BS EN 12420:2014

BSI Standards Publication

Copper and copper alloys — Forgings

National foreword

This British Standard is the UK implementation of EN 12420:2014. It supersedes BS EN 12420:1999 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee NFE/34/1, Wrought and unwrought copper and copper alloys.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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Copper and copper alloys - Forgings

Cuivre et alliages de cuivre - Pièces forgées

Kupfer und Kupferlegierungen - Schmiedestücke

This European Standard was approved by CEN on 24 April 2014.

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

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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Contents

Page

Foreword

This document (EN 12420:2014) has been prepared by Technical Committee CEN/TC 133 “Copper and copper alloys”, 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of an identical text or by endorsement, at the latest by December 2014 and conflicting national standards shall be withdrawn at the latest by December 2014.

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

This document supersedes EN 12420:1999.

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 Pressure Equipment Directive (PED) 97/23/EC.

For relationship with EU Directive 97/23/EC, see informative Annex ZA, which is an integral part of this document.

This is one of a series of European Standards for the copper and copper alloy products rod, wire, profile and forgings. Other products are specified as follows:

— EN 12163, *Copper and copper alloys — Rod for general purposes*;

— EN 12164, *Copper and copper alloys — Rod for free machining purposes*;

— EN 12165, *Copper and copper alloys — Wrought and unwrought forging stock*;

— EN 12166, *Copper and copper alloys — Wire for general purposes*;

— EN 12167, *Copper and copper alloys — Profiles and rectangular bars for general purposes*;

— EN 12168, *Copper and copper alloys — Hollow rod for free machining purposes*.

Within its programme of work, Technical Committee CEN/TC 133 requested CEN/TC 133/WG 4 “Extruded and drawn products, forgings and scrap” to revise the following standard: EN 12420:1999, *Copper and copper alloys — Forgings.*

In comparison with EN 12420:1999, the following significant technical changes were made:

1) new text has been introduced concerning optional restrictions to chemical compositions of materials with respect to individual uses or regulations for the use in contact with drinking water;

2) materials have been considered coherently with EN 12165:2011;

3) four new materials have been added: CuZn35Pb1,5AlAs (CW625N), CuZn33Pb1,5AlAs (CW626N), CuZn21Si3P (CW724R) and CuZn33Pb1AlSiAs (CW725R);

4) the mechanical properties have been modified to reflect market needs;

5) an informative Annex B Tensile properties has been introduced.

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

Introduction

The European Committee for Standardization (CEN) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning the alloys CuZn21Si3P (CW724R) and CuZn33Pb1AlSiAs (CW725R).

CEN takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has ensured the CEN that he/she is willing to negotiate licences under reasonable and not-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with CEN.

— For CuZn21Si3P (CW724R) information may be obtained from:

Wieland-Werke AG
Graf Arco Straße 36
89079 Ulm
GERMANY

— For CuZn33Pb1AlSiAs (CW725R) information may be obtained from:

Diehl Metall Messing
Heinrich-Diehl-Straße 9
D-90552 Röthenbach/Pegnitz
GERMANY

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

CEN (http://www.cen.eu/cen/WorkArea/IPR/Pages/default.aspx) and CENELEC (http://www.cenelec.eu/membersandexperts/toolsandapplications/index.html) maintain on-line lists of patents relevant to their standards. Users are encouraged to consult the lists for the most up to date information concerning patents.

Due to developing legislation, the composition of a material may be restricted to the composition specified in this European Standard with respect to individual uses (e.g. for the use in contact with drinking water in some Member States of the European Union). These individual restrictions are not part of this European Standard. Nevertheless, for materials for which traditional and major uses are affected, these restrictions are indicated. The absence of an indication, however, does not imply that the material can be used in any application without any legal restriction.

1 Scope

This European Standard specifies the composition, the property requirements and tolerances on dimensions and form for copper and copper alloy die and hand forgings.

The sampling procedures, the methods of test for verification of conformity to the requirements of this standard, and the delivery conditions are also specified.

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.

EN 1173, *Copper and copper alloys — Material condition designation*

EN 1655, *Copper and copper alloys — Declarations of conformity*

EN 1976, *Copper and copper alloys — Cast unwrought copper products*

EN 10204:2004, *Metallic products — Types of inspection documents*

EN 14977, *Copper and copper alloys — Detection of tensile stress — 5 % ammonia test*

EN ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method (ISO 6506-1)*

EN ISO 6509, *Corrosion of metals and alloys — Determination of dezincification resistance of brass (ISO 6509)*

ISO 2768-1, *General tolerances — Part 1: Tolerances for linear and angular dimensions without individual tolerance indications*

ISO 6957, *Copper alloys — Ammonia test for stress corrosion resistance*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
forging
wrought product, hot formed by hammering or pressing

3.1.1
die forging
forging produced between closed dies

3.1.2
hand forging
forging produced between open dies

3.1.3
cored forging
forging produced between closed dies including cores

3.2
deviation from concentricity
half of the difference between the maximum and the minimum wall thickness (s_{max} and s_{min}), measured in the same plane perpendicular to the axis of the forging

Note 1 to entry: Deviation from concentricity (mm) = (s_{max} − s_{min})/2.

3.3
inspection lot
definite quantity of products of the same cross-sectional dimensions, the same material and material condition, collected together for inspection (testing)

4 Designations

4.1 Material

4.1.1 General

The material is designated either by symbol or number (see Tables 1 to 8).

4.1.2 Symbol

The material symbol designation is based on the designation system given in ISO 1190-1.

NOTE Although material symbol designations used in this standard might be the same as those in other standards using the designation system given in ISO 1190-1, the detailed composition requirements are not necessarily the same.

4.1.3 Number

The material number designation is in accordance with the system given in EN 1412.

4.2 Material condition

For the purposes of this standard, the following designations, which are in accordance with the system given in EN 1173, apply for the material condition:

M Material condition for the product as manufactured without specified mechanical properties;

H... Material condition designated by the minimum value of hardness requirement for the product with mandatory hardness requirements;

S (suffix) Material condition for a product which is stress relieved.

Products in the M or H... condition may be specially processed (i.e. mechanically or thermally stress relieved) in order to lower the residual stress level to improve the resistance to stress corrosion and the dimensional stability on machining [see Clause 5, list entry g) and list entry h)].

Except when the suffix S is used, material condition is designated by only one of the above designations.

4.3 Product

The product designation provides a standardized pattern of designation from which a rapid and unequivocal description of a product is conveyed in communication. It provides mutual comprehension at the international level with regard to products which meet the requirements of the relevant European Standard.

The product designation is no substitute for the full content of the standard.

The product designation for products to this standard shall consist of:

— denomination (Forging);

— number of this European Standard (EN 12420);

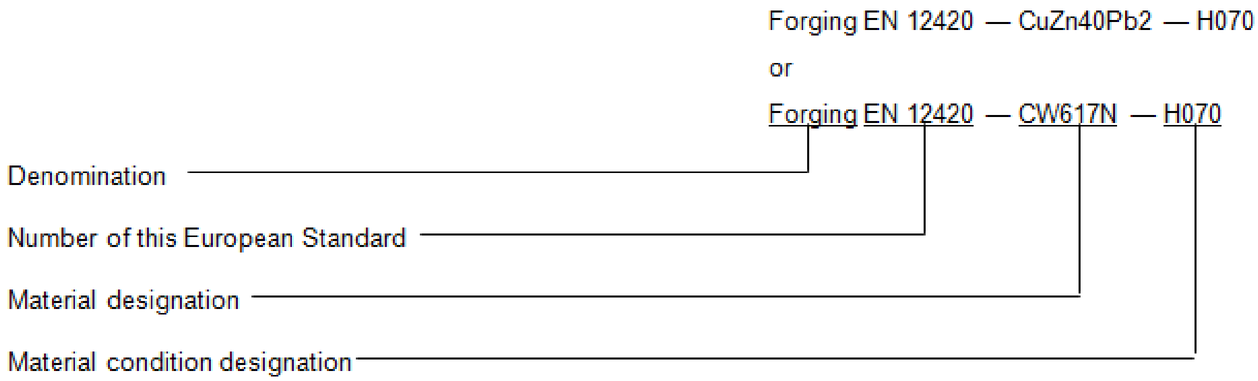
— material designation, either symbol or number (see Tables 1 to 8);

— for the use in contact with drinking water: DW for compliance in the chemical composition according to 4 MS Common Composition List;

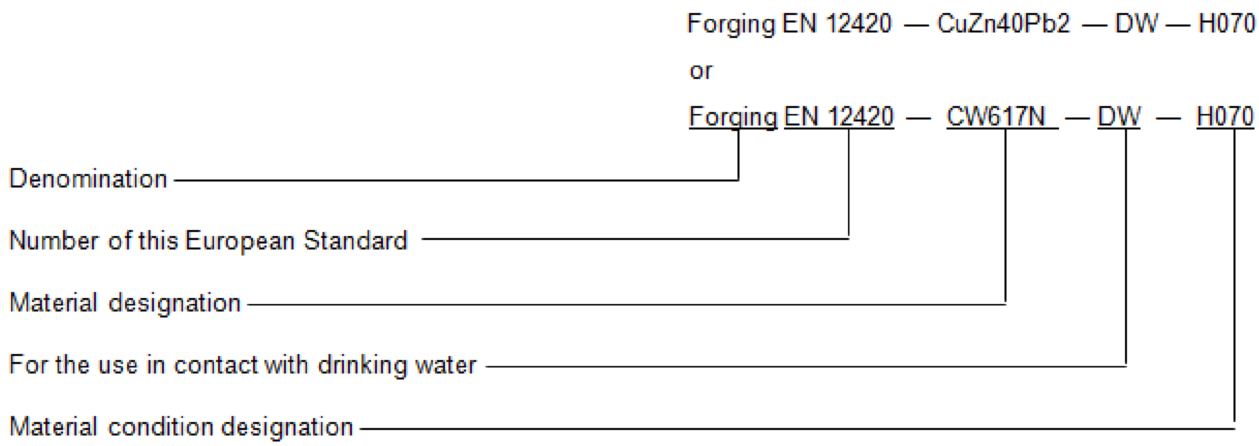
— material condition designation (see Tables 9 and 10).

The derivation of a product designation is shown in the following examples.

EXAMPLE 1 Forging conforming to this standard, in material designated either CuZn40Pb2 or CW617N, for standard applications, in material condition H070, will be designated as follows:



EXAMPLE 2 Forging conforming to this standard, in material designed either CuZn40Pb2 or CW617N, for the use in contact with drinking water DW, in material condition H070, will be designated as follows:



5 Ordering information

In order to facilitate the enquiry, order and confirmation of order procedures between the purchaser and the supplier, the purchaser shall state on his enquiry and order the following information:

a) quantity of product required (mass or number of pieces);

b) denomination (Forging);

c) number of this European Standard (EN 12420);

d) material designation (see Tables 1 to 8);

e) material condition designation (see 4.2 and Tables 9 and 10) if it is other than M;

f) for the use in contact with drinking water: DW for compliance in the chemical composition according to 4 MS Common Composition List;

g) nominal dimensions and/or tolerance drawing of the forging or finished part including the number of the drawing (see 6.6):

It is recommended that the product designation, as described in 4.3, is used for items b) to e).

In addition, the purchaser shall also state on the enquiry and order any of the following, if required:

h) whether the products are required to pass a stress corrosion resistance test. If so, which test method is to be used (see 8.5) if the choice is not to be left to the discretion of the supplier. If the purchaser chooses ISO 6957, the pH value for the test solution is to be selected;

i) whether the products are to be supplied in a thermally stress relieved condition;

j) when requested, tensile properties have to be agreed between purchaser and supplier (see 6.2.2 and Tables B.1 to B.3);

k) whether a declaration of conformity is required (see 9.1);

l) whether an inspection document is required, and if so, which type (see 9.2);

m) whether there are any special requirements for marking, labelling or packaging (see Clause 10).

EXAMPLE Ordering details for 200 forgings conforming to EN 12420, in material designated either CuZn40Pb2 or CW617N, for the use in contact with drinking water DW, in material condition H070, according to drawing number XY000:

200 pieces Forging EN 12420 — CuZn40Pb2 — DW — H070 — drawing number XY000

or

200 pieces Forging EN 12420 — CW617N — DW — H070 — drawing number XY000

6 Requirements

6.1 Composition

The composition shall conform to the requirements for the appropriate material given in Tables 1 to 8. In the same tables the hot working attitude is also reported.

Due to developing legislation, specific applications (see 4.3) may require restrictions in the chemical composition. In this case the limitations shall be stated in the ordering information [see Clause 5 list entry f)].

NOTE As the materials specified in this standard vary considerably e.g. in their resistance to forming, forging temperature and pressure, die wear and stresses, they have been classified into three groups of similar hot working attitudes (I, II or III in descending order of hot working attitude).

