.2 types of dryers

A. Dryers which operate by diluting the flammable substances below limit values dependent upon temperature and the safety devices fitted, which are given in the graphs of maximum admissible concentrations of flammable substances in annex A.

Type A-dryers will also be grouped as follows:

- i) Operation where temperatures exist in any part of the dryer coming into contact with the flammable substances are above the limiting temperature
- ii) Operation where temperatures exist in all parts of the dryer coming into contact with the flammable substances are below the limiting temperature.

B. Dryers which operate with an oxygen concentration insufficient to form hazardous explosive mixtures in any parts of the dryer and circulation system and exhaust.

C. Dryers of explosion-pressure-resistant design or explosion-pressure-shockresistant design.

NOTE: These are dryers which are so constructed that they can withstand an internal explosion of explosive mixtures without rupturing, see 6.5.2 of EN 1127-1:1997.

3.3 chamber dryers: Enclosures fitted with doors and charged in batch quantities.

NOTE: These dryers are relatively simple to operate and maintain. Conditions and knowledge of solvent loading, temperature, solvent vapour concentration and the degree of product dryness can vary considerably which increases the risk from hazards.

3.4 continuous flow dryers: Equipment containing tunnels or chambers and provided with openings through which the materials being processed can be introduced and removed (conveyed) continuously. Dryer section is a part of the dryer tunnel generally equipped with separate fresh air intake and exhaust, possibly with a recirculating system of its own.

3.5 drying: Evaporation of liquids from the materials being processed.

3.6 mould varnish drying: Process applied to mould coats with carrier liquids.

3.7 resin varnish drying: Process applied to materials impregnated with resin varnish.

NOTE (to 3.6 and 3.7): Mould varnishes (typical for coating casting moulds and cores), impregnated resin varnishes (typical for electrical devices, motor windings, etc.) and absorbent substrate materials (such as thick textiles, leather, special papers) have a longer drying time than surface coated materials because the solvents have to migrate further to the surface.

3.8 curing: Transformation of a liquid, paste or powder coating material into a finished solid material.

NOTE: Also known as gelling, through curing or through drying.

3.9 flammable substances - predominantly volatile organic compounds (VOC)-: Can include gases, vapours, liquids, solids, or mixtures of these, able to undergo an exothermic reaction with air when ignited.

NOTE: Examples:

- Solvents, which are flammable or slow burning; see 3.11,
- most coating materials, see 3.10.

See 3.1 of EN 1127-1:1997.

3.10 coating materials: Products, in liquid or powder form, that when applied to a substrate form a film possessing protective, decorative and/or other specific properties.

NOTE: Typical coating materials in this context are paints, lacquers, varnishes, impregnating resin varnishes, paste fillers, filling materials, impregnating agents, water repellents, anti-noise agents, fire resisting agents, stains, burnishes including their solvents and diluents (thinners), and also powder coatings.

3.11 solvents (organic solvents): Single component or blended liquids, which will be evaporated during the process of drying.

NOTE: Examples of solvents are:

Aldehydes, alcohols, hydrocarbons, esters, ketones, mineral oils, as well as mixtures containing these substances.

Printing inks, varnishes, lacquers etc., used as coating materials containing such solvents.

Solvents are also used as cleaning or washing agents, and could enter the dryer.

3.12 drying temperature: Temperature at which the heating medium contacts the materials being processed.

3.13 maximum drying temperature: Maximum circulated heating medium (usually air) temperature which could be reached within the effective space of the dryer or the dryer section.

3.14 ignition temperature (of a combustible gas or of a combustible liquid): The lowest temperature of a heated wall as determined under specified test conditions, at which ignition of a combustible substance in the form of gas or vapour mixture with air will occur.

NOTE: See 3.31 of EN 1127-1:1997.

3.15 flammability temperature: The lowest temperature at which symptoms of combustion can be found on the coated or uncoated material.

