SLOVENSKI STANDARD
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Vodocevni kotli in pomožne napeljave - 14. del: Zahteve za naprave dimnih plinov DENOX na tekoči amoniak in vodno raztopino amoniaka

Water-tube boilers and auxiliary installations - Part 14: Requirements for flue gas DENOX-systems using liquefied pressurized ammonia and ammonia water solution

Wasserrohrkessel und Anlagenkomponenten - Teil 14: Anforderungen an Rauchgas-DENOX-Anlagen die flüssiges Ammoniak und Ammoniakwasserlösung einsetzen

Chaudieres a tubes d'eau et installations auxilaires - Partie 14: Exigences pour les sytemes de dénitrification (DENOX) des fumées utilisant l'ammoniac liquéfié sous pression et l'ammoniaque liquide

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This European Standard was approved by CEN on 24 March 2004.

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COMITÉ EUROPÉEN DE NORMALISATION
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Contents

Foreword

This document (EN 12952-14:2004) has been prepared by Technical Committee CEN/TC 269 “Shell and water-tube boilers”, 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of an identical text or by endorsement, at the latest by December 2004, and conflicting national standards shall be withdrawn at the latest by December 2004.

This document 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 document.

The European Standard EN 12952 concerning water-tube boilers and auxiliary installations consists of the following parts:

— *Part 1: General*
— *Part 2: Materials for pressure parts of boilers and accessories*
— *Part 3: Design and calculation for pressure parts*
— *Part 4: In-service boiler life expectancy calculations*
— *Part 5: Workmanship and construction of pressure parts of the boiler*
— *Part 6: Inspection during construction, documentation and marking of pressure parts of the boiler*
— *Part 7: Requirements for equipment for the boiler*
— *Part 8: Requirements for firing systems for liquid and gaseous fuels for the boiler*
— *Part 9: Requirements for firing systems for pulverized solid fuels for the boiler*
— *Part 10: Requirements for safeguards against excessive pressure*
— *Part 11: Requirements for limiting devices of the boiler and accessories*
— *Part 12: Requirements for boiler feedwater and boiler water quality*
— *Part 13: Requirements for flue gas cleaning systems*
— *Part 14: Requirements for flue gas DENOX-systems using liquified pressurized ammonia and ammonia water solution*
— *Part 15: Acceptance tests*
— *Part 16: Requirements for grate and fluidized-bed firing systems for solid fuels for the boiler*

CR 12952-17: Water-tube boilers and auxiliary installations – Part 17: Guideline for the involvement of an inspection body independent of the manufacturer

Although these Parts may be obtained separately, it should be recognized that the parts are interdependent. As such, the design and manufacture of boilers requires the application of more than one Part in order for the requirements of the standard to be satisfactorily fulfilled.

NOTE Part 4 and 15 are not applicable during the design, construction and installation stages.

The annex A of this European Standard is informative.

This document includes a Bibliography.

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

1 Scope

This draft European Standard covers the safety requirements regarding the storage and use of:

— liquefied pressurized ammonia for steam boiler plants;

— liquid ammonia water solution for the reduction of NOx in the flue gas from boiler plants.

Annex A summarizes the operational aspects.

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 (including amendments).

EN 287-1, *Qualification test of welders — Fusion welding — Part 1: Steels.*

EN 764:1994, *Pressure equipment — Terminology and symbols — Pressure, temperature, volume.*

EN 764-7, *Pressure equipment —Part 7: Safety systems for unfired pressure equipment.*

EN 1011-1, *Welding — Recommendations for welding of metallic materials — Part 1: General guidance for arc welding.*

EN 1011-2, *Welding — Recommendations for welding of metallic materials — Part 2: Arc welding of ferritic steels.*

EN 1011-3, *Welding — Recommendations for welding of metallic materials — Part 3: Arc welding of stainless steels.*

EN 1043-1, *Destructive tests on welds in metallic materials — Hardness testing — Part 1: Hardness test on arc welded joints.*

EN 1043-2, *Destructive tests on welds in metallic materials — Hardness testing — Part 2: Micro hardness testing on welded joints.*

EN 1563, *Founding — Spheroidal graphite cast irons.*

EN 1712, *Non-destructive examination of welds — Ultrasonic examination of welded joints — Acceptance levels.*

EN 1713, *Non-destructive examination of welds — Ultrasonic examination — Characterization of indications in welds.*

EN 1714, *Non-destructive examination of welds — Ultrasonic examination of welded joints.*

EN 10002-1, *Metallic materials — Tensile testing — Part 1: Method of test at ambient temperature.*

EN 10025, *Hot rolled products of non-alloy structural steels — Technical delivery conditions*

EN 10028-3, *Flat products made of steels for pressure purposes — Part 3: Weldable fine grain steels, normalized.*