A direct proportionality exists between the group and preheating temperature.

6.2 Mechanical properties

6.2.1 Hardness properties

The hardness properties shall conform to the appropriate requirements given in Tables 9 and 10. For the alloys not mentioned in these tables the hardness values shall be agreed between purchaser and supplier.

6.2.2 Tensile properties

This standard does not specify mandatory tensile properties. The values for the tensile properties given in Tables B.1 to B.3 are for information only.

6.3 Electrical properties

Forgings materials listed in Table 11 shall conform to the electrical properties specified in the same table.

6.4 Resistance to dezincification

The maximum depth of dezincification, in any direction, of CuZn38As (CW511L), CuZn36Pb2As (CW602N), CuZn35Pb1,5AlAs (CW625N), CuZn33Pb1,5AlAs (CW626N), CuZn32Pb2AsFeSi (CW709R), CuZn21Si3P (CW724R) and CuZn33Pb1AlSiAs (CW725R) products shall be 150 µm.

The amount of β phase for CuZn38As (CW511L), CuZn36Pb2As (CW602N), CuZn35Pb1,5AlAs (CW625N), CuZn33Pb1,5AlAs (CW626N), CuZn32Pb2AsFeSi (CW709R) and CuZn33Pb1AlSiAs (CW725R) shall be less than 3 %.

The test shall be carried out in accordance with 8.4.

NOTE The supplied material for forgings may not necessarily meet this requirement unless suitably heat treated. The test is intended to demonstrate that forgings produced are capable of being processed so as to pass the test requirement.

Products in alloys other than CuZn21Si3P (CW724R) shall be subjected to heat treatment approximately in the range 500 °C to 550 °C after hot stamping. Should the user need to heat the material above 530 °C (i.e. soldering, brazing or welding operations) then advice should be sought from the supplier.

6.5 Residual stress level

Forgings ordered in the stress relieved condition (see 4.2, 2nd paragraph) shall show no evidence of cracking when tested. The tests shall be carried out in accordance with 8.5.

6.6 Tolerances for die forgings

6.6.1 General

Tolerances on dimensions and on form indicated in the drawings of a forging shall conform to the tolerances specified in this standard. If no tolerances are indicated in the drawings, the tolerances according to

ISO 2768-1, Tolerance Class c, shall apply. When more than one general tolerance is applicable, the larger of the possible general tolerances shall be used.

It is recommended that reference to this standard is made on the drawings.

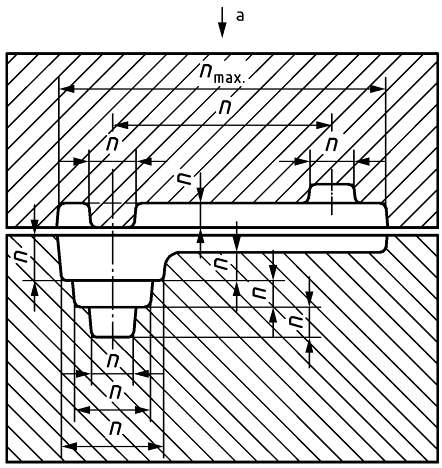
Two different types of dimensions are distinguished for die forgings:

a) dimensions within the die cavity which originate from the forging shape in one separate die part and which does not have components moving towards one another, see dimensions *n* in Figure 1.

These die parts may consist of one single piece or of several components immovable towards one another.

b) dimensions across the die parting line which originate from two or more die parts moving towards one another, see dimensions *t* in Figure 2.

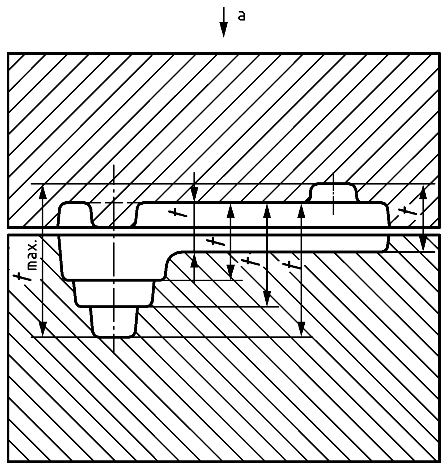
The die forging produced in the dies demonstrated in Figure 1 and Figure 2 is shown in Figure 3.



Key

a direction of forging

Figure 1 — Dimensions *n* within the die cavity



Key

a direction of forging

Figure 2 — Dimensions *t* across the die parting line

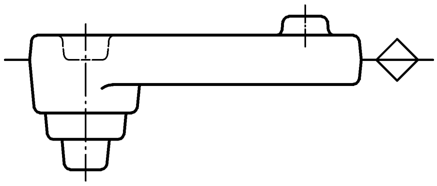


Figure 3 — Die forging

For recommended machining allowances and total allowances see A.3.10 and Table A.6.

6.6.2 Tolerances for dimensions within the die cavity and for dimensions across the die parting line

The dimensions *n* and *t* shall conform to the tolerances given in Table 12 for material group I, Table 13 for material group II and Table 14 for material group III.

The polygonal shapes shall conform to the tolerances given in Table 15 for material group I.

The largest dimension t_{max} in the direction of forging is the basic dimension for applying tolerances for dimensions t across the die parting line. The tolerance for t_{max} depends on the area A of the part viewed in the direction of blow. The area A in the case of round parts is equal to the area of the circle and in the case of irregularly shaped parts is equal to the area of the circumscribing rectangle (see Figure 4). All smaller dimensions t have the same tolerance as t_{max}.

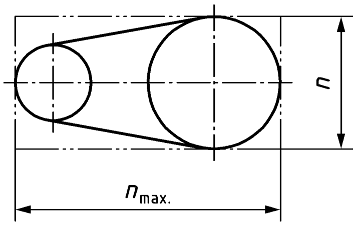


Figure 4 — Area *A* (in mm^2) = $n_{max} \times n$

The tolerances given in Tables 12 to 14 are also applicable for die forgings which are produced with a die cavity in one die half only facing a plane opposite die half.

The tolerance need not necessarily be applied symmetrically about the nominal dimension; it may be all plus or all minus.

6.6.3 Mismatch

Mismatch is not associated with a particular direction (see Figure 5).

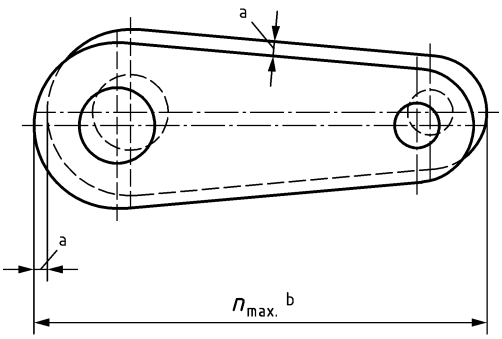
The mismatch shall be determined by reference to the largest nominal dimension n_{max} as viewed in the direction of forging (see Figure 5).

The permissible mismatch is given in Tables 12 to 14.

The maximum permitted mismatch shall be indicated above the title block or in the title block of the drawing of the forging, e.g.: mismatch max. 0,5 mm.

Mismatch is not included in the tolerances for dimensions within the die cavity: the tolerances for dimensions within the die cavity and for mismatch are in this case independently applied (see Figure 6 and Figure 7).

Dimensions in millimetres



Key

a mismatch

b reference dimension for mismatch

Figure 5 — Mismatch

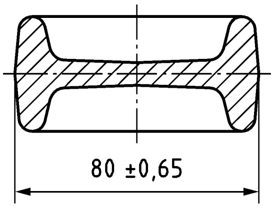
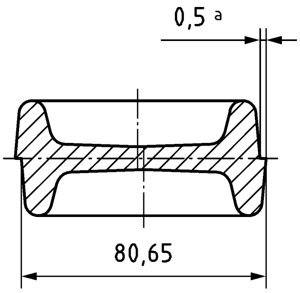


Figure 6 — Intended construction



Key

a mismatch

Figure 7 — Permanent actual dimensions

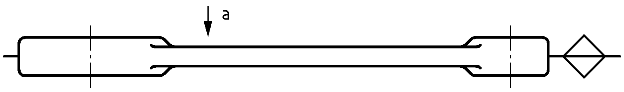
6.6.4 Flash projection

The flash projection is determined by reference to the largest nominal dimension n_{max} perpendicular to the direction of forging (see Figure 8).

The permissible flash projection is given in Tables 12 to 14.

The flash originating from the die parting line shall be trimmed by the manufacturer.

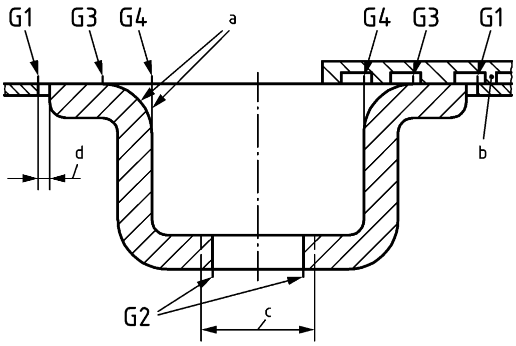
Flash caused by deburring, punching or piercing or through-die inserts (see G1, G2, G3 and G4 in Figure 9) is permissible, provided that it is either removed during machining or is not objectionable if left on the finished part. This flash shall be indicated in the drawing and shall not exceed 1,5 mm.



Key

a direction of forging

Figure 8 — Dimension n_{max} used as reference dimension for flash projection



a production by choice

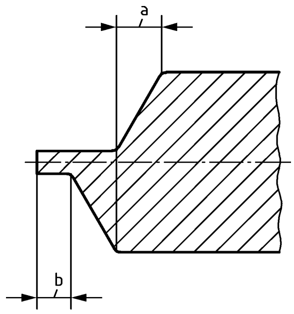
b work-holder

c finished part

d permitted flash projection

Figure 9 — Types of flash

Flash projection is applied independently of dimensional tolerances.



Key

a mismatch

b residual flash projection

Figure 10 — Flash projection

NOTE As the flash of type samples is generally trimmed by hand they do not represent the quality of trimming during bulk production.

6.6.5 Ejector marks

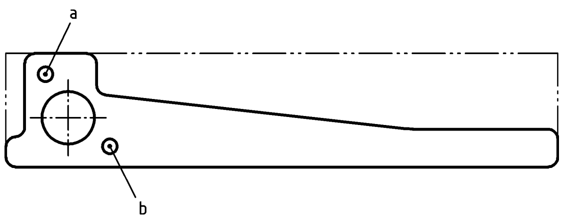
If ejectors are necessary for manufacturing reasons, ejector marks can result as ridges (convex) or indentations (concave) (see Figure 11 and Tables 12 to 14). If the ejector marks may be either concave only or convex only, the total permissible variation applies.

EXAMPLE

— Permissible ejector mark: ± 0,3 mm;

— Ejector mark only raised: + 0,6 mm;

— Ejector mark only recessed: – 0,6 mm.



Key

a ejector mark recessed

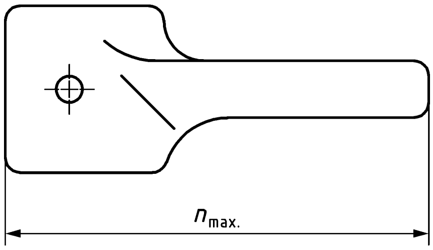
b ejector mark raised

Figure 11 — Ejector marks

6.6.6 Flatness tolerances

In addition to the tolerances caused by the forging process, deviation from flatness may result from distortion, when ejecting, flash clipping, or any heat treatment.

Flatness tolerances shall be determined by reference to the largest nominal dimension n_{max} as viewed in the direction of forging, see Figure 12 and Tables 12 to 14, and they are applied independently from all tolerances of form or position.



Key

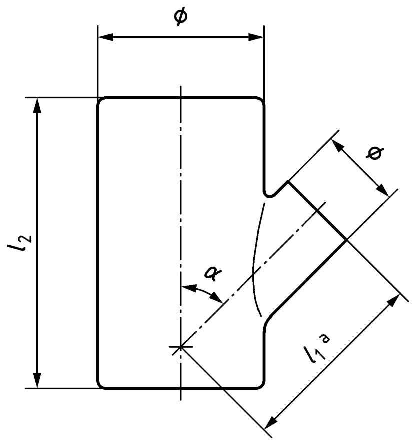
n_{max} reference dimension for the flatness tolerance

Figure 12 — Dimension n_{max} used as reference dimension of flatness tolerance

6.6.7 Angular tolerances

The tolerances in Table 16 apply to all angles α (see Figure 13) except draft angles.

NOTE For draft angles see guidelines for design in Annex A.



Key

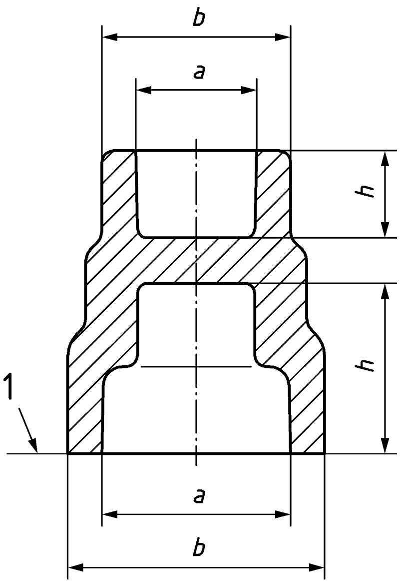
a shorter leg

Figure 13 — Definition of shorter leg

6.7 Tolerances for cored forgings

External diameter *a* and internal diameter *b* and depth of core penetration *h* for cored forgings shown schematically in Figure 14 and 15 shall conform to the tolerances given in Table 17.

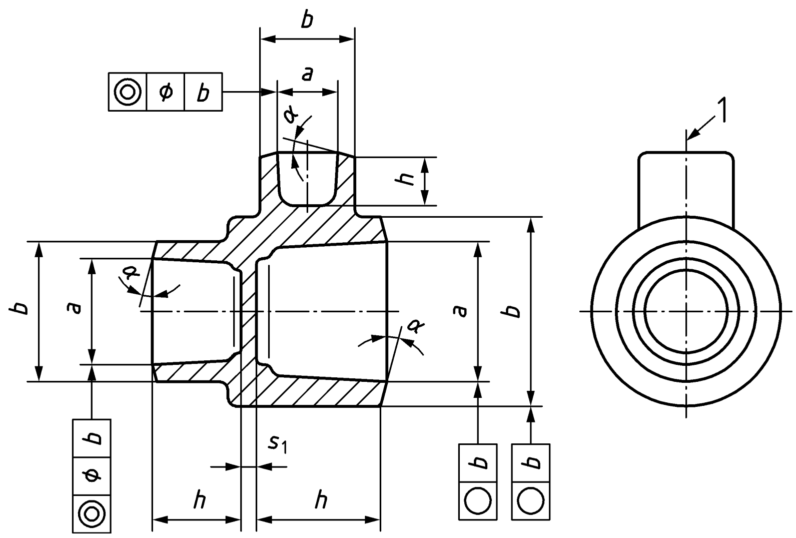
Circularity tolerance relating to outer diameter shall be calculated by summing the absolute values of *n* or t_{max} of Table 12.



Key

1 parting line

Figure 14 — Cored forgings (products cored in the forging direction)



Key

1 parting line

Figure 15 — Cored forgings (products cored normally to the forging direction)

6.8 Tolerances for hand forgings

6.8.1 General

The purchaser may supply nominal dimensions and/or a toleranced drawing of the forging or finished part but the tolerances on dimensions and on form shall conform to the requirements of 6.8.2 and 6.8.3.

It is recommended that reference to this standard is made on drawings.

In order to facilitate the preparation of drawings and the manufacture of sawing templates, all sawed length and sawed width dimensions shall carry identical tolerances; the tolerance band being governed by the maximum length.

NOTE For recommended machining allowances and total allowances see A.4.4, A.4.5 and Table A.7.

6.8.2 Tolerances on dimensions

Dimensions generally produced by machining *n*-dimensions and by forging *t*-dimensions shall conform to the tolerances given in Table 18 (see Figures 16 and 17).

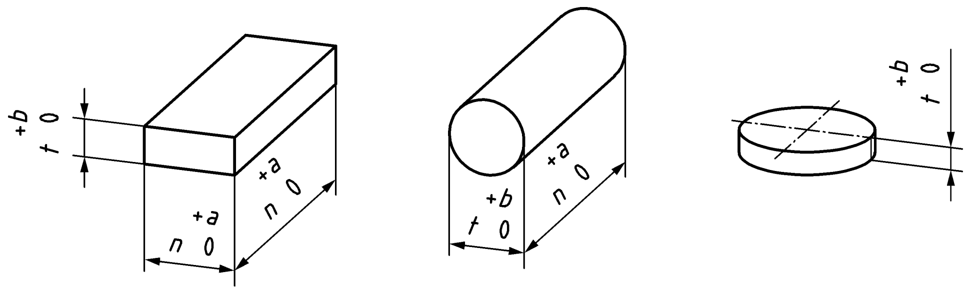


Figure 16 — Dimensions *t* and *n*

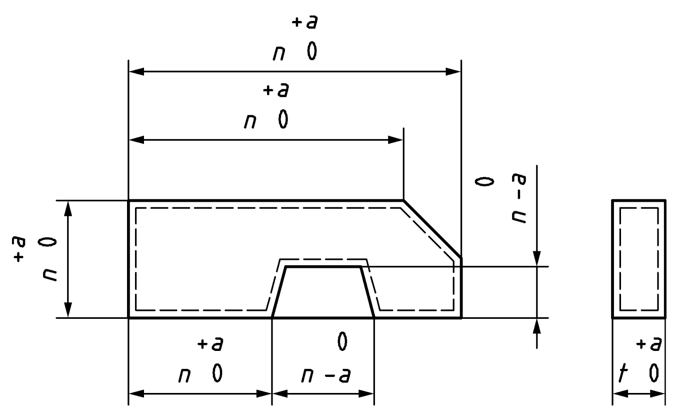


Figure 17 — Dimensions + *a* **and –** *a*

As variations in the finished diameter of discs and stepped hand forgings are difficult to control due to spread and edge distortion, no tolerances are specified. It is recommended either that these tolerances be agreed between purchaser and supplier or that these parts are supplied in the pre-machined condition.

6.8.3 Flatness tolerance

In addition to the tolerances caused by the forging operation, there will be deviations from flatness due to bending, twisting or the release of stresses, particularly during any subsequent heat treatment.

Forgings shall conform to the flatness tolerances given in Table 19, which are related to the length of the forging and are applied independently from dimensional tolerances.

Dependent on the forging geometry (e.g. different section thicknesses) the deviation from flatness may be checked using a straightedge or surface plate. Where this is not possible, a datum plane shall be established by positioning the forging on three datum points.

6.9 Surface quality

Forgings as blanks have a surface corresponding to the manufacturing process.

Ridges, indentations, folds, mechanical damage on the surface of forgings, which will have no detrimental effect on the use of the forgings, shall not be cause for rejection. Such surface irregularities and imperfections may be removed by suitable means provided that this does not invalidate the specified tolerances.

Special surface requirements are subjected to agreement between purchaser and supplier.

NOTE Hand forgings are generally completely machined.

6.10 Drawings

The purchaser shall supply a drawing of the finished part for die and cored forgings and if necessary for hand forgings. If possible, also a drawing of the forging showing the dimensions and tolerances as well as the tooling points of first-stage machining should be supplied.

Guidelines for the design of forgings are given in Annex A.

The manufacturer of die forgings shall prepare a drawing of the forging, including tolerances, from the data submitted by the purchaser. This drawing shall be checked and approved by the purchaser and returned to the manufacturer before die-production is started.

Unless otherwise agreed between the manufacturer and the purchaser the manufacturer shall produce type samples which shall be submitted to the purchaser for testing. When approved, the type sample and the drawing of the forging shall be the basis of agreement for bulk production.

7 Sampling

7.1 General

When required (e.g. if necessary in accordance with specified procedures of a supplier's quality system, or when the purchaser requests inspection documents with test results, or for use in cases of dispute), an inspection lot shall be sampled in accordance with 7.2 and 7.3.

7.2 Analysis

The sampling rate shall be in accordance with Table 20. A test sample, depending on the analytical technique to be employed, shall be prepared from each sampling unit and used for the determination of the composition.

When preparing the test sample, care should be taken to avoid contaminating or overheating the test sample. Carbide tipped tools are recommended; steel tools, if used, should be made of magnetic material to assist in the subsequent removal of extraneous iron. If the test samples are in finely divided form (e.g. drillings, millings), they should be treated carefully with a strong magnet to remove any particles of iron introduced during preparation.

In cases of dispute concerning the results of analysis, the full procedure given in ISO 1811-2 should be followed.

Results may be used from analyses carried out at an earlier stage of manufacturing the product, e.g. at the forging stock stage, if the material identity is maintained and if the quality system of the manufacturer is certified e.g. as conforming to EN ISO 9001.

7.3 Hardness, stress corrosion resistance, dezincification resistance and electrical property tests

The sampling rate shall be in accordance with Table 20. Sampling units shall be selected from the finished products. The test samples shall be cut from the sampling units. Except in cases of dispute, the location of the point in which the hardness is determined shall be on a representative surface. Test samples, and test pieces prepared from them, shall not be subjected to any further treatment, other than any machining operations necessary in the preparation of the test pieces.

8 Test methods

8.1 Analysis

Analysis shall be carried out on the test pieces, or test portions, prepared from the test samples obtained in accordance with 7.2. Except in cases of dispute, the analytical methods used shall be at the discretion of the supplier. For expression of results, the rounding rules given in 8.7 shall be used.

In cases of dispute concerning the results of analysis, the methods of analysis to be used should be agreed between the disputing parties.

8.2 Hardness test

The Brinell hardness test shall be carried out according to EN ISO 6506-1.

The test pieces shall be cut from the test samples obtained in accordance with 7.3.

8.3 Electrical conductivity test

The electrical conductivity test method used shall be at the discretion of the supplier and shall be carried out on the test pieces prepared from the test samples obtained in accordance with 7.3.

In cases of dispute the method of test should be agreed between the disputing parties.

8.4 Dezincification resistance test

The test method given in EN ISO 6509 shall be used on the test samples obtained in accordance with 7.3. A test piece shall be taken from each test sample, so as to expose a prepared cross-sectional surface to the test solution.

At the completion of the test the maximum depth of dezincification in a longitudinal direction (i.e. along the forged flow) shall be measured.

8.5 Stress corrosion resistance test

The test method given in either ISO 6957 or EN 14977 shall be used on the test pieces prepared from the test samples obtained in accordance with 7.3. The choice of which of these tests is used shall be at the discretion of the supplier, unless a preference is expressed by the purchaser [see Clause 5, list entry g)].

8.6 Retests

8.6.1 Analysis, hardness, electrical conductivity and dezincification resistance tests

If there is a failure of one, or more than one, of the tests in 8.1, 8.2, 8.3, or 8.4, two test samples from the same inspection lot shall be permitted to be selected for retesting the failed property (properties). One of these test samples shall be taken from the same sampling unit as that from which the original failed test piece was taken, unless that sampling unit is no longer available, or has been withdrawn by the supplier.

If the test pieces from both test samples pass the appropriate test(s), then the inspection lot represented shall be deemed to conform to the particular requirement(s) of this standard. If a test piece fails a test, the inspection lot represented shall be deemed not to conform to this standard.

NOTE If an inspection lot of dezincification resistant alloys CuZn36Pb2As (CW602N) CuZn38As (CW511L) and CuZn32Pb2AsFeSi (CW709R) fails the dezincification resistance test when tested or retested, the supplier has the option to further heat treat the inspection lot and resubmit it for all the tests called for on the order, except for analysis.

8.6.2 Stress corrosion resistance test

If a test piece fails the test in 8.5, the inspection lot represented by the failed test piece shall be permitted to be subjected to a stress relieving treatment. A further test sample shall then be selected in accordance with 7.3.

If a test piece from the further test sample passes the test, the stress relieved product shall be deemed to conform to the requirements of this standard for residual stress level and shall then be subjected to all the other tests called for on the purchase order, except for analysis. If the test piece from the further test sample fails the test, the stress relieved product shall be deemed not to conform to this standard.

8.7 Rounding of results

For the purpose of determining conformity to the limits specified in this standard, an observed or a calculated value obtained from a test shall be rounded in accordance with the following procedure, which is based upon the guidance given in EN ISO 80000-1:2013, Annex B. It shall be rounded in one step to the same number of figures used to express the specified limit in this European Standard.

The following rules shall be used for rounding:

— if the figure immediately after the last figure to be retained is less than 5, the last figure to be retained shall be kept unchanged;

— if the figure immediately after the last figure to be retained is equal to or greater than 5, the last figure to be retained shall be increased by one.

9 Declaration of conformity and inspection documentation

9.1 Declaration of conformity

When requested by the purchaser [see Clause 5, list entry j)] and agreed with the supplier, the supplier shall issue for the products the appropriate declaration of conformity in accordance with EN 1655.

9.2 Inspection documentation

When requested by the purchaser [see Clause 5, list entry k)] and agreed with the supplier, the supplier shall issue for the products the appropriate inspection document in accordance with EN 10204:2004.

10 Marking, labelling, packaging

Unless otherwise specified by the purchaser and agreed by the supplier, the marking, labelling and packaging shall be left to the discretion of the supplier [see Clause 5, list entry l)].

Table 1 — Composition of copper

Material designation		Composition % (mass fraction)								Density[b] g/cm³	Hot working attitude group
		Element	Cu[a]	Bi	O	P	Pb	Other elements (see NOTE)			
Symbol	Number							total	excluding	approx.	
Cu-ETP	CW004A	min. max.	99,90 —	— 0,000 5	— 0,040 [c]	— —	— 0,005	— 0,03	Ag, O	8,9	II
Cu-OF	CW008A	min. max.	99,95 —	— 0,000 5	— — [d]	— —	— 0,005	— 0,03	Ag	8,9	II
Cu-HCP	CW021A	min. max.	99,95 —	— 0,000 5	— —	0,002 0,007	— 0,005	— 0,03	Ag, P	8,9	II
Cu-DHP	CW024A	min. max.	99,90 —	— —	— —	0,015 0,040	— —	— —	—	8,9	II

NOTE The total of other elements (than copper) is defined as the sum of Ag, As, Bi, Cd, Co, Cr, Fe, Mn, Ni, O, P, Pb, S, Sb, Se, Si, Sn, Te and Zn, subject to the exclusion of any individual elements indicated.

[a] Including silver, up to a maximum of 0,015 %.

[b] For information only.

[c] Oxygen content up to 0,060 % is permitted, subject to agreement between the purchaser and the supplier.

[d] The oxygen content shall be such that the material conforms to the hydrogen embrittlement requirements of EN 1976.

Table 2 — Composition of copper alloys, low alloyed

Material designation		**Composition** % (mass fraction)												**Density**[a] g/cm³ approx.	**Hot working attitude group**
Symbol	Number	Element	Cu	Be	Co	Cr	Fe	Mn	Ni	Pb	Si	Zr	Others total		
CuBe2	CW101C	min. max.	Rem. —	1,8 2,1	— 0,3	— —	— 0,2	— —	— 0,3	— —	— —	— —	— 0,5	8,3	III
CuCo1Ni1Be	CW103C	min. max.	Rem. —	0,4 0,7	0,8 1,3	— —	— 0,2	— —	0,8 1,3	— —	— —	— —	— 0,5	8,8	III
CuCo2Be	CW104C	min. max.	Rem. —	0,4 0,7	2,0 2,8	— —	— 0,2	— —	— 0,3	— —	— —	— —	— 0,5	8,8	III
CuCr1Zr	CW106C	min. max.	Rem. —	— —	— —	0,5 1,2	— 0,08	— —	— —	— —	— 0,1	0,03 0,3	— 0,2	8,9	III
CuNi1Si	CW109C	min. max.	Rem. —	— —	— —	— —	— 0,2	— 0,1	1,0 1,6	— 0,02	0,4 0,7	— —	— 0,3	8,8	III
CuNi2Si	CW111C	min. max.	Rem. —	— —	— —	— —	— 0,2	— 0,1	1,6 2,5	— 0,02	0,4 0,8	— —	— 0,3	8,8	III
CuZr	CW120C	min. max.	Rem. —	— —	— —	— —	— —	— —	— —	— —	— —	0,1 0,2	— 0,1	8,9	III

[a] For information only.

Table 3 — Composition of copper-aluminium alloys

Material designation		Composition % (mass fraction)											Density[a] g/cm³ approx.	Hot working attitude group
Symbol	Number	Element	Cu	Al	Fe	Mn	Ni	Pb	Si	Sn	Zn	Others total		
CuAl8Fe3	CW303G	min. max.	Rem. —	6,5 8,5	1,5 3,5	— 1,0	— 1,0	— 0,05	— 0,2	— 0,1	— 0,5	— 0,2	7,7	II
CuAl10Fe1	CW305G	min. max.	Rem. —	9,0 10,0	0,5 1,5	— 0,5	— 1,0	— 0,02	— 0,2	— 0,1	— 0,5	— 0,2	7,6	II
CuAl10Fe3Mn2	CW306G	min. max.	Rem. —	9,0 11,0	2,0 4,0	1,5 3,5	— 1,0	— 0,05	— 0,2	— 0,1	— 0,5	— 0,2	7,6	II
CuAl10Ni5Fe4	CW307G	min. max.	Rem. —	8,5 11,0	3,0 5,0	— 1,0	4,0 6,0	— 0,05	— 0,2	— 0,1	— 0,4	— 0,2	7,6	II
CuAl11Fe6Ni6	CW308G	min. max.	Rem. —	10,5 12,5	5,0 7,0	— 1,5	5,0 7,0	— 0,05	— 0,2	— 0,1	— 0,5	— 0,2	7,4	II

[a] For information only.

Table 4 — Composition of copper-nickel alloys

Material designation		Composition % (mass fraction)													Density[a] g/cm³ approx.	Hot working attitude group
Symbol	Number	Element	Cu	C	Co	Fe	Mn	Ni	P	Pb	S	Sn	Zn	Others total		
CuNi10Fe1Mn	CW352H	min. max.	Rem. —	— 0,05	— 0,1[b]	1,0 2,0	0,5 1,0	9,0 11,0	— 0,02	— 0,02	— 0,05	— 0,03	— 0,5	— 0,2	8,9	III
CuNi30Mn1Fe	CW354H	min. max.	Rem. —	— 0,05	— 0,1[b]	0,4 1,0	0,5 1,5	30,0 32,0	— 0,02	— 0,02	— 0,05	— 0,05	— 0,5	— 0,2	8,9	III

a For information only.

b Co max. 0,1 % is counted as Ni.

Table 5 — Composition of copper-nickel-zinc alloys

Material designation		Composition % (mass fraction)									Density[a] g/cm³ approx.	Hot working attitude group
Symbol	Number	Element	Cu	Fe	Mn	Ni	Pb	Sn	Zn	Others total		
CuNi7Zn39Pb3Mn2	CW400J	min. max.	47,0 50,0	— 0,3	1,5 3,0	6,0 8,0	2,3 3,3	— 0,2	Rem. —	— 0,2	8,5	III

a For information only.

Table 6 — Composition of copper-zinc alloys, binary

Material designation		**Composition** % (mass fraction) [b]										**Density** [a] g/cm³ approx.	**Hot working attitude group**
Symbol	Number	Element	Cu	As	Al	Fe	Ni	Pb	Sn	Zn	Others total		
CuZn37	CW508L	min. max.	62,0 64,0	— —	— 0,05	— 0,1	— 0,3	— 0,1	— 0,1	Rem. —	— 0,1	8,4	II
CuZn40	CW509L	min. max.	59,0 61,5	— —	— 0,05	— 0,2	— 0,3	— 0,2	— 0,2	Rem. —	— 0,2	8,4	I
CuZn42	CW510L	min. max.	57,0 59,0	— —	— 0,05	— 0,3	— 0,3	— 0,2	— 0,3	Rem. —	— 0,2	8,4	I
CuZn38As	CW511L	min. max.	61,5 63,5	0,02 0,15	— 0,05	— 0,1	— 0,3	— 0,2	— 0,1	Rem. —	— 0,2	8,4	I

[a] For information only.

[b] For drinking water applications, restrictions to the chemical composition of some materials listed in this table may apply according to national regulations/laws, e.g. as specified in the 4 MS Common Composition List. For the use in contact with drinking water see the 4 MS Common Composition List.

Table 7 — Composition of copper-zinc-lead alloys

Material designation		Composition % (mass fraction) [b]										Density [a] g/cm³ approx.	Hot working attitude group
Symbol	Number	Element	Cu	Al	As	Fe	Mn	Ni	Pb	Sn	Zn	Others total		
CuZn36Pb2As	CW602N	min. max.	61,0 63,0	— 0,05	0,02 0,15	— 0,1	— 0,1	— 0,3	1,7 2,8	— 0,1	Rem. —	— 0,2	8,4	I
CuZn38Pb1	CW607N	min. max.	60,0 61,0	— 0,05	— —	— 0,2	— —	— 0,3	0,8 1,6	— 0,2	Rem. —	— 0,2	8,4	I
CuZn38Pb2	CW608N	min. max.	60,0 61,0	— 0,05	— —	— 0,2	— —	— 0,3	1,6 2,5	— 0,2	Rem. —	— 0,2	8,4	I
CuZn39Pb1	CW611N	min. max.	59,0 60,0	— 0,05	— —	— 0,3	— —	— 0,3	0,8 1,6	— 0,3	Rem. —	— 0,2	8,4	I
CuZn39Pb2	CW612N	min. max.	59,0 60,0	— 0,05	— —	— 0,3	— —	— 0,3	1,6 2,5	— 0,3	Rem. —	— 0,2	8,4	I
CuZn39Pb2Sn	CW613N	min. max.	59,0 60,0	— 0,1	— —	— 0,4	— —	— 0,3	1,6 2,5	0,2 0,5	Rem. —	— 0,2	8,4	I
CuZn39Pb3	CW614N	min. max.	57,0 59,0	— 0,05	— —	— 0,3	— —	— 0,3	2,5 3,5	— 0,3	Rem. —	— 0,2	8,4	I
CuZn40Pb1Al	CW616N	min. max.	57,0 59,0	0,05 0,30	— —	— 0,2	— —	— 0,2	1,0 2,0	— 0,2	Rem. —	— 0,2	8,3	I
CuZn40Pb2	CW617N	min. max.	57,0 59,0	— 0,05	— —	— 0,3	— —	— 0,3	1,6 2,5	— 0,3	Rem. —	— 0,2	8,4	I
CuZn35Pb1,5AlAs	CW625N	min. max.	62,0 64,0	0,5 0,7	0,02 0,15	— 0,3	— 0,1	— 0,2	1,2 1,6	— 0,3	Rem. —	— 0,2	8,4	I
CuZn33Pb1,5AlAs	CW626N	min. max.	64,0 66,0	0,8 1,0	0,02 0,15	— 0,3	— 0,1	— 0,2	1,2 1,7	— 0,3	Rem. —	— 0,2	8,4	I

[a] For information only.

[b] For drinking water applications, restrictions to the chemical composition of some materials listed in this table may apply according to national regulations/laws, e.g. as specified in the 4 MS Common Composition List. For the use in contact with drinking water see the 4 MS Common Composition List.

Table 8 — Composition of copper-zinc alloys, complex

Material designation		Composition % (mass fraction) [b]													Density [a] g/cm³ approx.	Hot working attitude group
Symbol	Number	Element	Cu	Al	As	Fe	Mn	Ni	P	Pb	Si	Sn	Zn	Others total		
CuZn23Al6Mn4Fe3Pb	CW704R	min.	63,0	5,0	—	2,0	3,5	—	—	0,2	—	—	Rem.	—	8,2	I
		max.	65,0	6,0	—	3,5	5,0	0,5	—	0,8	0,2	0,2	—	0,2		
CuZn32Pb2AsFeSi	CW709R	min.	64,0	—	0,03	0,1	—	—	—	1,5	0,45	—	Rem.	—	8,4	I
		max.	66,5	0,05	0,08	0,2	—	0,3	—	2,2	0,8	0,3	—	0,2		
CuZn35Ni3Mn2AlPb	CW710R	min.	58,0	0,3	—	–	1,5	2,0	—	0,2	—	—	Rem.	—	8,3	I
		max.	60,0	1,3	—	0,5	2,5	3,0	—	0,8	0,1	0,5	—	0,3		
CuZn36Sn1Pb	CW712R	min.	61,0	—	—	—	—	—	—	0,2	—	1,0	Rem.	—	8,3	I
		max.	63,0	—	—	0,1	—	0,2	—	0,6	—	1,5	—	0,2		
CuZn37Mn3Al2PbSi	CW713R	min.	57,0	1,3	—	—	1,5	—	—	0,2	0,3	—	Rem.	—	8,1	I
		max.	59,0	2,3	—	1,0	3,0	1,0	—	0,8	1,3	0,4	—	0,3		
CuZn39Sn1	CW719R	min.	59,0	—	—	—	—	—	—	—	—	0,5	Rem.	—	8,4	I
		max.	61,0	—	—	0,1	—	0,2	—	0,2	—	1,0	—	0,2		
CuZn40Mn1Pb1	CW720R	min.	57,0	—	—	—	0,5	—	—	1,0	—	—	Rem.	—	8,3	I
		max.	59,0	0,2	—	0,3	1,5	0,6	—	2,0	0,1	0,3	—	0,3		
CuZn40Mn1Pb1AlFeSn	CW721R	min.	57,0	0,3	—	0,2	0,8	—	—	0,8	—	0,2	Rem.	—	8,3	I
		max.	59,0	1,3	—	1,2	1,8	0,3	—	1,6	—	1,0	—	0,3		
CuZn40Mn1Pb1FeSn	CW722R	min.	56,5	—	—	0,2	0,8	—	—	0,8	—	0,2	Rem.	—	8,3	I
		max.	58,5	0,1	—	1,2	1,8	0,3	—	1,6	—	1,0	—	0,3		
CuZn21Si3P	CW724R	min.	75,0	—	—	—	—	—	0,02	—	2,7	—	Rem.	—	8,3	I
		max.	77,0	0,05	—	0,3	0,05	0,2	0,10	0,10	3,5	0,3	—	0,2		
CuZn33Pb1AlSiAs	CW725R	min.	64,0	0,1	0,05	—	—	—	—	0,4	0,1	—	Rem.	—	8,5	I
		max.	67,0	0,4	0,08	0,3	0,1	0,2	0,02	0,9	0,3	0,3	—	0,2		

[a] For information only.

[b] For drinking water applications, restrictions to the chemical composition of some materials listed in this table may apply according to national regulations/laws, e.g. as specified in the 4 MS Common Composition List. For the use in contact with drinking water see the 4 MS Common Composition List.

Table 9 — Hardness properties for forgings of material group I

Designations			Hardness
Material		Material condition	HBW
Symbol	Number		min.
CuZn40 CuZn42	CW509L CW510L	M	as manufactured
		H070	70
CuZn38As	CW511L	M	as manufactured
		H060	60
CuZn36Pb2As	CW602N	M	as manufactured
		H060	60
CuZn38Pb1 CuZn38Pb2 CuZn39Pb2 CuZn39Pb2Sn CuZn39Pb3 CuZn40Pb1Al CuZn40Pb2	CW607N CW608N CW612N CW613N CW614N CW616N CW617N	M	as manufactured
		H070	70
CuZn35Pb1,5AlAs CuZn33Pb1,5AlAs	CW625N CW626N	M	as manufactured
		H060	60
CuZn32Pb2AsFeSi	CW709R	M	as manufactured
		H070	70
CuZn37Mn3Al2PbSi	CW713R	M	as manufactured
		H130	130
CuZn39Sn1	CW719R	M	as manufactured
		H070	70
CuZn40Mn1Pb1AlFe Sn	CW721R	M	as manufactured
		H100	100
CuZn40Mn1Pb1FeS n	CW722R	M	as manufactured
		H080	80
CuZn21Si3P	CW724R	M	as manufactured
		H120	120
CuZn33Pb1AlSiAs	CW725R	M	as manufactured
		H060	60

Table 10 — Hardness properties for forgings of material group II

Designations			Hardness
Material		Material condition	HBW
Symbol	Number		min.
Cu-ETP Cu-OF Cu-HCP	CW004A CW008A CW021A	M	as manufactured
		H040	40
CuAl8Fe3	CW303G	M	as manufactured
		H090	90
CuAl10Fe3Mn2	CW306G	M	as manufactured
		H120	120
CuAl10Ni5Fe4	CW307G	M	as manufactured
		H170	170
CuAl11Fe6Ni6	CW308G	M	as manufactured
		H180	180
CuZn37	CW508L	M	as manufactured
		H070	70

Table 11 — Electrical properties at 20 °C

Designations		Conductivity	
Material		MS/m	% IACS[a]
Symbol	Number	min.	min.
Cu-ETP Cu-OF	CW004A CW008A	58,0	100,0
Cu-HCP	CW021A	57,0	98,0
CuCo1Ni1Be CuCo2Be	CW103C CW104C	25,0[b]	43,1[b]
CuCr1Zr	CW106C	43,0[b]	74,1[b]
CuNi2Si	CW111C	17,0[b]	29,3[b]

NOTE The % IACS values are calculated as percentages of the standard value for annealed high conductivity copper as laid down by the International Electrotechnical Commission. Copper having an electrical conductivity of 58 MS/m at 20 °C is defined as corresponding to a conductivity of 100 %.

a IACS = International Annealed Copper Standard.

b Forged and precipitation hardened.

Table 12 — Tolerances for die forgings of material group I

Dimensions in millimetres

Nominal dimension		Tolerance on dimensions *n* (within die cavity) (see Figure 1)	Tolerance on dimensions t_{max} (see Figure 2) (across the die parting line) for area *A* in square millimetres (see Figure 4)						Tolerances on form		
over	up to and including		up to and including 2 500	over 2 500 up to and including 5 000	over 5 000 up to and including 10 000	over 10 000 up to and including 20 000	over 20 000 up to and including 40 000	over 40 000 up to and including 80 000	Mismatch (see 6.6.3 and Figure 5) max.	Flash projection (see 6.6.4 and Figure 10) max.	Flatness tolerance (see 6.6.6 and Figure 12) max.
—	20	± 0,2	- 0,2 + 0,3	- 0,2 + 0,3	± 0,3	± 0,4	± 0,5	± 0,5	0,2	0,3	0,3
20	40	± 0,3	- 0,3 + 0,4	- 0,3 + 0,4	± 0,4	± 0,5	- 0,5 + 0,7	- 0,5 + 0,7	0,2	0,3	0,3
40	60	± 0,3	—	± 0,5	± 0,5	± 0,5	- 0,5 + 0,7	- 0,5 + 0,7	0,3	0,4	0,5
60	100	± 0,4	—	- 0,5 + 0,7	- 0,5 + 0,7	- 0,5 + 0,7	- 0,5 + 0,7	- 0,5 + 0,7	0,4	0,4	0,5
100	150	± 0,5	—	—	- 0,5 + 0,8	- 0,5 + 0,8	- 0,5 + 0,8	- 0,5 + 1,0	0,5	0,5	0,7
150	200	± 0,6	—	—	—	- 0,5 + 0,8	- 0,5 + 1,0	- 0,7 + 1,0	0,6	0,5	0,9
200	300	± 0,8	—	—	—	—	—	- 0,7 + 1,3	0,6	1,0	1,4
Ejector mark (see 6.6.5 and Figure 11)			± 0,3	± 0,3	± 0,3	± 0,5	± 0,5	± 0,8	—	—	—
Circularity tolerance relating to outer diameter shall be calculated by summing the absolute values of *n* or t_{max} of the corresponding cell. Flashes shall not be considered.											
NOTE Only referred to products obtained by a not movable punch process. For movable punch process refer to Table 18.											

Table 13 — Tolerances for die forgings of material group II

Dimensions in millimetres

Nominal dimension over	Nominal dimension up to and including	Tolerance on dimensions *n* (within die cavity) (see Figure 1)	Tolerance on dimensions t_{max} (see Figure 2) (across the die parting line) for area *A* in square millimetres (see Figure 4): up to and including 2 500	over 2 500 up to and including 5 000	over 5 000 up to and including 10 000	over 10 000 up to and including 20 000	over 20 000 up to and including 40 000	over 40 000 up to and including 80 000	Tolerances on form: Mismatch (see 6.6.3 and Figure 5) max.	Flash projection (see 6.6.4 and Figure 10) max.	Flatness tolerance (see 6.6.6 and Figure 12) max.
—	20	± 0,3	± 0,55	± 0,45	± 0,6	—	—	—	0,3	0,4	0,45
20	50	± 0,5	- 0,45 + 0,75	- 0,45 + 0,75	- 0,6 + 0,9	- 0,6 + 1,05	- 0,75 + 1,35	- 0,75 + 1,8	0,3	0,4	0,45
50	100	± 0,6	- 0,45 + 0,75	- 0,45 + 0,75	- 0,6 + 0,9	- 0,75 + 1,2	- 0,75 + 1,5	- 0,9 + 1,95	0,5	0,6	0,75
100	150	± 0,8	—	—	- 0,6 + 1,05	- 0,75 + 1,35	- 0,75 + 1,65	- 0,9 + 2,1	0,6	0,8	1,05
150	200	± 0,9	—	—	—	- 0,75 + 1,5	- 0,75 + 1,8	- 1,05 + 2,1	0,8	0,8	1,35
200	300	± 1,2	—	—	—	—	—	- 1,05 + 2,4	0,8	1,0	2,1
Ejector mark (see 6.6.5 and Figure 11)			± 0,3	± 0,3	± 0,3	± 0,5	± 0,5	± 0,8	—	—	—
Circularity tolerance relating to outer diameter shall be calculated by summing the absolute values of *n* or t_{max} of the corresponding cell. Flashes shall not be considered.											
NOTE Only referred to products obtained by a not movable punch process. For movable punch process refer to Table 18.											

Table 14 — Tolerances for die forgings of material group III

Dimensions in millimetres

Nominal dimension		Tolerance on dimensions n (within die cavity) (see Figure 1)	Tolerance on dimensions t_{max} (see Figure 2) (across the die parting line) for area A in square millimetres (see Figure 4)						Tolerances on form		
over	up to and including		up to and including 2 500	over 2 500 up to and including 5 000	over 5 000 up to and including 10 000	over 10 000 up to and including 20 000	over 20 000 up to and including 40 000	over 40 000 up to and including 80 000	Mismatch (see 6.6.3 and Figure 5) max.	Flash projection (see 6.6.4 and Figure 10) max.	Flatness tolerance (see 6.6.6 and Figure 12) max.
—	20	± 0,4	± 0,6	± 0,6	± 0,6	—	—	—	0,3	0,4	0,6
20	50	± 0,6	- 0,6 + 1,0	- 0,6 + 1,0	- 0,8 + 1,2	- 0,8 + 1,4	- 1,0 + 1,8	- 1,0 + 2,4	0,3	0,4	0,6
50	100	± 0,8	- 0,6 + 1,0	- 0,6 + 1,0	- 0,8 + 1,2	- 1,0 + 1,6	- 1,0 + 2,0	- 1,2 + 2,6	0,5	0,6	1,0
100	150	± 1,0	—	—	- 0,8 + 1,4	- 1,0 + 1,8	- 1,0 + 2,2	- 1,2 + 2,8	0,6	0,8	1,4
150	200	± 1,2	—	—	—	- 1,0 + 2,0	- 1,0 + 2,4	- 1,4 + 2,8	0,8	0,8	1,8
200	300	± 1,6	—	—	—	—	—	- 1,4 + 3,2	0,8	1,0	2,8
Ejector mark (see 6.6.5 and Figure 11)			± 0,3	± 0,3	± 0,3	± 0,5	± 0,5	± 0,8	—	—	—
Circularity tolerance relating to outer diameter shall be calculated by summing the absolute values of n or t_{max} of the corresponding cell. Flashes shall not be considered.											
NOTE Only referred to products obtained by a not movable punch process. For movable punch process refer to Table 18.											

Table 15 — Tolerances for die forgings of material group I

Dimensions in millimetres

Nominal width across flats		Dimensional tolerance
over	up to and including	
—	10	0 − 0,2
10	25	0 − 0,3
25	50	0 − 0,4
50	80	0 − 0,5
80	100	0 − 0,6
100	120	0 − 0,7

Table 16 — Angular tolerances

Nominal dimension l_1 of the shorter leg[a] mm		Tolerances of angle α [a]
over	up to and including	
—	20	± 2°
20	40	± 1°
40	60	± 1°
60	100	± 0° 30′
100	200	± 0° 30′
200	300	± 0° 25′

a See Figure 13.

Table 17 — Tolerances of cored forgings

Dimensions in millimetres

Nominal diameter *a*		Tolerance on nominal diameter *a*	Circularity	Deviation from concentricity	Tolerance on depth of core penetration *h* [a]			Tolerance on depth of core penetration *h* [b]		
over	up to and including				up to and including 30	over 30 up to and including 50	over 50 up to and including 80	up to and including 30	over 30 up to and including 50	over 50 up to and including 80
		± 0,2	0,25	0,4	0 − 0,5	± 0,5	—	± 1	+ 1 − 1,5	—
20	40	± 0,3	0,3	0,5	± 0,5	+ 0,5 − 0,6	+ 0,5 − 0,7	+ 1 − 1,5	± 1,5	± 1,5
40	60	± 0,4	0,4	0,6	+ 0,5 − 0,6	+ 0,5 − 0,7	± 0,7	± 1,5	± 1,5	+ 1,5 − 2
60	80	± 0,5	0,5	1,0	+ 0,5 − 0,7	± 0,7	± 0,8	± 1,5	+ 1,5 − 2	+ 1,5 − 2
80	100	± 0,6	0,6	1,2	± 0,7	± 0,8	± 1,0	± 1,5	+ 1,5 − 2	+ 1,5 − 2
100	120	± 0,7	0,7	1,4	± 0,8	± 1,0	+ 1,0 − 1,5	+ 1,5 − 2	+ 1,5 − 2	+ 1,5 − 2
120	—	± 0,8	0,9	1,6	± 1,0	+ 1,0 − 1,5	± 1,5	+ 1,5 − 2	+ 1,5 − 2	+ 1,5 − 2

For cored forgings it is recommended that the diameter of the core penetration should be equal to or greater than 10 mm.

NOTE 1 The ratio depth of core penetration/diameter of core penetration is generally less than 2.

NOTE 2 The web-thickness X is generally equal to or more than the adjacent wall thickness.

NOTE 3 Symbols for form tolerances and position tolerances according to EN ISO 1101.

[a] Valid for products cored in the forging direction (see Figure 14).

[b] Valid for products cored normally to the forging direction (see Figure 15).

Table 18 — Tolerances *a* and *b* for dimensions *n* and *t*

Dimensions in millimetres

Nominal dimensions		Plus tolerance *b* for *t* [a]	Plus or minus tolerance *a* for *n* [b]
over	up to and including		
—	50	4	4
50	100	5	5
100	150	8	6
150	250	10	10
250	400	12	15
400	630	—	20
630	1 000	—	25
1 000	1 600	—	30
1 600	2 500	—	35

NOTE External dimensions are specified as plus tolerances, see tolerance + *a* in Figures 15 and 16, and internal dimensions are always specified as minus tolerances, see tolerance — *a* in Figure 16.

a In the direction of forging.

b Perpendicular to the direction of forging.

Table 19 — Flatness tolerance

Dimensions in millimetres

Method of measurement	Flatness tolerance for nominal length						
	up to and including 100	over 100 up to and including 250	over 250 up to and including 400	over 400 up to and including 630	over 630 up to and including 1 000	over 1 000 up to and including 1 600	over 1 600 up to and including 2 500
Straightedge	1	1,5	2,5	3	4	5	6
Datum point	± 1	± 1,5	± 2,5	± 3	± 4	± 5	± 6

Table 20 — Sampling rate

Values in kilograms

Mass of an individual forging		Mass of inspection lot for one test sample
over	up to and including	up to and including
—	0,5	500
0,5	2,0	1 000
2,0	10	1 500
10	—	2 000
NOTE Larger inspection lots require sampling in proportion up to a maximum of five test samples.		

Annex A
(informative)

Recommended guidelines for design

A.1 Introduction

This annex gives general guidelines which enable the purchaser to take into account manufacturing processes when designing a forged component.

It is recommended that the purchaser should contact the manufacturer for advice, especially in the case of forgings which are difficult to produce with respect to material, shape and size.

A.2 General information

As forgings are generally produced near net shape with good dimensional accuracy and surface finish, any subsequent machining is minimized. The consolidated wrought structure produced by forging allied with appropriate design, can achieve optimal grain/fibre flow which will better withstand any high operational stresses that the component may be subjected to in subsequent service (compare Figures A.1 and A.2 with Figure A.3).

During the design of forgings large cross-sectional changes, abrupt transitions, and accumulation of material should be avoided. Thin forgings of large surface areas are notably problematic due to their susceptibility to warping which usually necessitates difficult straightening operations.

As changes in the design are difficult after tool manufacture has begun, it is recommended that any possibility of alteration should be fully discussed between the purchaser and the supplier prior to die production so that if necessary or practical they can be accommodated economically. The purchaser should also be aware that the accommodation of such modifications or the requirement for smaller dimensions/tolerances than those specified or recommended in this standard will increase the cost of production as a consequence of shorter die life and increased production times.

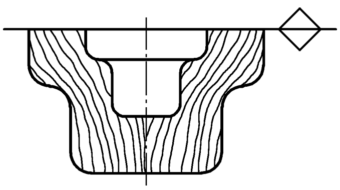


Figure A.1 — Forged in the die from a bar: Suitable fibre flow

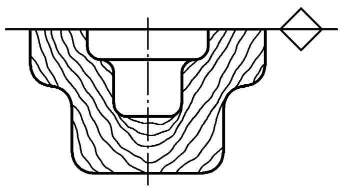


Figure A.2 — Forged in the die from a rough forging: Suitable fibre flow

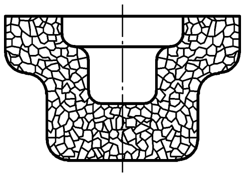


Figure A.3 — Casting: No fibre flow

A.3 Guidelines for die forgings

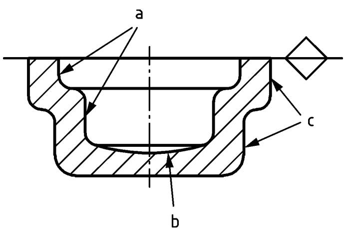
A.3.1 Drafts

Generally all areas lying in the direction of forging of the die components should have 30' external and 1° internal drafts, in order that the parts can be easily lifted out of the die. In particular cases, larger or even smaller drafts may be necessary for reasons associated with the die and/or the press.

The use of web drafts is recommended, particularly in the case of parts of large area with relatively small wall thickness, in order that material can flow easily from the centre to the sides (see Figure A.4).

A.3.2 Web thicknesses

The smallest web thickness s_1 depends on the largest area A of the die forging transverse to the direction of forging, which, in the case of round parts, is equal to the area of the circle and in the case of irregularly shaped parts is equal to the area of the circumscribing rectangle (see Figure A.5 and Table A.1).



Key

a interior draft

b web draft

c exterior draft

Figure A.4

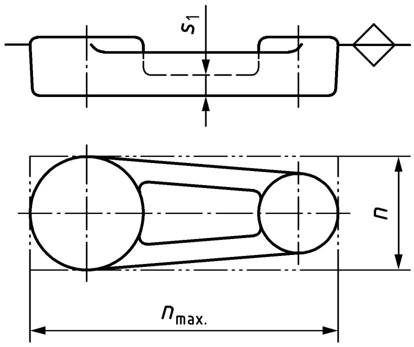


Figure A.5 — Area A (in mm^2) = n_{max} × n

Table A.1 — Web thicknesses

Dimensions in millimetres

Material group	Minimum web thickness s_1 for area A in mm^2					
	up to and including 2 500	over 2 500 up to and including 5 000	over 5 000 up to and including 10 000	over 10 000 up to and including 20 000	over 20 000 up to and including 40 000	over 40 000 up to and including 80 000
I	2	3	4	5,5	7	10
II	3	4,5	6	8,25	10,5	15
III	4	6	8	11	14	20

A.3.3 Side wall thicknesses

Side wall thicknesses s_2 apply to uniform and symmetrical cross-sections (see Figure A.6 and Table A.2).

If tapering of cross-sections is unavoidable for constructional reasons, gradual tapering of the wall thickness from the web to the level of the flash is advisable. For this purpose the smallest wall thickness should be that for the side wall thickness s_2 (see Figure A.7 and Table A.2).

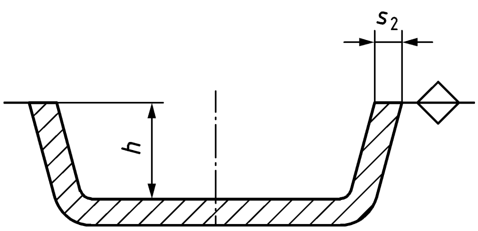


Figure A.6

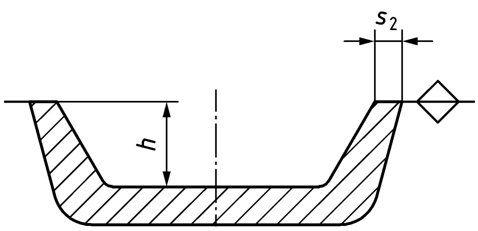


Figure A.7

Table A.2 — Side wall thicknesses

Dimensions in millimetres

Material group	Minimum side wall thickness s_2 for nominal dimension h						
	up to and including 10	over 10 up to and including 14	over 14 up to and including 20	over 20 up to and including 32	over 32 up to and including 50	over 50 up to and including 80	over 80
I	2	2,5	3	3,5	4	5	6
II	3	3,75	4,5	5,25	6	7,5	9
III	4	5	6	7	8	10	12

Differences and abrupt changes in wall thicknesses in the direction of the flash should be avoided. However if such changes are unavoidable, they should be kept to a minimum and should incorporate gradual transitions (see Figures A.8 and A.9).

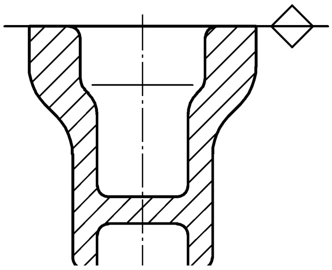


Figure A.8

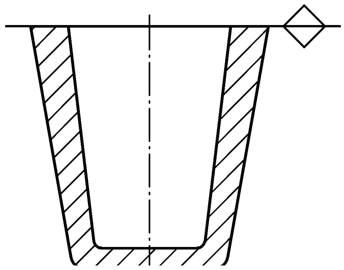


Figure A.9

A.3.4 Rib design

The drafting angles of ribs should follow the general guidelines of A.3.1 and have the recommended dimensions given in Table A.3. The end faces of ribs are normally rounded, r_1 generally being equal to half the rib thickness s_3 (see Figure A.12).

If ribs are provided for reasons of improving strength, they are generally not more than half the height of the outer ribs, and should preferably incorporate gradual transitions (see Figures A.10 and A.11).

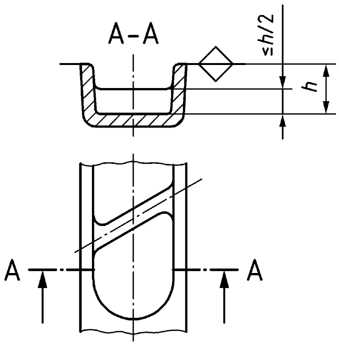


Figure A.10 — Permissible rib shape

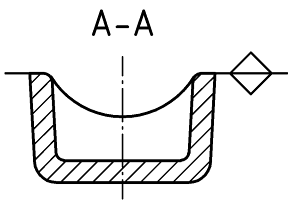


Figure A.11 — Preferred rib shape

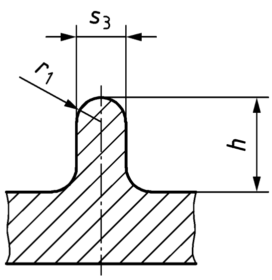


Figure A.12

Table A.3 — Ribs

Dimensions in millimetres

Material group	Minimum rib radius r_1 and minimum rib thickness s_3 for nominal dimension h						
	up to and including 4	over 4 up to and including 6	over 6 up to and including 10	over 10 up to and including 16	over 16 up to and including 25	over 25 up to and including 40	over 40
I	0,5	0,5	0,5	1	1	1,5	2
II	0,75	0,75	0,75	1,5	1,5	2,25	3
III	1	1	1	2	2	3	4
I	2	2,5	3	4	5,5	7	> 10
II	3	3,75	4,5	6	8,25	10,5	> 15
III	4	5	6	8	11	14	> 20

Where possible, ribs should have the same thickness s_3 overall on the end face as this facilitates die manufacture (see Figure A.13).

In order to obtain well-formed ribs, the ratio “height : thickness” of the rib should be as small as possible.

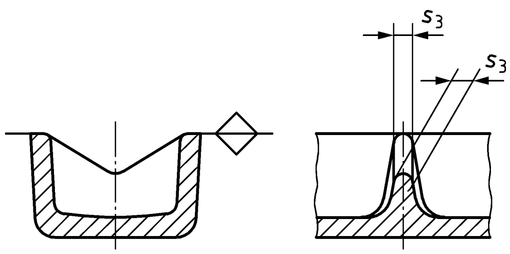
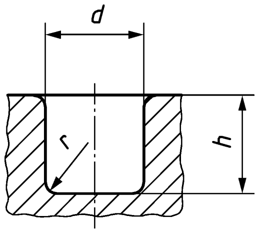


Figure A.13

A.3.5 Cores

The use of cores, which enable holes and recesses to be forged simultaneously, has the advantage of working the material more thoroughly, introducing more favourable grain/fibre flow, and reducing subsequent machining.

The recommendations for design shown in Figures A.14 and A.15 are for cores on one side, and in Figures A.16 and A.17 are for cores on both sides of a forging (for tolerances on core penetration see 6.7).



Key

d = 8 mm to 25 mm

h = *d*

Figure A.14

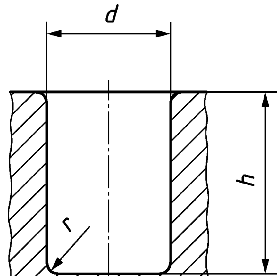
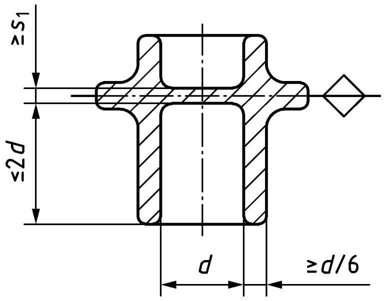
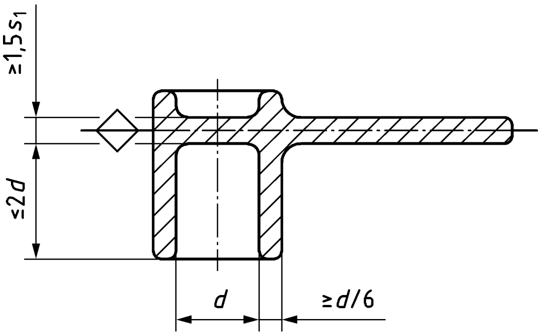


Figure A.15

For transition radii see A.3.7.





NOTE 1 For *r* see A.3.7 and Table A.4.

NOTE 2 For s_1 see A.3.2 and Table A.1.

NOTE 3 $d \geq 25$ mm: for symmetrical parts $h \leq 1{,}5\ d$
for asymmetrical parts $h \leq 1{,}2\ d$.

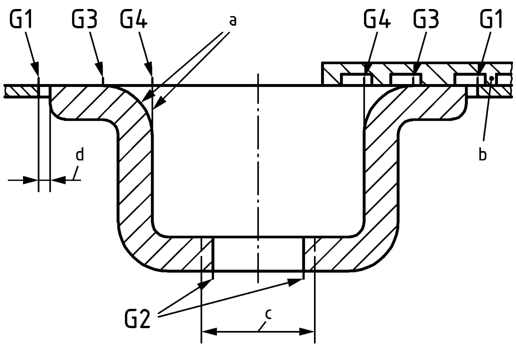
Figure A.16 — Symmetrical parts

Figure A.17 — Asymmetrical parts

A.3.6 Flash

Flash occurs mainly where the dies part and to a lesser extent at discontinuities produced by inserts, pegs, punches, etc.

The flash generated at the die parting line is generally removed or trimmed as part of the production route. However, as the removal of flash due to deburring, punching or piercing (see G1 and G2 in Figure A.18) and die inserts, punches etc. (see G3 and G4 in Figure A.18) may require additional efforts and costs, it is recommended that their positions are located where they will be removed by any subsequent machining operation. If the position on a machine tooling surface cannot be avoided, then appropriate recessing of the machining work holders will be required (see Figure A.18).



Key

a production by choice

b work-holder

c finished part

d permitted flash projection

Figure A.18

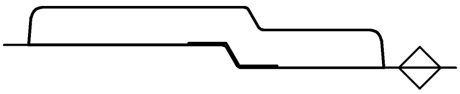


Figure A.19 — Die parting with flash offset

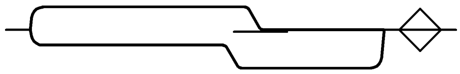
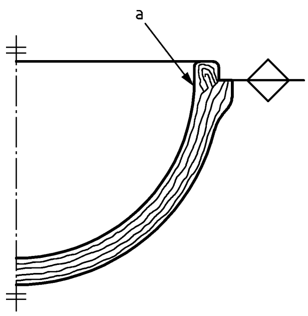


Figure A.20 — Die parting without flash offset

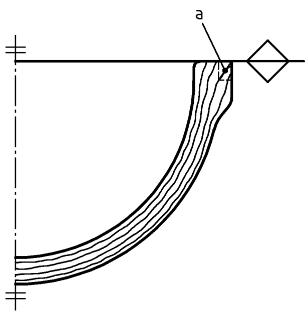
To facilitate economic manufacture of forging tools, it is recommended that flash off-sets which would require stepped die parting lines are avoided (see Figures A.19 and A.20). Positioning of the flash should also be such as to avoid adverse material flow which could lead to the formation of folds, laps, rupture, etc. (see Figures A.21 and A.22).



Key

a rupture by suction effect

Figure A.21 — Unsuitable position of the flash



a to be machined

Figure A.22 — Suitable position of the flash

A.3.7 Transition radii

It is recommended that all transition radii are uniform to facilitate the manufacture of dies (see Figures A.23 and A.24).

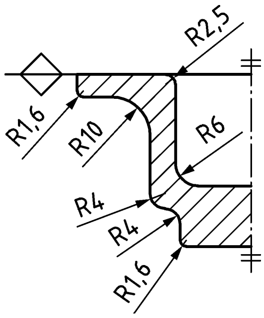


Figure A.23 — Example of unsuitable design (five different transition radii)

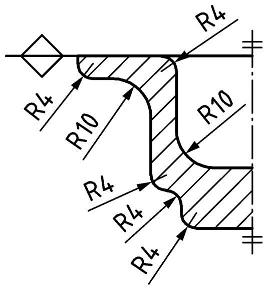


Figure A.24 — Example for suitable design (only two different transition radii)

Examples of the relationship of forging features to the minimum recommended transition radii (see Table A.4) are given in Figures A.25 to A.29.

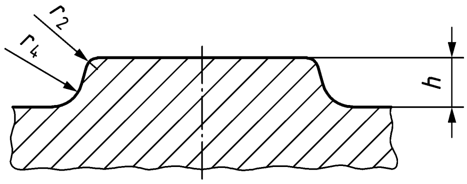


Figure A.25 — Eyes

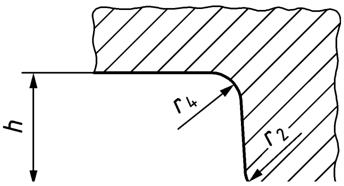


Figure A.26 — Corner radii

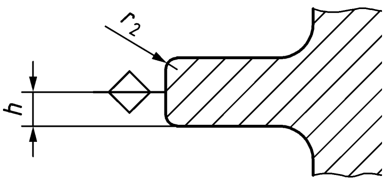


Figure A.27 — Flash zone

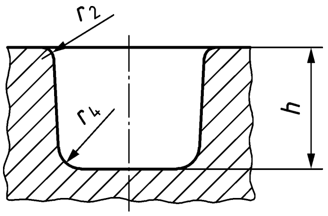


Figure A.28 — Cores

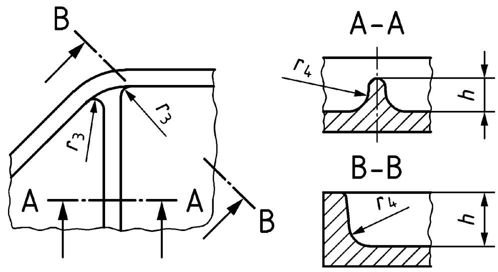


Figure A.29 — Ribs/webs

Table A.4 — Minimum transition radii

Dimensions in millimetres

Transition radii (see Figures A.25 to A.29)	Material group	Minimum transition radii for nominal dimension *h*						
		up to and including 4	over 4 up to and including 10	over 10 up to and including 25	over 25 up to and including 40	over 40 up to and including 63	over 63 up to and including 100	over 100
Corner radii r_2	I	0,5	1	1,6	2,5	4	6	10
	II	0,75	1,5	2,4	3,75	6	9	15
	III	1	2	3,2	5	6	9	15
Profile radii r_3 Fillet radii r_4	I	2,5	4	6	10	12	16	16
	II	3,5	6	9	15	18	24	24
	III	5	8	12	18	18	24	24

A.3.8 Clamping lengths and clamping areas for finish machining

A.3.8.1 If clamping lengths are to be provided, particularly on conical parts difficult to clamp, it is possible to locate these either on the inside or on the outside area of the parts with a very slight draft. This should be limited to the smallest possible dimension *a* (see Figures A.30 and A.31 and Table A.5).

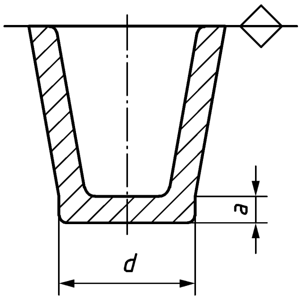


Figure A.30

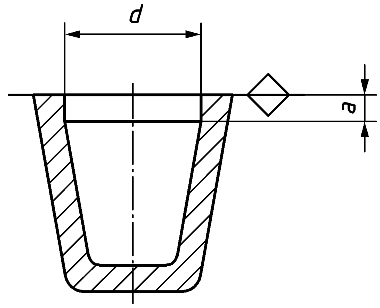


Figure A.31

Table A.5 — Clamping lengths for finish machining

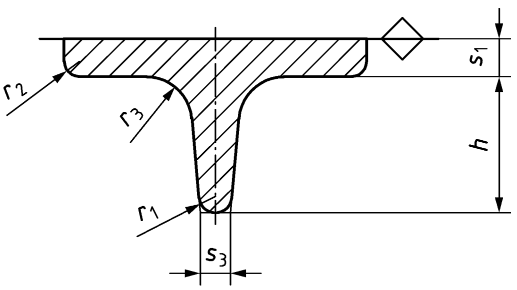
Dimensions in millimetres

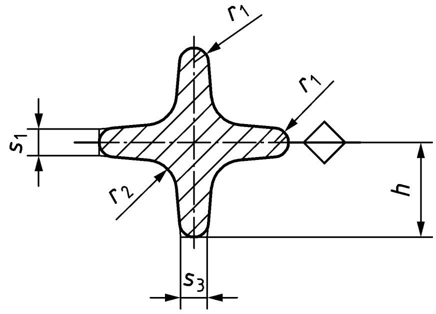
Material group	Maximum dimension a of clamping lengths for nominal dimension *d*				
	up to and including 25	over 25 up to and including 50	over 50 up to and including 100	over 100 up to and including 200	over 200
I	4	6	8	10	12
II	6	9	12	15	18
III	8	12	16	20	24

A.3.8.2 Use of drill centres as tooling points should be avoided where they would adversely affect material flow or promote premature tool wear. The design of such tooling points should be agreed between the purchaser and the supplier.

A.3.9 Design for cross-sectional shapes

The recommended design of cross-sectional shapes and the relationships between height *h*, thickness s_1 and transition radii *r* is shown in Figures A.32 and A.33.





Key

NOTE 1 Areas extending in the direction of die parting can be designed without drafts.

NOTE 2 For s_1 see A.3.2;

for h, s_3 and r_1 see A.3.4;

for r_2 and r_3 see A.3.7.

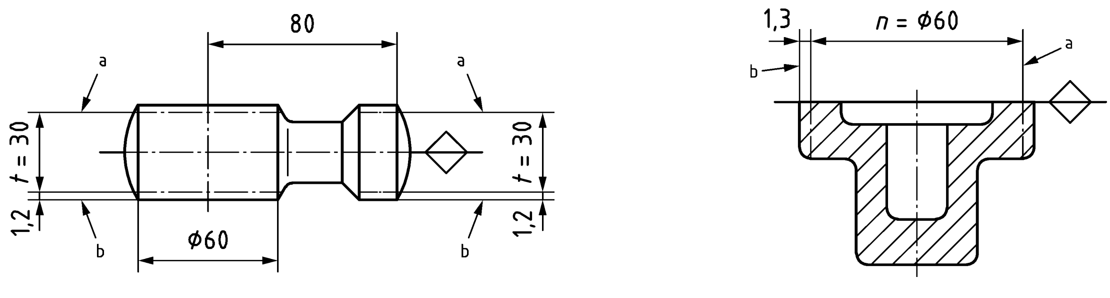
Figure A.32 — T cross-section **Figure A.33 — Cruciform cross-section**

A.3.10 Recommended machining allowances and total allowances

Machining allowances are related to the shape and size of the forging as well as the manner of mounting for machining; therefore the tooling points or surfaces, especially for the first machining operation, should be indicated in the drawing submitted by the purchaser.

Machining allowances should be applied according to Table A.6; examples of which are given in Figure A.34.

Dimensions in millimetres



a) area A = 6 600 mm^2 **b) area A = 2 800 mm^2**

Key

a finished part

b machining allowance

Figure A.34

Table A.6 — Machining allowances for drop or die forgings

Dimensions in millimetres

Nominal dimension		**Machining allowance for**					
		dimension n within the die cavity (see Figure 1)	dimensions *t* across the die parting line (see Figure 2) for area *A* in square millimetres				
over	up to and including	up to and including	up to and including 2 500	over 2 500 up to and including 5 000	over 5 000 up to and including 10 000	over 10 000 up to and including 20 000	over 20 000
—	50	1	1,1	1,1	1,2	1,3	1,4
50	120	1,3	1,4	1,4	1,5	1,6	1,6
120	250	1,6	1,8	1,9	2,0	2,0	2,1
250	500	2	2,4	2,5	2,5	2,5	2,5
500	—	3	3,1	3,1	3,1	3,1	3,1

The total allowance per side of the forging is the total of the machining allowances (see Table A.6) plus the flatness tolerance (see 6.6.6) or the mismatch (see 6.6.3) as appropriate (see Examples 1 and 2 in Figures A.35 and A.36).

Dimensions in millimetres

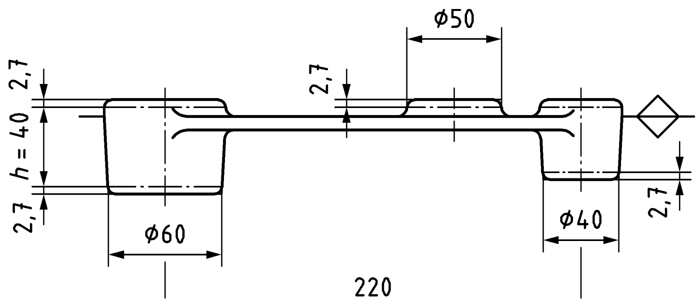


Figure A.35 — Total allowance taking into account the deviations of flatness

EXAMPLE 1 A forging with area A = 16 200 mm^2 and maximum dimension n = 220 mm + 30 mm + 20 mm = 270 mm:

The machining allowance according to Table A.6 (h = 40 mm, A = 16 200 mm^2):	1,3 mm
The flatness tolerance according to 6.6.6, see Table 14:	1,4 mm
Total allowance per side:	2,7 mm

Dimensions in millimetres

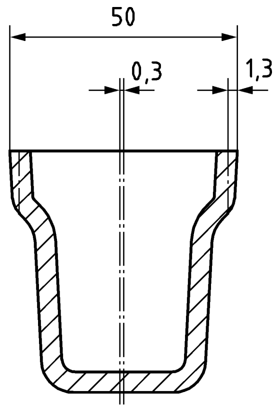


Figure A.36 — Total allowance in case of mismatch

EXAMPLE 2 A forging with area A = 1 964 mm^2 and maximum dimension n = 50 mm:

The machining allowance according to Table A.7 (n = 50 mm):	1,0 mm
The mismatch according to 6.6.3:	0,3 mm
Total allowance per side:	1,3 mm

A.4 Guidelines for hand forgings

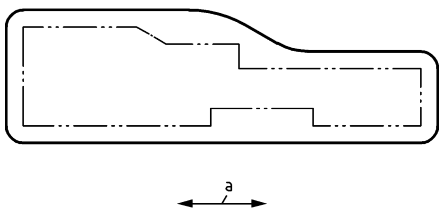
A.4.1 General

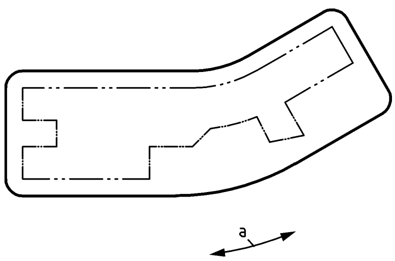
These guidelines are intended as a working basis for the design of hand forgings enabling the purchaser to take the specific manufacturing processes of the supplier into account. When a purchaser requires a hand forging of a complex shape which may be difficult to forge he should supply a drawing and consult the supplier.

A.4.2 General information

The use of hand forgings is recommended whenever:

a) selected grain flow patterns are required in a forging to increase strength corresponding to actual stresses when in use, see Figures A.37 and A.38:





Key

a grain direction

Figure A.37

a grain direction

Figure A.38

b) single parts or a small number of the same parts are needed;

c) it is inexpedient for configuration, cost or other reasons to produce the required parts from e.g. rolled, extruded, drawn or cast products (see Figures A.39 and A.40).

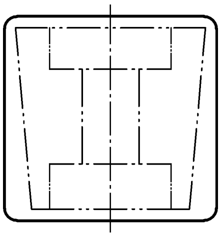


Figure A.39

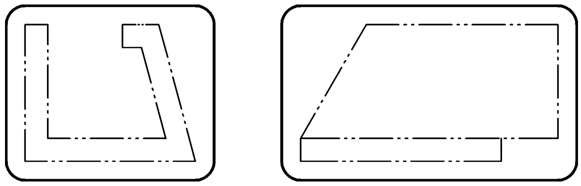


Figure A.40

Most hand forgings are produced by using simple standard tools, such as flat and profiled open dies, ensuring a wrought structure. They will have a surface which is typical of the manufacturing process. As hand forgings can only approach the finished-part contours, they need machining.

Parts having large area and small thickness are difficult to produce. Depending on the material and material condition, they tend to distort during forging, heat-treatment and/or machining operations. In most cases it will therefore be necessary to straighten and machine such hand forgings carefully.

A.4.3 Section changes and transitions

Whenever possible, hand forgings should be free from any abrupt cross-sectional changes or transitions by providing sufficiently large transition radii and avoiding tight dimensional requirement.

A.4.4 Recommended machining allowances

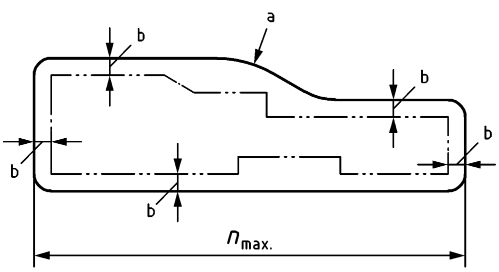
As hand forgings can only be approximate to the final shape of the finished part, Table A.7 recommends values for machining allowances. These values are applicable for all dimensions of a hand forging. The value of the machining allowance is decided by reference to the largest nominal dimension n_{max} of a forging and its mass.

Table A.7 — Machining allowance for hand forgings

Mass per piece kg		**Machining allowance for largest nominal dimension** n_{max} in mm				
over	up to and including	up to and including 250	over 250 up to and including 400	over 400 up to and including 630	over 630 up to and including 1 000	over 1 000 up to and including 1 600
—	20	3	5	6	8	10
20	50	4	5	8	8	10
50	100	—	8	8	10	12
100	250	—	10	10	12	15
250	500	—	10	10	12	15

A.4.5 Total allowances per side of forging

The total allowances per side of the forging (see Figures A.41 and A.42) is the total of the machining allowances (see Table A.7) and the flatness tolerance (see 6.8.3 and Table 19), to ensure the dimensions of the finished part.

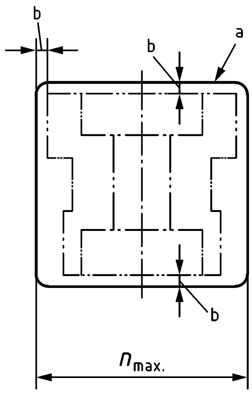


Key

a forging contour

b total allowances

Figure A.41



Key

a forging contour

b total allowances

Figure A.42

EXAMPLE A forging with a mass of 30 kg and a length of 800 mm:

The machining allowance according to Table A.7:	8 mm
<u>The flatness tolerance according to Table 19:</u>	<u>4 mm</u>
Total allowances per side:	12 mm

A.5 Guidelines for marking

Marking area can often be affected by defects.

To avoid such defects the marking position, size, shape, thickness and/or indent depth etc., are to be appropriately designed after agreement between purchaser and supplier.

Annex B
(informative)

Tensile properties

The materials listed in this standard show different resistance characteristics and forgeability at deformation's temperature. High zinc and special copper-zinc alloys are forged at relative lower temperature than copperaluminium alloys, copper, low alloyed copper alloys and copper-nickel alloys. The relative forgeability is referred to variable factors as: pressure, die wear and plasticity at high temperature. Furthermore intricate forgings and closer tolerances are achievable only with some of these alloys. In the different alloys group, some are commonly used and thus are generally available as stock; others, that are less used, are often produced on order.

It is recommended that the purchaser should contact the manufacturer for advice, especially in the case of forgings which are difficult to produce with respect to material.

The tensile properties given in Tables B.1 to B.3 are for information only because the values depend on:

— shape of forged parts;

— sizes and thicknesses of forged parts;

— forging process.

Table B.1 — Tensile properties for forgings of material group I (for information only)

Designations Material Symbol	 Number	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.
CuZn40	CW509L	300	100	20
CuZn42	CW510L	350	140	15
CuZn38As	CW511L	280	120	20
CuZn36Pb2As	CW602N	280	120	20
CuZn38Pb1 CuZn38Pb2 CuZn39Pb2 CuZn39Pb2Sn CuZn39Pb3 CuZn40Pb1Al CuZn40Pb2	CW607N CW608N CW612N CW613N CW614N CW616N CW617N	350	140	15
CuZn35Pb1,5AlAs CuZn33Pb1,5AlAs	CW625N CW626N	280	120	20
CuZn23Al6Mn4Fe3Pb	CW704R	700	500	5
CuZn32Pb2AsFeSi	CW709R	350	160	15
CuZn35Ni3Mn2AlPb	CW710R	440	180	10
CuZn36Sn1Pb	CW712R	350	160	15
CuZn37Mn3Al2PbSi	CW713R	550	200	8
CuZn39Sn1 CuZn40Mn1Pb1	CW719R CW720R	350	160	15
CuZn40Mn1Pb1AlFeSn CuZn40Mn1Pb1FeSn	CW721R CW722R	440	180	10
CuZn21Si3P	CW724R	500	250	15
CuZn33Pb1AlSiAs	CW725R	280	120	20
NOTE 1 N/mm² is equivalent to 1 MPa.				

Table B.2 — Tensile properties for forgings of material group II (for information only)

Designations		Tensile strength R_m	0,2 % proof strength $R_{p0,2}$	Elongation *A*
Material		N/mm²	N/mm²	%
Symbol	Number	min.	min.	min.
Cu-ETP Cu-OF Cu-HCP Cu-DHP	CW004A CW008A CW021A CW024A	200	50	30
CuAl8Fe3	CW303G	460	180	30
CuAl10Fe1	CW305G	420	180	20
CuAl10Fe3Mn2	CW306G	500	250	12
CuAl10Ni5Fe4	CW307G	650	350	12
CuAl11Fe6Ni6	CW308G	750	450	5
CuZn37	CW508L	300	100	20
NOTE 1 N/mm² is equivalent to 1 MPa.				

Table B.3 — Tensile properties for forgings of material group III (for information only)

Designations		Tensile strength R_m	0,2 % proof strength $R_{p0,2}$	Elongation A
Material		N/mm^2	N/mm^2	%
Symbol	Number	min.	min.	min.
CuBe2	CW101C	450	200	20
		1100	950	5
CuCo1Ni1Be CuCo2Be	CW103C CW104C	300	200	20
		650	550	8
CuCr1Zr	CW106C	250	150	20
		370	300	15
CuNi1Si	CW109C	300	200	20
		440	300	15
CuNi2Si	CW111C	320	200	20
		500	380	10
CuZr	CW120C	200	80	30
		220	80	30
CuNi10Fe1Mn	CW352C	280	100	20
CuNi30Mn1Fe	CW354C	310	100	20
CuNi7Zn39Pb3Mn2	CW400J	460	250	12
NOTE 1 N/mm^2 is equivalent to 1 MPa.				

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 97/23/EC, Pressure Equipment Directive (PED)

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 97/23/EC, Pressure Equipment Directive (PED).

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

For this harmonized supporting standard for materials, presumption of conformity to the Essential Requirements of the Directive is limited to technical data of the material in the standard and does not presume adequacy of the material to specific equipment. Consequently, the technical data stated in the material standard should be assessed against the design requirements of the specific equipment to verify that the Essential Requirements of the Pressure Equipment Directive (PED) are satisfied.

Table ZA.1 — Correspondence between this European Standard and Directive 97/23/EC, Pressure Equipment Directive (PED)

Clause(s)/ subclause(s) of this EN	Essential Requirements (ERs) of Directive 97/23/EC	Qualifying remarks/Notes
6.2.1	Mechanical properties	Annex **I** 4.1(a) of the Directive
9.2	Conformity of product and manufacturer's certified documentation	Annex **I** 4.3 of the Directive

NOTE Brittle fracture prevention: Copper, having a face-centred cubic crystal structure, does not suffer a transition from ductile to brittle failure like some other materials.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

[1] EN 1412, *Copper and copper alloys - European numbering system*

[2] EN ISO 1101, *Geometrical product specifications (GPS) - Geometrical tolerancing - Tolerances of form, orientation, location and run-out (ISO 1101)*

[3] EN ISO 9001, *Quality management systems - Requirements (ISO 9001)*

[6] EN ISO 80000-1:2013, *Quantities and units - Part 1: General (ISO 80000-1:2009 + Cor 1:2011)*

[4] ISO 1190-1, *Copper and copper alloys — Code of designation — Part 1: Designation of materials*

[5] ISO 1811-2, *Copper and copper alloys — Selection and preparation of samples for chemical analysis — Part 2: Sampling of wrought products and castings*

[7] Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment

[8] Acceptance for metallic materials used for products in contact with drinking water — 4 MS Common Approach — Part B “4 MS Common Composition List[1])

1) www.umweltbundesamt.de/wasser-e/themen/trinkwasser/4ms-initiative.html

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