NOTE: Flammability temperature of a material is a characteristic figure for which a continuous combustion could be stimulated under specified test conditions. It could be determined for combustible solid substances such as paper or similar base stock and their coating. Signs of combustion are flames, glowing or pyrogenic symptoms.

3.16 limiting temperature: The lower figure of either the flammability temperature (see 3.15) or 0,8 times the ignition temperature (see 3.14) of any combustible gas or vapour from any combustible liquid or solid used in the dryer.

NOTE: See 6.4.2 of EN 1127-1:1997.

3.17 lower explosion limit (LEL): Lower limit of the explosion range.

NOTE 1: "Explosion limit", "ignition limit" and "flammable limit" are equivalent. In accordance with international usage only the term "explosion limit" is used in this standard.
See 3.8 of EN 1127-1:1997.

NOTE2: Explosion limits are the limits of the explosion range. Explosion range is the range of concentration of a flammable substance within air, which an explosion can occur.
See 3.7 and 3.13 of EN 1127-1:1997.

3.18 explosive mixture: Mixture with air of combustible substances in the form of gases, vapours, mist or dust, in which after ignition has occurred, combustion spreads to the entire unburned mixture. Explosive atmosphere is an explosive mixture under atmospheric conditions, see 3.17 of EN 1127-1:1997.

3.19 hazardous explosive mixture: Explosive mixture which, if it explodes, causes damage.

3.20 normal operation (see also 5.2.2 a) of EN 292-1:1991) is the situation when the dryer performs the intended function within its design parameters.

NOTE: Minor releases of flammable material may be part of normal operation. For example, releases from seals which rely on wetting by fluid which is being pumped are considered to be minor releases. Failures (such as breakdown of pump seals, flange gaskets or releases of substances caused by accidents) which involve repair or shut-down are not considered to be part of normal operation.
See 3.34 of EN 1127-1:1997.

3.21 maximum admissible quantity of flammable substances: That which may be released per charge into chamber dryers corresponding to the minimum exhaust flow rate of the forced ventilation (see 3.27) and includes correction for drying temperature.

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3.22 minimum forced ventilation flow rate: Air throughflow achieved by fans or by other powered means which dilutes the released flammable substances within the dryer to the required concentration level.

3.23 maximum admissible throughput of flammable substances: That quantity which will be released in a continuous flow dryer per unit time corresponding to the minimum exhaust flow rate of the forced ventilation (see 3.22 and 3.27) corrected for drying temperature.

3.24 maximum admissible concentration of flammable substances: That concentration within the total space of the dryer, which shall not be exceeded.

3.25 total space: Net volume within the dryer which may contain released flammable substances. It includes all section(s) (either single or multiple) of the dryer's recirculation system(s) and ends at the outlet connection of the dryer housing to the external exhaust.

NOTE: The total space does not include any charged materials, supports, transport systems, thermal cleaning systems (incinerator), chimneys or other ducts, between ventilation sections or equipment which could adversely affect the values of calculations concerning essential safety requirements.

3.26 effective space: That part of the total space in which the material to be dried is charged or moved and includes the clearance space around the charge.

3.27 minimum exhaust flow rate: Temperature corrected air volume flow which corresponds to the maximum admissible quantity or throughput of flammable substances for all specified operating conditions (see 3.21 and 3.23).

NOTE: This minimum exhaust flow rate is equal to or greater than the minimum forced ventilation flow rate (see 3.22).

3.28 main vaporization time in chamber dryers: The period during which the major quantity of flammable substances have been released.

NOTE: See B.1.1.1 of annex B.

3.29 charged amount of flammable substances: Total amount introduced in a chamber dryer per charge during the drying process.

NOTE: It is normally determined by equating the applied quantity of coating to the content of flammable substances released from the coating, allowances being made for pre-drying losses (if any).

3.30 pre-drying loss: Reduction in the amount of releasable flammable substances due to drying by air before the coated material is charged into the dryer for thermal processing.

NOTE: See B.1.1.1. of annex B.

3.31 peak release rate: Maximum short-term release of flammable substances within the dryer (related to time).