EN 10028-7, *Flat products made of steels for pressure purposes — Part 7: Stainless steels.*

EN 10204:1991, *Metallic products — Types of inspection documents.*

EN 10213-2, *Technical delivery conditions for steel castings for pressure purposes — Part 2: Steel grades for use at room temperature and elevated temperatures.*

EN 10216-1, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 1: Non-alloy steel tubes with specified room temperature properties.*

EN 10216-2, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 2: Non-alloy and alloy steel tubes with specified elevated temperature properties.*

EN 10216-3, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 3: Alloy fine grain steel tubes.*

EN 10217-1, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 1: Non-alloy steel tubes with specified room temperature properties.*

EN 10222-4, *Steel forgings for pressure purposes — Part 4: Weldable fine grain steels with high proof strength.*

EN 10228-3, *Non-destructive testing of steel forgings — Part 3: Ultrasonic testing of ferritic or martensitic steel forgings.*

EN 12266-1:2003, *Industrial valves — Testing of valves — Part 1: Pressure tests, test procedures and acceptance criteria — Mandatory requirements.*

EN 12952-2, *Water-tube boilers and auxiliary installations — Part 2: Materials for pressure parts of boilers and accessories.*

EN 12952-3:2001, *Water-tube boilers and auxiliary installations — Part 3: Design and calculation for pressure parts.*

EN 12952-5, *Water-tube boilers and auxiliary installations — Part 5: Workmanship and construction of pressure parts of the boiler.*

EN 13445-1:2002, *Unfired pressure vessels — Part 1: General.*

EN 13445-2, *Unfired pressure vessels — Part 2: Materials.*

EN 13445-3, *Unfired pressure vessels — Part 3: Design.*

EN 13445-4, *Unfired pressure vessels — Part 4: Fabrication.*

EN 13445-5, *Unfired pressure vessels — Part 5: Inspection and testing.*

EN 13480-3, *Metallic industrial piping — Part 3: Design and calculation.*

EN 20898-2, *Mechanical properties of fasteners — Part 2: Nuts with specified proof load values — Coarse thread (ISO 898-2:1992).*

prEN 50156-1, *Electrical equipment for furnaces and ancillary equipment — Part 1: Requirements for application design and installation.*

EN 60079-10, *Electrical apparatus for explosive gas atmospheres — Part 10: Classification of hazardous areas (IEC 60079-10:2002).*

EN ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs (ISO 898-1:1999).*

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

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 764:1994 and EN 13445-1:2002 and the following apply.

3.1
liquefied pressurized ammonia
ammonia under a pressure of 10 bar to 15 bar, waterfree, flammable and with a boiling point of – 33°C

3.2
liquid ammonia
solution of water, with more the 10 % up to a maximum of 33 % ammonia (used between 15 % and 25 %), flammable, boiling point 37 °C

4 Installations for the storage of liquefied pressurized ammonia

4.1 Plant design

Stress corrosion is a hazard associated with the storage of liquid ammonia.

If required, protection against external mechanical and thermal effects shall be provided which shall be suitable for the required installation site.

NOTE This may include requirements for irrigation and fire protection systems, see relevant national law in the country of installation.

4.2 Materials

4.2.1 Liquefied pressurized ammonia storage vessel

4.2.1.1 The requirements for materials give in EN 13445-2 shall apply.

4.2.1.2 Plates shall be of fine-grained steels of the basic series or low temperature series in accordance with EN 10028-3 up to a minimum value of yield stress at room temperature of 355 N/mm^2. Limit values for chemical composition and for the measured yield stress at room temperature shall be in accordance with the requirements of 4.2.1.7.

4.2.1.3 Seamless tubes shall be of either:

a) fine-grained steels of the basic series or low temperature series in accordance with EN 10216-3 up to a minimum value of yield stress at room temperature of 355 N/mm^2. Limit values for chemical composition and for the measured yield stress at room temperature shall be in accordance with the requirements of 4.2.1.7 or;

b) P195 test category 2 and P235 test category 2 in accordance with EN 10216-2.

4.2.1.4 Flanges shall be made from S235JRG2 or S235J2G3 in accordance with EN 10025. Austenitic steel flanges shall be in accordance with EN 10028-7.

4.2.1.5 Forgings (rings, hollow parts, bars) shall be of either:

a) fine-grained steels of the basic series in accordance with EN 10222-4 up to a minimum value of yield stress at room temperature of 355 N/mm^2. Limit values for chemical composition and the measured yield stress at room temperature in accordance with the requirements of 4.2.1.7 or;

b) S235JRG2 and S235J2G3 in accordance with EN 10025.

