SIST

SLOVENSKI STANDARD
SIST EN 14324:2004

01-november-2004

Trdo spajkanje – Navodilo za uporabo spajkanih spojev

Brazing - Guidance on the application of brazed joints

Hartlöten - Anleitung zur Anwendung hartgelöteter Verbindungen

Brasage fort - Guide d'application pour les assemblages réalisés par brasage fort

Ta slovenski standard je istoveten z: **EN 14324:2004**

ICS:

25.160.50 Trdo in mehko lotanje Brazing and soldering

SIST EN 14324:2004 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14324

September 2004

ICS 25.160.50

English version

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. EN 14324:2004: E

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Foreword

This document (EN 14324:2004) has been prepared by Technical Committee CEN/TC 121 “Welding”, 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of an identical text or by endorsement, at the latest by March 2005, and conflicting national standards shall be withdrawn at the latest by March 2005.

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

Introduction

The purpose of this document is to provide information and guidance to users whose knowledge of brazing is limited, either as regards the whole process or in some specific areas. It is not intended to replace textbooks but to make readily available certain important information and hopefully prevent some common errors.

Brazing techniques offer a wide field for joining, cladding, building up and comparable applications where brazing filler materials can be used. Structures similar to brazed joints can be achieved by arc brazing processes (MIG, TIG, plasma), infra-red brazing and electron beam brazing, which are better described as braze welding.

Where the word 'material' is used for components, they can be metallic or non-metallic, except when the component can only be metallic, when it is so described. The same usage applies to filler materials, although the use of non-metallic filler materials is very limited.

1 Scope

This document gives guidance on the application of brazing and the manufacture of brazed joints. This standard gives an introduction to brazing and a basis for the understanding and use of brazing in different applications. Because of the wide range of applications of brazing this standard does not give detailed guidance that might be product specific. For such information reference should be made to the appropriate product standard or, for applications where this does not exist, the relevant criteria should be clearly established before any brazing is undertaken.

This standard covers joint design and assembly, material aspects for both parent material and filler materials, brazing process and process variables, pre- and post-braze treatment and inspection.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1044:1999, *Brazing — Filler metals.*

EN 1045, *Brazing — Fluxes for brazing — Classification and technical delivery conditions.*

EN 12797, *Brazing — Destructive tests of brazed joints.*

EN 12799, *Brazing — Non-destructive examination of brazed joints.*

EN 13133, *Brazing — Brazer approval.*

EN 13134, *Brazing — Procedure approval.*

EN ISO 18279, *Brazing — Imperfections in brazed joints (ISO 18279:2003).*

3 Terms and definitions

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

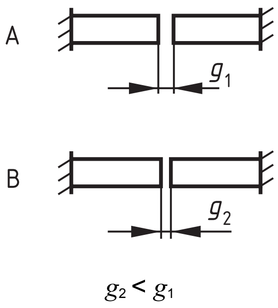
3.1
brazing
joining process in which a filler material is used which has a liquidus temperatur above 450 °C, but below the solidus of the parent material, and which is mainly distributed in the brazing gap by capillary attraction

NOTE Other joining methods exist (see E.6.3).

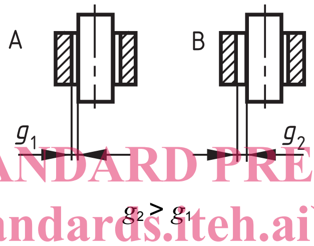
3.2
brazed joint
result of a joining process where the parent materials are not melted and the filling material and braze material have different chemical compositions compared to the parent materials

3.3
brazing gap
narrow, mainly parallel gap at the brazing temperature between the components to be brazed (see Figure 1 and 4.3.4)

3.4
assembly gap
fit up
narrow, mainly parallel gap at room temperature between the components to be brazed (see Figure 1 and 4.3.4)



a) Constrained butt joint



Shaded component has higher coefficient of expansion.

b) Tube joint (dissimilar materials)

Key

A Assembly at ambient temperature

B Assembly at brazing temperature

g_1 Assembly gap

g_2 Brazing gap

Figure 1 — Assembly gap and brazing gap

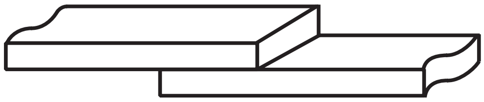
4 Joint design

4.1 Principle

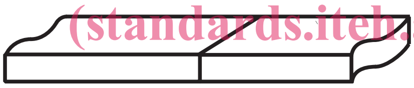
The brazing process depends upon capillary flow of a molten brazing filler material between parts separated by a narrow gap. The filler material has a different composition from the components to be brazed. This compositional difference may affect the properties of the assembly in service, e.g. at elevated temperature, in corrosive media or under fatigue loading. In addition the properties of the parent material of the components to be brazed can be affected by the brazing cycle.

4.2 Types of joint

There are basically two types of joint as shown in Figure 2. In practice very few assemblies are as simple as the basic types shown in Figure 2 (see annex A).



a) Lap



b) Butt

Figure 2 — Basic joint types

Lap joints are generally used because they are easier to fabricate and offer increased strength. Butt joints are used where adequate strength is readily obtained, e.g. where the mechanical properties of the parent materials are lower than those of the brazed joint, or where the thickness and/or length of a lap joint is undesirable.

It should be noted that the useful overlap for a lap joint in shear is related to the thickness of the thinner component; beyond the optimum overlap there is little to be gained in joint strength by increasing the overlap length.

4.3 Assembly gap and brazing gap

4.3.1 General

The areas of a brazed assembly are defined as shown schematically in Figure 3.

Perhaps the most critical feature in brazing is the control of the brazing gap, i.e. the gap at the brazing temperature, between the components to be brazed and through which the filler material has to flow by capillary action. There are several factors that influence the choice of the brazing gap and which have to be taken into consideration. It is essential to recognise that where joints are to be made between different parent materials, the assembly gap (fit up) will usually have to be different from the brazing gap (see 4.3.4).

NOTE The assembly gap may need to be larger or smaller than the brazing gap, depending on the thermal expansion coefficients of the materials, the configuration and the brazing process.

Different filler materials require different gaps even within the same group, as can be seen from the typical ranges given in Table 1, but the optimum gap may also be affected by a number of other joint parameters (see example in Figure 4), e.g.:

— parent material(s);

— geometry of the joint;

— surface finish of the faying surfaces;

— use of a flux or protective atmosphere;

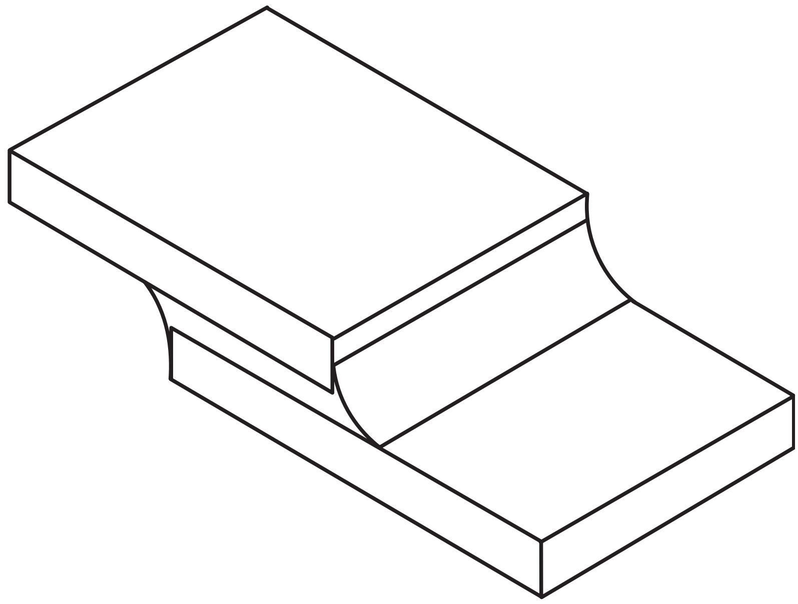
— careful control of brazing temperature and heating rate;

— brazing process.

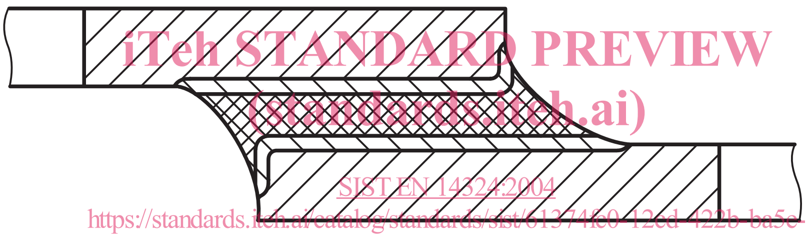
Table 1 — Typical brazing gaps

Filler material class according to EN 1044	Brazing gap[a] mm
AL	0,05 to 0,25
AG	0,05 to 0,30
CP	0,05 to 0,30
CU1XX CU2XX & CU3XX	Up to 0,15 0,05 to 0,20
NI	Up to 0,15
AU	Up to 0,10

[a] Brazing gap will depend on the selected filler materials, the brazing process and the brazing conditions.

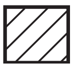


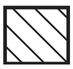
a) Simple brazed assembly

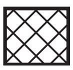


Key

 Parent material

 Parent material affected by brazing (heat affected zone (HAZ))

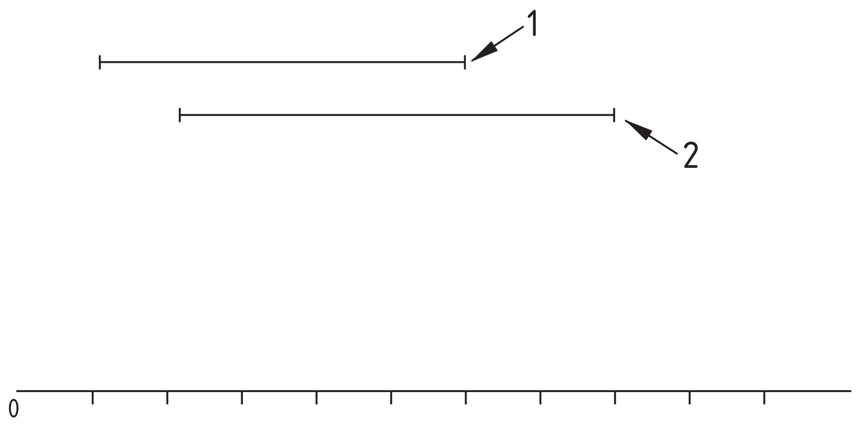
 Diffusion-transition zone

 Braze material

NOTE Extent of HAZ will vary with materials and brazing process.

b) Section through assembly in a)

Figure 3 — Schematic of brazed assembly



Key

1 Mechanized flame brazing with flux

2 Hand flame brazing with flux

Figure 4 — Schematic of differences in brazing gap ranges with different brazing processes (in this example for mild steel brazed with an AG filler materials)

4.3.2 Influence of brazing filler materials

Those types with the shortest melting range, often containing significant additions of temperature depressant elements (e.g. Si, B, P and Zn) exhibit enhanced fluidity and excellent capillary penetration. This also applies to most eutectic compositions and many pure metals. Conversely, those filler materials having wide melting ranges will generally have better wide gap filling characteristics and are more suitable for brazing when gaps are at the upper end of the stated range.

4.3.3 Influence of parent material

For those parent materials that are not readily soluble in the brazing filler material, or do not undergo mutual interaction to form alloy layers, gaps may, in general, be tighter than with those combinations where significant alloying occurs. Extensive inter-alloying will impair the fluidity of the brazing filler material and necessitate the use of wider brazing gaps to ensure complete penetration of the joint by the brazing filler material.

4.3.4 Influence of dissimilar parent materials

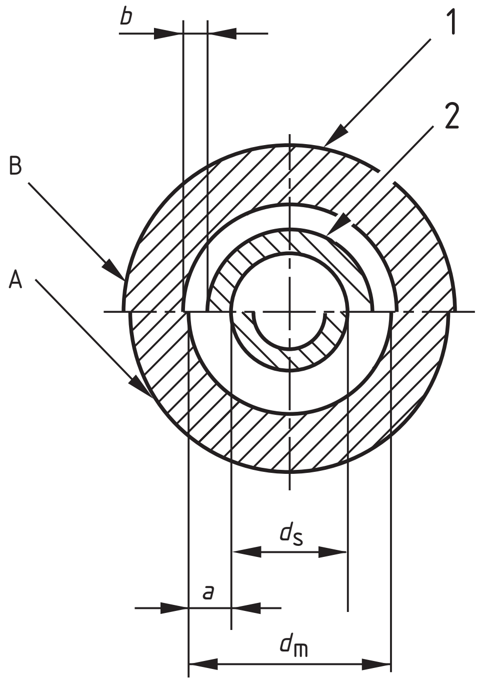
When dissimilar parent materials, of different coefficients of thermal expansion, are to be joined, care has to be exercised in designing the joint in order to obtain the correct brazing gap (see Figure 5). In extreme cases, joint gaps may close completely or open excessively at brazing temperature resulting in non-penetration or non-retention of the brazing filler material, respectively. Given that the brazing gap is the essential parameter, the assembly gap (to which the components will be machined) has to be calculated from the expansion coefficients of the parent materials, the sizes of the components and the brazing temperature.

This problem becomes greater:

— as the size of the brazed assembly increases;

— as the brazing temperature becomes higher;

— as the thermal expansion differential widens.



Key

1 Molybdenum

2 Steel

A Assembly at ambient temperature

B Assembly at brazing temperature

d_s Outer diameter of steel part (before brazing)

d_m Inner diameter of molybdenum part (before brazing)

a Assembly gap

b Brazing gap

Thermal expansion coefficient α
α steel > α molybdenum

Figure 5 — Influence on the brazing gap of dissimilar parent materials with different thermal expansion coefficients (schematic)

4.3.5 Influence of surface finish

Too coarse or too fine a surface finish will adversely affect the filling of the joint gap. The flow of the filler material may be influenced by the surface finishes of the joint materials.

4.3.6 Influence of atmospheres or fluxes

Processes using a protective atmosphere or a vacuum will tolerate tighter joint gaps, with given brazing filler materials, than an equivalent process where a flux is used. Unless joint gaps are adequate, flux and gas pockets will be by-passed and become entrapped in the finished joint.

4.4 Surface preparation

The component parts of a joint should be clean and properly fitting. When required by the brazing method, oxide, grease and oil should be removed by chemical, thermal and/or mechanical methods. This may involve degreasing, pickling, scratch brushing and other similar processes. The surface of the component within the brazed joint should not be polished. A roughened surface will assist filler materials flow particularly in the direction of machining. To improve the fit-up it may be necessary to modify the surface by methods such as knurling. To improve wettablilty of materials such as nickel alloys containing titanium and aluminium, and ceramics, it may be necessary to cover the surfaces with a suitable material, e.g. by plating or metallizing.

To prevent the flow of filler materials outside the joint area, it may be necessary to apply a 'stopping-off' agent. Care should be taken that this does not penetrate into the capillary joint gap and inhibit flow.

The degree of cleanliness required depends upon the ultimate quality required of the component and also the brazing process to be used. The degree of preparation is most severe for flux-free controlled atmosphere brazing at higher temperatures.

4.5 Stress distribution in service

Figure B.1 illustrates design modifications which endeavour to remove high stress concentrations from joint edges and distribute the stress more evenly in the parent materials.

4.6 Application of filler material

The brazing filler material is available in various forms (see 5.2.2).

For hand torch brazing applications, the brazing filler material is generally hand fed as rod or wire but may be pre-placed. In mechanized brazing applications, the brazing filler material is either pre-placed or automatically fed. In furnace brazing it has to be pre-placed. Examples of filler material placement are shown in Figure B.2.

The point at which the filler material is applied can greatly affect the quality of the joint. Internal pre-placement can also serve to demonstrate that capillary flow through the joint has occurred.

4.7 Assembly

It is essential, when designing joints, to ensure that the component parts will retain the required relationship during the brazing process. There are several effective methods of achieving this (see Figure B.3).

4.8 Good brazing design

Examples of good brazing design are given in Tables B.1 and B.2.