SLOVENSKI STANDARD
SIST EN 12392:2002

01-februar-2002

Aluminij in aluminijeve zlitine - Gnetne zlitine - Posebne zahteve za aluminijeve izdelke za izdelavo naprav, ki delajo pod tlakom

Aluminium and aluminium alloys - Wrought products - Special requirements for products intended for the production of pressure equipment

Aluminium und Aluminiumlegierungen - Kneterzeugnisse - Besondere Anforderungen an Erzeugnisse für die Fertigung von Druckgeräten

Aluminium et alliages d'aluminium - Produits corroyés - Exigences particulieres pour les produits destinés a la fabrication des appareils a pression

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Aluminium and aluminium alloys - Wrought products - Special requirements for products intended for the production of pressure equipment

Aluminium et alliages d'aluminium - Produits corroyés - Exigences particulières pour les produits destinés à la fabrication des appareils à pression

Aluminium und Aluminiumlegierungen - Kneterzeugnisse - Besondere Anforderungen an Erzeugnisse für die Fertigung von Druckgeräten

This European Standard was approved by CEN on 3 December 1999.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 132 "Aluminium and aluminium alloys", the secretariat of which is held by AFNOR.

Within its programme of work, Technical Committee CEN/TC 132 has entrusted CEN/TC 132/WG 7 "Sheets, strips and plates" to prepare the following standard:

EN 12392, *Aluminium and aluminium alloys – Wrought products – Special requirements for products intended for the production of pressure equipment*.

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of an identical text or by endorsement, at the latest by September 2000, and conflicting national standards shall be withdrawn at the latest by September 2000.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.

1 Scope

This European Standard specifies particular requirements and testing procedures applicable to wrought aluminium and aluminium alloys intended for the production of pressure equipment.

It includes :

— the products forms, grades and tempers of wrought aluminium and aluminium alloys which may be used for such application, together with their permissible working temperature range ;

— the technical conditions for inspection and delivery, mechanical property limits and tolerances on form and dimensions by reference to the applicable European Standards for wrought aluminium and aluminium alloys ;

— additional requirements specific to pressure vessel application.

It applies to hot-rolled or cold-rolled sheet, strip, plate and circle, extruded or extruded and cold drawn rod/bar and tube, extruded open and hollow sections, and forgings.

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.

EN 485-1, *Aluminium and aluminium alloys - Sheet, strip and plate - Part 1 : Technical conditions for inspection and delivery.*

EN 485-2, *Aluminium and aluminium alloys - Sheet, strip and plate - Part 2 : Mechanical properties.*

EN 485-3, *Aluminium and aluminium alloys - Sheet, strip and plate - Part 3 : Tolerances on shape and dimensions for hot-rolled products.*

EN 485-4, *Aluminium and aluminium alloys - Sheet, strip and plate - Part 4 : Tolerances on shape and dimensions for cold-rolled products.*

EN 586-1, *Aluminium and aluminium alloy - Forgings - Part 1 : Technical conditions for inspection and delivery.*

EN 586-2, *Aluminium and aluminium alloy - Forgings - Part 2 : Mechanical properties and additional property requirements.*

prEN 586-3 : 1996, *Aluminium and aluminium alloy - Forgings - Part 3 : Tolerances on dimensions and form.*

EN 754-1, *Aluminium and aluminium alloy - Cold drawn rod/bar and tube - Part 1 : Technical conditions for inspection and delivery.*

EN 754-2, *Aluminium and aluminium alloy - Cold drawn rod/bar and tube - Part 2 : Mechanical properties.*

EN 754-3, *Aluminium and aluminium alloy - Cold drawn rod/bar and tube - Part 3 : Round bars, tolerances on dimensions and form.*

EN 754-4, *Aluminium and aluminium alloy - Cold drawn rod/bar and tube - Part 4 : Square bars, tolerances on dimensions and form.*

EN 754-5, *Aluminium and aluminium alloy - Cold drawn rod/bar and tube - Part 5 : Rectangular bars, tolerances on dimensions and form.*

EN 754-6, *Aluminium and aluminium alloy - Cold drawn rod/bar and tube - Part 6 : Hexagonal bars, tolerances on dimensions and form.*

EN 754-7, *Aluminium and aluminium alloy - Cold drawn rod/bar and tube - Part 7 : Seamless tubes, tolerances on dimensions and form.*