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4 LIST OF SIGNIFICANT HAZARDS

4.1 General

This clause contains all the significant hazards, as far as they are dealt with in this standard, identified by risk assessment significant for this type of machinery and which require action to eliminate or reduce the risk.

The purpose of this clause is to describe the different types of hazards caused by the dryer, where flammable substances are released, and thus to help carrying out risk analysis, especially for

- risk assessment and
- the design of dryers.

NOTE: See EN 1050.

4.2 Mechanical hazards

4.2.1 Shearing, crushing and drawing-in hazards

Hazards caused, for example, by:

- actuators, hoisting devices (during charging the dryer, including charging mechanisms and conveyors on continuous flow dryers),
- fans (e.g. injuries caused by rundown fan wheel) and inlets for air,
- damper adjusters,
- moving parts of dryers (e.g. doors, gates, hoods, top and bottom boxes of continuous flow dryers).

4.2.2 Entrapment of operators in case of dryers which can be entered

4.2.3 Hazards by ejected parts

Hazards caused by ejected parts of the dryer (e.g. doors) or of the dryer's content (e.g. parts to be dried) due to an explosion within the dryer (see 4.7.2).

4.3 Electrical hazards

Electric shock (by direct and indirect contact).

This hazard may be caused for example by the use of unsuitable insulation for the electrical cables.

4.4 Thermal hazards

Burns and scalds, caused, for example, by:

- flame or explosions,
- radiation of heat sources,
- contact with hot surfaces of the dryer within the working and traffic area.

4.5 Hazards generated by noise

These hazards could be generated by noise emissions (e.g. by fans, high air speeds in air ducts and equipment, as well as excitation of resonant frequencies) and could impair the hearing ability and/or health of the user.

4.6 Hazards generated by radiation

Hazards caused, for example, by:

- burner flame (can cause eye damage, damage to sight),
- infra-red (IR), (visible) radiation and ultraviolet radiation (UV),
(can cause:
 - burning from flames, arcs, walls, materials.
 - excessive heat, UV eye and skin damage, damage to sight, eye and tissue damage).
- micro-wave (can cause body tissue and physiological organ damage).
- electron beam (can cause body tissue and organ damage).

4.7 Materials and substances processed, used, released or exhausted by dryers

4.7.1 Hazards resulting from contact with or inhalation of fluids, gases, vapours, mists, fumes and dusts, which are hazardous to health

Hazards caused, for example, by:

- solvents, varnishes, paints,
- powder coatings,
- emissions of products of combustion,
- emissions of asphyxiating and/or toxic gases.

4.7.2 Explosion hazards

Explosion hazards could occur if the lower explosion limit (LEL) of the released flammable substances is exceeded and if simultaneously an ignition source is available.

Examples of released flammable substances are:

- solvent vapours from the drying process,
- gases released from deposits,
- flammable combustion products derived from the heating medium,
- combustible heating gases,
- gases from fuels,
- controlled addition of solvents during automatic blanket washing and/or other operations,
- manually applied and therefore uncontrollable additions of solvents during blanket washing and/or other operations.

Here, especially peak concentrations occurring e.g. during blanket washing on web-fed rotary printing presses shall be observed.

Examples of sources of ignition are:

- hot surfaces (e.g. of heating systems, of electrical equipment),
- heating systems,
- sparks created by mechanically induced energy (e.g. fans, conveyors),
- electrostatic discharges,
- electrical sparks,
- welding and other heating sources used during maintenance and cleaning.

In addition, the preconditions for explosion hazards can occur as a result of external influences as well as faults in parts of the control system, see 4.8.3 .

4.7.3 Fire hazards

Fire hazards could occur from the ignition of released flammable substances possibly followed by a fire sustained by other combustible substances present in the dryer. Examples of combustible substances are:

- coating materials,
- objects to be coated/materials being processed,
- component parts of dryers,
- condensates,
- deposits,
- combustible heating fluids and gases.

(Ignition sources see 4.7.2).