4.2.1.6 Welded attachments shall be made from either of the following steel grades:

a) fine-grained steels in accordance with 4.2.1.2 or;

b) S35JRG2 and S235J2G3 in accordance with EN 10025.

4.2.1.7 Additional requirements for fine-grained steels in accordance with EN 10028-3, EN 10222-4 and EN 10216-3:

a) in the ladle analysis the percent by mass of molybdenum shall not exceed 0,04 % and of vanadium shall not exceed 0,02 %;

b) for the steel types with a minimum yield stress of 355 N/mm^2 the chemical composition shall be such that in the normalized condition the measured yield stress at room temperature shall not exceed the value of 440 N/mm^2;

c) for hot formed ends made from plates, which meet the requirements of b) a measured yield stress at room temperature of up to 470 N/mm^2 shall be permitted. Values exceeding 470 N/mm^2 shall be permitted if it is proved by means of an additional normalized specimen taken from the end, that the requirements of b) regarding the yield stress are met.

4.2.1.8 The suitability for the intended purpose and the quality characteristics for other normalised carbon steels which are not listed in 4.2.1.2 to 4.2.1.6 shall be proven. In which case the following general requirements shall be met for ferritic steels:

a) the minimum value of the elongation (A) characterizing the grade of steel shall not be less than 22 % on transverse specimen;

b) the minimum value of impact energy obtained on a transverse specimen (mean value obtained from three Charpy-V-notch impact test specimens), characterizing the grade of steel, shall not be less than 21 J at – 20 °C for fine-grained steels, and shall not be less than 27 J at 20 °C for other steel grades;

c) the weldability shall be proved by the material manufacturer. Preheating, welding heat input and type of heat treatment shall be stated by the material manufacturer.

In cases where steel impact properties are limited to 27 J at + 20 °C, the design values stated in this standard take account of the risk of brittle fracture by reducing the maximum permissible load in line with the published literature ([2] to [6]). Alternatively, the design must limit the lowest scheduled operating temperature of the plant to +20 °C and preclude loadings likely to lead to brittle fracture, not limited to operating instructions to that effect.

4.2.1.9 Weld filler metals and welding consumables shall be to the requirements in accordance with 4.4.1.5.

4.2.1.10 Stabilized austenitic stainless steels and stainless steels with a carbon content ≤ 0,03 % in accordance with EN 10028-7 may also be used as cladding material for roll claddings.

4.2.1.11 Copper, copper alloys and nickel alloys which contain copper shall not be used.

4.2.1.12 The steels covered by 4.2.1.2 to 4.2.1.6 shall be tested in accordance with the relevant European Standards.

a) in the case of fine-grained steels in accordance with EN 10028-3, EN 10222-4 and EN 10216-3, the impact energy shall be tested;

b) the plates shall be subjected to ultrasonic testing in accordance with EN 1712, EN 1713 and EN 1714 as follows;

   — test grid ≤ 200 mm or in lines with a distance of ≤ 100 mm. Zones for longitudinal, circumferential and nozzle welds and for connection of support brackets and lifting lugs, on a width equal to plate thickness, but at least 50 mm;
   — plates for ends (heads) shall be subject to ultrasonic surface area testing, and the ends shall be subjected to ultrasonic edge zone testing;

c) forgings in accordance with 4.2.1.5 greater than DN 100 shall be subjected to ultrasonic testing in accordance with EN 10228-3;

d) products made from steels in accordance with 4.2.1.10 shall be tested in accordance with the requirements in accordance with EN 10028-7.

4.2.1.13 Material certificates for pressure bearing parts shall be in accordance with inspection certificate 3.1.B in accordance with EN 10204:1991. For materials in accordance with EN 10025 test report 2.2 in accordance with EN 10204:1991 shall be sufficient.

4.2.2 Plant components

4.2.2.1 The requirements given in EN 13445-2 shall apply.

4.2.2.2 Copper, copper alloys and nickel alloys which contain copper, shall not be used for ammonia-containing plant parts. This shall also apply to pressure parts which may come into contact with ammonia due to leakage or diffusion, e.g. stem nuts, control air lines. Lammellar-graphite cast iron shall not be used.

4.2.2.3 The following materials shall be used for ammonia-containing components:

a) for piping, seamless pipes made from P195GH, P235GH or P265GH in accordance with EN 10216-2;

— Piping components which are part of pressure vessels (ammonia storage vessels or evaporators) shall comply with test category 2 in accordance with EN 10216-2.

b) for flanges, S235JRG2 and S235J2G3 in accordance with EN 10025. Austenitic steel flanges shall be in accordance with EN 10028-7;

c) for forgings, S235JRG2 and S235J2G3 in accordance with EN 10025;

d) for welded attachments, S235JRG2 and S235J2G3 in accordance with EN 10025;

e) for bolts and nuts shall be in accordance with EN ISO 898-1 and EN 20898-2;

f) for casings of pumps and compressors, spheroidal graphite cast iron JS1024, 1025, 1014, 1015 in accordance with EN 1563 or cast steel GP240GH/GR in accordance with EN 10213-2;

g) for valves, unalloyed forging steels to c). For special valves not made from forged steels, cast steel may be used in accordance with f).