EN 754-8, *Aluminium and aluminium alloy - Cold drawn rod/bar and tube - Part 8 : Porthole tubes, tolerances on dimensions and forms.*

EN 755-1, *Aluminium and aluminium alloy - Extruded rod/bar, tube and profiles - Part 1 : Technical conditions for inspection and delivery.*

EN 755-2, *Aluminium and aluminium alloy - Extruded rod/bar, tube and profiles - Part 2 : Mechanical properties.*

EN 755-3, *Aluminium and aluminium alloy - Extruded rod/bar, tube and profiles - Part 3 : Round bars, tolerances on dimensions and form.*

EN 755-4, *Aluminium and aluminium alloy - Extruded rod/bar, tube and profiles - Part 4 : Square bars, tolerances on dimensions and form.*

EN 755-5, *Aluminium and aluminium alloy - Extruded rod/bar, tube and profiles - Part 5 : Rectangular bars, tolerances on dimensions and form.*

EN 755-6, *Aluminium and aluminium alloy - Extruded rod/bar, tube and profiles - Part 6 : Hexagonal bars, tolerances on dimensions and form.*

EN 755-7, *Aluminium and aluminium alloy - Extruded rod/bar, tube and profiles - Part 7 : Seamless tubes, tolerances on dimensions and form.*

EN 755-8, *Aluminium and aluminium alloy - Extruded rod/bar, tube and profiles - Part 8 : Porthole tubes, tolerances on dimensions and form.*

prEN 755-9 : 1998, *Aluminium and aluminium alloy - Extruded rod/bar, tube and profiles - Part 9 : Profiles, tolerances on dimensions and form.*

EN 941, *Aluminium and aluminium alloy - Circle and circle stock for general applications – Specifications.*

prEN 2002-20 : 1996, *Aerospace series - Test methods for metallic materials - Part 20 : Eddy current inspection of circular cross-section tubes.*

EN 2101, *Aerospace series - Chromic anodisation of aluminium and wrought aluminium alloys.*

EN 10204, *Metallic products - Types of inspection documents.*

EN 10233, *Metallic materials - Tube - Flattening test.*

EN 10234, *Metallic materials - Tube - Drift expanding test.*

EN 12258-1, *Aluminium and aluminium alloys - Terms and definitions - Part 1 : General terms.*

3 Terms and definitions

For the purposes of this standard the definitions of EN 12258-1 apply together with the following :

3.1
heat-treatment batch or lot
quantity of products of the same grade or alloy, form, thickness or cross-section and produced in the same way, heat-treated in one furnace load, or such products solution-treated and subsequently precipitation-treated in one furnace load. More than one solution-treatment lot can be included in one furnace load

For the heat-treatment in a continuous furnace, the products heat-treated during a time less than 8 h can be considered. This limit of 8 h can be exceeded, in the case of a thick plate, solution heat treated in a continuous furnace.

3.2
inspection lot
consignment, or a part thereof, submitted for inspection, comprising products of the same grade or alloy, form, thickness or cross-section, and processed in the same manner

3.3
cast
group of ingots poured simultaneously from the same source of molten metal. In the case of continuous casting, the cast is identified as the quantity of metal poured continuously from the same source of molten metal while no additional metal input is made to that source (except for possible grain refining addition)

3.4
working temperature range
permitted working temperature range of the material in pressure equipment application

4 Materials

4.1 The materials used for the production of pressure equipment shall be suitable for the intended purpose. Account shall be taken of mechanical properties, temperature and internal as well external environment.

They shall have adequate ductility and toughness and not be adversely affected by ageing. They shall display adequate resistance to stress corrosion and to intercrystalline corrosion (see e.g. EN 485-2) and not be adversely affected by long time exposure at maximum working temperature (see Tables 5 and 6).

They shall have a lead content not exceeding 150 µg/g. For particularly safety-sensitive applications (e.g. high volumes at high pressure), it is recommended that lower values be agreed upon between producer and purchaser.

NOTE For that purpose, specific national variants have been developed for some alloys, such as EN AW-6061A, EN AW-6082A, EN AW-6351A. The only difference of these national variants with respect to the parent alloy is the upper limit of lead content.

4.2 Unless otherwise specified in a specific application standard, the minimum percentage elongation at fracture A, as specified in the relevant material standard (see clause 6) shall not be lower than 5 %.

The conversion of A into A_{50mm} and vice versa shall be done as specified in Annex A.

NOTE In order to facilitate the use of this standard a list of materials which comply with the 14 % elongation (A) criterium is given for information in Annex C.

4.3 Materials (alloys and tempers), which may be used in compliance with the present standard in accordance with 4.1 and 4.2, are listed in Table 1 together with their welding characteristics, main field of application and working temperature ranges. The corresponding product forms for which mechanical properties at ambient temperature are specified in the referenced European Standards are given for convenience in annex B, Table B.1.

NOTE For heat exchangers, for use in equipment not subject to the requirements of the EU directive listed in annexe ZA, other materials can be used after written agreement between purchaser and manufacturer.

4.4 If the pressure equipment is operating above room temperature for time exceeding 100 h, than the long time behaviour of the material according to Tables 5 and 6 shall be considered.

4.5 For products intended to be formed, proper consideration shall be given to the formability to the material.

5 Technical conditions for inspection and delivery

5.1 General

5.1.1 The provisions of EN 485-1 (sheets, strips and plates), EN 941 (circles), EN 755-1 (extruded rods/bars, tubes and profiles), EN 754-1 (cold drawn rods/bars, and tubes) and EN 586-1 (forgings) apply with the amendments and additions specified in 5.2 to 5.5 below.

5.1.2 Generally, the production and manufacturing processes shall be left to the discretion of the producer. However, for tubes and hollow profiles, the porthole die extrusion technique may only be used after written agreement between producer and purchaser, and which shall include specific testing schedules (see 5.3.10).

5.1.3 It is recommended that the material to be used for welded components be produced from rolling or extrusion ingots with an hydrogen level no greater than 0,2 ml per 100 g aluminium, measured on liquid metal during casting.

5.2 Orders or tenders

5.2.1 Orders or tenders shall refer to the present standard, expressly implying that the ordered material is to be used for the construction of pressure equipment.

5.2.2 Particular requirements such as flattening test, leak test, ultrasonic test, etc., shall be expressly stated together with the criteria to which the material shall be verified.

5.3 Test procedure

5.3.1 General

Unless otherwise specified by the contracting parties and stated on the order, the following minimum test frequencies shall apply.

5.3.2 Chemical analysis

The specimens for chemical analysis shall be taken at the time of casting. At least one specimen shall be taken from each cast.

5.3.3 Tensile test

Tensile testing shall be carried out as specified in EN 485-1, EN 586-1, EN 754-1 and EN 755-1, as applicable, noting the following :

a) frequency of test :

1) for sheet, strip and plate at least one test-piece shall be taken from each cast represented in each inspection lot, or heat-treatment lot where applicable, of 10 000 kg or part thereof. For single plate or coil weighing more than 10 000 kg each, only one test-piece per plate or coil shall be taken ;

2) for extruded or extruded and cold drawn products :

i) for products having a nominal mass up to and including 1 kg/m, at least one test piece shall be taken from each cast represented in each inspection lot or heat-treatment lot of 1 000 kg or part thereof ;

ii) for products having a nominal mass comprised over 1 kg/m to 5 kg/m including, at least one test piece shall be taken from each cast represented in each inspection lot or heat-treatment lot of 2 000 kg or part thereof ;

3) for forgings :

i) for forgings weighing up to 2 kg at least one test piece shall be taken from each inspection lot or heat treatment lot of 1 000 kg or part thereof ;

ii) for forgings weighing greater than 2 kg up to and including 10 kg at least one test piece shall be taken from each inspection lot or heat-treatment lot of 2 000 kg or part thereof ;

iii) for forgings weighing greater than 10 kg at least one test piece shall be taken from each inspection lot or heat-treatment lot of 3 000 kg or part thereof ;

b) proof stress measurement :

1) $R_{p0,2}$ shall be measured for all alloys ;

2) for aluminium grades EN AW-1080A, EN AW-1070A and EN AW-1050A, in temper O or H111, $R_{p1,0}$ (proof stress at 1 % permanent elongation) shall also be measured. Results shall meet the requirements specified in Table 2.

5.3.4 Bending test for sheet and plate

Sheet and plate shall be capable of being bent under the conditions specified in EN 485-2.

The test need not be conducted unless specified on the order.

5.3.5 Internal quality for plate

When specified by the purchaser in the order, plate 12,5 mm in thickness and greater shall be ultrasonically tested in accordance with a method and to criteria agreed upon between producer and purchaser ; prEN 4050 : 1996 Parts 1 to 4 may be used as a guide line.

5.3.6 Flattening test for seamless tube

When specified by the purchaser in the order, tube in the alloys and tempers listed in Table 3 shall be tested in full section in accordance with test method in EN 10233. The test-piece shall show no evidence of cracking when the distance between plates, H, is no more than the values specified in Table 3, where H is expressed as a multiple of the thickness, t.

This test only applies to tube with a wall thickness not exceeding 10 % of the outside diameter.

The test shall be carried out on one section from one end of 10 % of the tubes in the inspection lot.

5.3.7 Drift expanding (flaring) test for tube

When specified by the purchaser in the order, tube in alloys and tempers listed in Table 1 (piping applications) shall be tested in accordance with test method in EN 10234, using a tapered pin with a 74° ± 1° included angle. The test piece shall show no evidence of crack formation or other defects clearly visible to the unaided eye when flared to the maximum outside diameter C specified in Table 4.

The test shall be carried out on one section from one end of 10 % of the tubes in the inspection lot.

5.3.8 Pressure test

When specified by the purchaser in the order, tube shall be tested for leaks by one of the following methods at the option of the producer :

— method 1 : Tubes 38 mm or less in outside diameter shall be tested pneumatically at no less than 0,40 MPa air pressure while immersed in water or other suitable liquid. Any evidence of leakage shall be cause for rejection ;

— method 2 : Tubes 38 mm or less in outside diameter shall be tested pneumatically at no less than 0,60 MPa air pressure with a gauge that will indicate loss of pressure. There shall not be any loss of pressure during a test period of at least 15 s duration ;

— method 3 : Tube 38 mm or less in outside diameter and with a wall thickness not exceeding 2 mm shall be subjected to an eddy current test according to prEN 2002-20 : 1996. The tube shall be tested over its whole length. This test normally applies only to drawn tube. As an alternative ASTM E 215 may be used after agreement between producer and purchaser.

Each tube in the inspection lot shall be tested.

For tube with an outside diameter above 38 mm and hollow profiles, test methods shall be agreed upon between producer and purchaser.

5.3.9 Surface inspection of forgings

When specified by the purchaser in the order, all hand or die forgings shall be visually inspected on all their surface, using one of the following methods :

— pickling ;

— pickling and chromic anodizing followed by a cold water rinse according to EN 2101.

The test method to be used shall be indicated on the order. The surface of the forging shall be free from defects prejudicial to its use such as cracks, cold shuts, etc.

5.3.10 Porthole extruded tube and hollow profile

Porthole extruded tube and hollow profile shall be tested 100 % by non-destructive test methods such as ultrasonic test etc., or by pressure test taking into account the shape, the dimensions and the intended use of the product. The test procedure and the testing conditions shall be defined by written agreement between producer and purchaser. If the purchaser intends to perform the test by himself, he shall state this in the order.

5.3.11 Other tests

Other tests like pressure test for tubes and hollow profiles, or impact strength test for thick walled products shall be defined by written agreement between producer and purchaser.

5.4 Inspection documents

Inspection documents covering the specific tests, as described in EN 10204, shall be made out by agreement between producer and purchaser. Unless otherwise agreed between producer and purchaser and stated on the order, an inspection test certificate "3.1.B" shall be provided.

5.5 Marking

All products shall be marked with the producer symbol, the alloy and temper designations, an identification number traceable to the cast number, or when applicable to the heat-treatment lot number.

Where tubes, bars or profiles are delivered in bundles, it is permissible, instead of individual marking of the products, for the bundles to be marked as lots through the attachment of a tag.

Unless otherwise stipulated, the marks are applied by means of punches or by painting or inking. Where paint or ink is used for marking, paints or inks that are insoluble in water shall be employed. Roll-stamping over the entire length is acceptable.

6 Mechanical properties

Mechanical property limits at ambient temperature are specified in the following European Standards : EN 485-2, EN 586-2, EN 754-2, EN 755-2, EN 941.

7 Tolerances on dimensions and form

7.1 Sheet, strip, plate and circle

Tolerances on dimensions and form for sheet, strip, plate and circle are specified in the following European Standards : EN 485-3, EN 485-4, EN 941.

7.2 Extruded rod/bar, tube and profile

Tolerances on dimensions and form for extruded rod/bar, tube and profile are specified in the following European Standards : EN 755-3, EN 755-4, EN 755-5, EN 755-6, EN 755-7, EN 755-8, prEN 755-9 : 2000.