4.2.2.4 The suitability for the intended purpose and the quality characteristics for other normalized carbon steels which are not listed in 4.2.2.3 shall be proven in which case the following general requirements shall be met for ferritic steels:

a) the minimum value of the elongation (A) characterizing the grade of steel shall not be less than 22 % on transverse specimen;

b) the minimum value of the impact energy (means value obtained on three Charpy-V-notch specimens in transverse direction) characterising the grade of steel shall not be less than 27 J for steels at 20 °C;

c) the weldability shall be proved by the manufacturer. Preheating, welding heat input and type of heat treatment shall be stated by the manufacturer.

In cases where steel impact properties are limited to 27 J at + 20 °C, the design values stated in this standard take account of the risk of brittle fracture by reducing the maximum permissible load in line with the published literature ([2] to [6]). Alternatively, the design must limit the lowest scheduled operating temperature of the plant to +20 °C and preclude loadings likely to lead to brittle fracture, not limited to operating instructions to that effect.

4.2.2.5 Stabilized austenitic stainless steels and stainless steels with a carbon content ≤ 0,03 % to EN 10028-7 may also be used as cladding material for roll cladding.

4.2.2.6 For evaporators and other pressure vessels with volumes > 100 l, the requirements of 4.2.1 shall apply.

4.2.2.7 The suitability for the intended use and the quality characteristics for other materials not covered by 4.2.2.1 to 4.2.2.5 shall be proved.

4.2.2.8 The following testing of materials shall be done:

a) the steels to 4.2.2.3 shall be tested in accordance with the relevant European Standards mentioned there;

b) forgings in accordance with 4.2.2.3 c) and 4.2.2.3 g) greater than DN 100 shall be subjected to ultrasonic testing in accordance with EN 10228-3;

c) products made from steels to 4.2.2.5 shall be tested in accordance with EN 10028-7.

4.2.2.9 Material certificates for pressure bearing parts shall be in accordance with inspection certificate 3.1.B in accordance with EN 10204:1991. For materials in accordance with EN 10025 test report 2.2 in accordance with EN 10204:1991 shall be sufficient.

4.3 Design of storage vessel

4.3.1 When designing the vessels local material and filler metal accumulations as well as abrupt wall thickness transitions, i.e. local changes in stiffness, shall be avoided. If practicable, the welds shall be positioned in zones subject to lower stresses, i.e. neither in the direct vicinity of transitions due to change in dimension or cross-section nor at points of load application. Irrespective of the design requirements to contain the internal pressure the vessel dimensions shall be selected so that no welded-on reinforcing rings are required for the purpose of vessel stability.

4.3.2 All nozzle and other connections shall be arranged in the gas space.

All nozzles shall have a minimum nominal diameter of DN 50.

Two access openings shall be provided. These openings shall be arranged in the vicinity of the vessel ends, and shall have a minimum nominal diameter of DN 800.

Where a manhole ring (dome) is provided for access openings and pipe connections it shall be high enough to ensure that all flange connections are located beneath its upper edge. The manhole ring need not be connected to the pressure vessel by means of welds. It shall be designed so as to keep constraints at the vessel shell as low as possible.

4.3.3 All nozzles shall be fully welded over their circumference to the vessel wall. Nozzles with a nominal diameter of up to and including DN 100 may be set on by welding. Set on nozzles shall have their roots ground. The drilled edges in the vessel shall be rounded.

All nozzles with an inside diameter ≤ 120 mm shall be designed so as to make external ultrasonic examination possible if required, to examine for cracking in the nozzle weld on the inside of the vessel. Rings for reinforcement of openings shall not be permitted.

The reduced area shall be compensated by adequately dimensioning the wall thickness of the nozzles.

Welded attachments shall be fixed by double-vee butt or double fillet welds. Unwelded residual gaps shall not be permitted.

4.3.4 Welded connections are preferred to flanged connections. When flanged connections are incorporated flanges rated at PN 40 and provided with form-fit gaskets, shall be used.

4.3.5 All welded joints on the vessel shall be capable of being non-destructively examined. Prior to stress-relief heat treatment, the weld surfaces shall be dressed as follows:

a) vessel inside (wetted by ammonia):

   The longitudinal and circumferential welds shall be ground flush to the plate surface to make examinations possible. Inside nozzle welds and welds for attachments shall be ground notch-free to form smooth transitions.

b) vessel outside: