International Standard ISO 5179

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Investigation of brazeability using a varying gap test piece

Étude de l'aptitude au brasage au moyen d'une éprouvette à jeu variable

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ISO 5179-1983 (E)

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 5179 was developed by Technical Committee ISO/TC 44, *Welding and allied processes*, and was circulated to the member bodies in March 1982.

It has been approved by the member bodies of the following countries :

Australia	Finland	Norway
Austria	France	Pakistan
Belgium	India	Romania
Brazil	Ireland	Spain
Canada	Italy	Sweden
China	Japan	Switzerland
Czechoslovakia	Korea, Rep. of	USSR
Egypt, Arab Rep. of	Netherlands	

The member bodies of the following countries expressed disapproval of the document on technical grounds :

United Kingdom
USA

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0 Introduction

When designing and making a brazed joint, quite apart from the physical properties of the brazing alloy and the mechanical properties which may be expected from the joint, it is important to know the brazeability as a function of the operating conditions adopted. The determination of wettability has already been the subject of numerous investigations and proposals regarding testing methods.

In carrying out these investigations, the most frequently used methods are based on the spreading of a drop, or on the measurement of surface tension, but they in fact only take into account one element of the problem. It is important to know not only the way in which the liquid filler metal wets the surface of the parent metal but also how this same liquid filler metal behaves in a given gap between the joint components when diffusion takes place.

The test piece described in this International Standard gives guidance about the effects of brazing variables on filler metal flow when capillary gaps of different dimensions are used.

1 Scope and field of application

This International Standard specifies a varying gap test piece and a testing method for assessing the influence of the various parameters which can influence brazing during manufacture as a function of clearances.

2 Description of the varying gap test piece

The design of the varying gap test piece is shown in figure 1. By using this configuration, it is possible to investigate flow characteristics in the same specimen with capillary gaps varying from 0 to 0,5 mm.

The test piece consists of :

a) an outer tube A :

exterior diameter, 19 ± 0,1 mm
interior diameter, 14 ± 0,02 mm
height, 80 ± 0,05 mm;

The inner end of tube A is bevelled to 45°, while keeping a root face with a width of 0,5 ± 0,05 mm.

b) an inner tube B :

exterior diameter, 13,5 ± 0,02 mm
interior diameter, 9,5 ± 0,1 mm
height, 80 ± 0,05 mm;

c) a cup C used as a bottom for the test piece;

NOTE — It is necessary that there is a gap between the base of the inner tube B and the cup C to allow the filler metal to flow into the capillary gap between tubes A and B.

d) two adjustment screws press the inner cylinder B against the inner wall of the outer cylinder A in such a way that, on looking at a cross-section of the assembly, the gap varies from 0 to 0,5 mm over one half of the circumference.

The filler metal(cut in pieces of 15 mm to 20 mm) is introduced into the bore of the inner tube B. If it requires fluxing at the temperature of the test, then the flux is also introduced into the bore. The method of mixing filler metal and flux will depend upon their characteristics. It is suggested that about 1 400 mm^3 of filler metal and the appropriate quantity of flux be used.

3 Purpose of the test

The variables that can be investigated by this test include :

a) parent material : light alloys, copper and its alloys, non-allied steels and steels with low levels of addition elements and stainless steels, etc.;

b) surface condition : various machine finishes, surface roughness effects, chemical and other cleaning, plating, etc.;

c) filler metals : silver based, copper based, nickel based, noble metal based, etc.;

d) flux : various types of flux;

e) atmosphere : air, hydrogen, vacuum, cracked ammonia;

f) method of heating : torch, furnace, induction, infra-red, etc.;

g) heating cycle : degree of superheat, time at temperature, time to reach temperature, cooling rate.

4 Preparation of test piece

The test piece is prepared according to a schedule, if methods of cleaning or surface preparation are part of the investigation, then these should be carefully applied.

5 Brazing cycle

The assembly is heated to the appropriate temperature. The method of measuring temperature shall be such that a standard is achieved. The thermocouple shall record the maximum temperature achieved by the sample. It is important that a uniform temperature be achieved over the whole of the sample, unless "variability in temperature" is the factor being investigated. In this case, the sample must be instrumented sufficiently to give maximum information. Factors such as "rate of rise to temperature" and "time at temperature" must be carefully recorded.

6 Examination

After brazing, the specimen should be radiographed along two or more perpendicular axes (see figure 3). The height of the liquid metal rise is then measured on the films and the values thus obtained are plotted against the angle on a developed diagram. Micrographic inspection of the top of the test piece will enable accurate measurement of the rise of the filler metal at 80 mm up the test piece to be carried out.

7 Micrographic inspection

Micrographic inspection is carried out on a section taken at right angles to the axis of the test piece at a point 30 mm up its length to assess the flow of filler metal at this point. Other sections can be taken at right angles to the axis at various distances from the base. This will enable more data to be obtained. The width of the filler metal should be measured, and other features should be investigated such as filler metal alloying and grain boundary penetration into the parent material. Their relationship to the capillary joint gap should be noted. By carrying out several tests, the operator can study parameters such as :

- performance of the parent metal;
- surface condition of the parts to be brazed;
- grade of the filler metal;
- type of flux or atmosphere;
- method and conditions of heating (rate of filling, temperature,
- time,
- rate of cooling, etc.).

8 Results

The results can be conveniently collated on a test data sheet in a similar way to that shown in figure 5. The table can be extended to include other variables investigated.

Dimension in millimetres

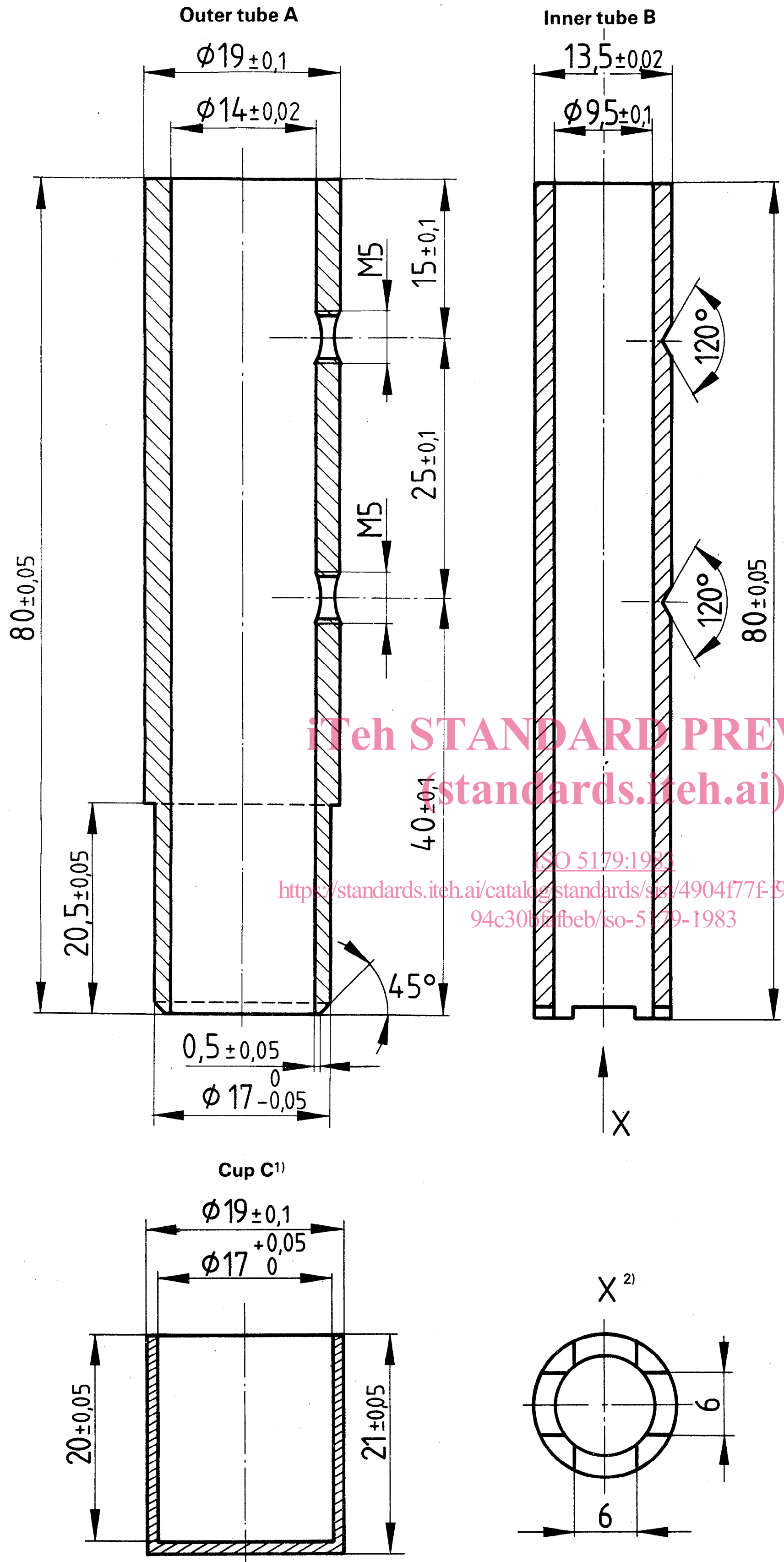


Figure 1 — Components (Scale : 1,5)

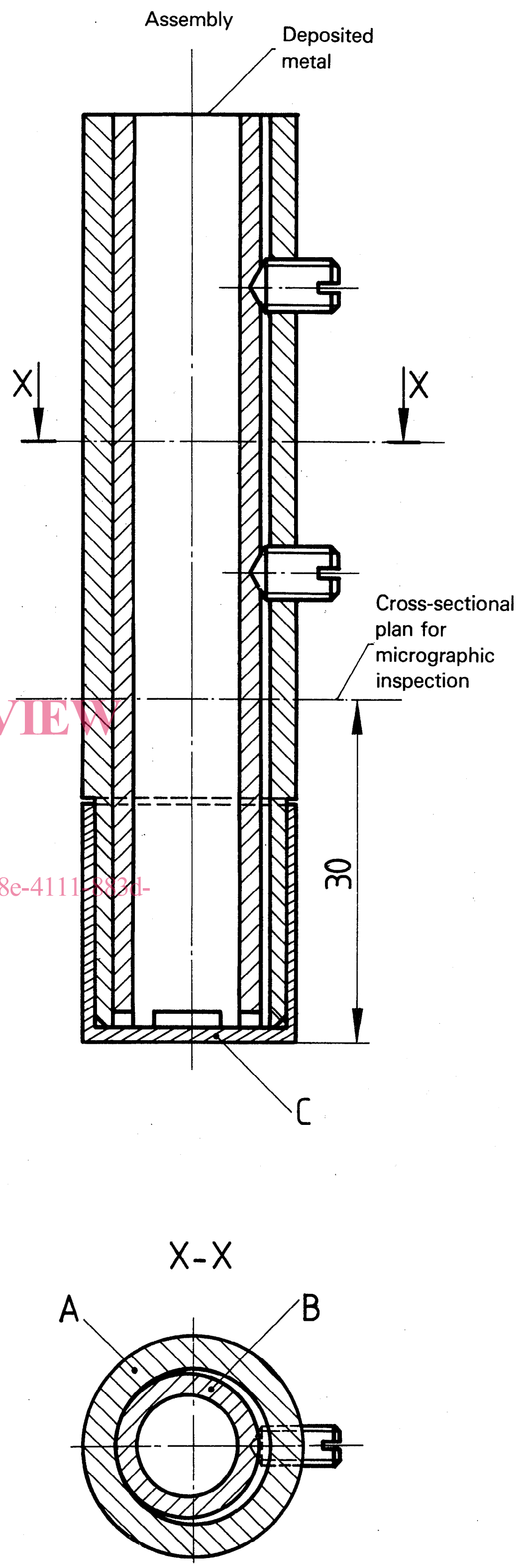


Figure 2 — Assembly (Scale : 1,5)

1) Cup C forms the base for the test piece.

2) The power end of tube B is provided with four identical centred recesses, 1 $^{+0,05}_{0}$ mm high in the shape of an orthogonal cross of 6 ± 0,05 mm width obtained by stamping.

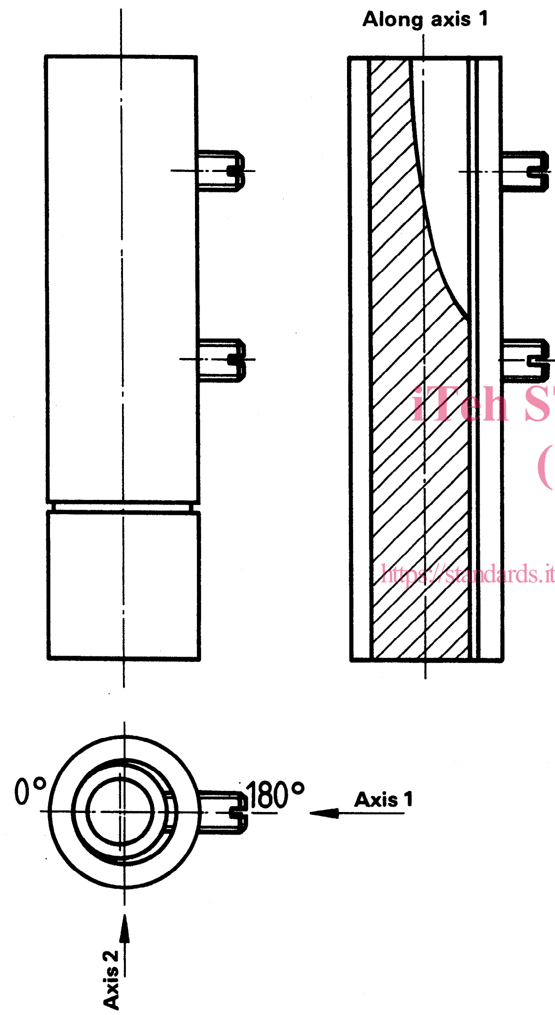


Figure 3 — Examination of the radiograph

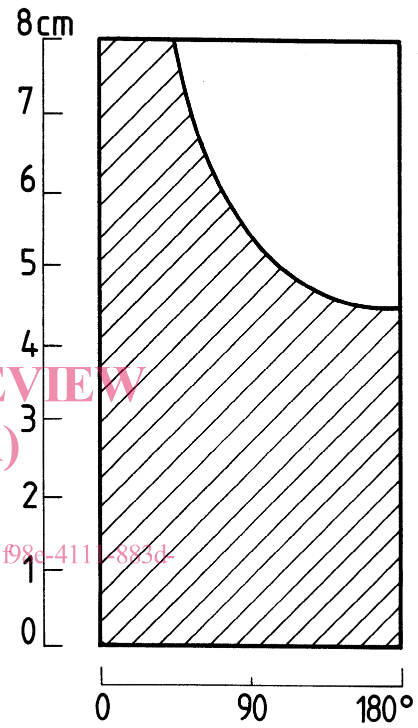


Figure 4 — Curve shown flat

NOTE — The height of the capillary rise can be measured either from the base of the test piece or from the bottom of the meniscus of the molten metal located at the bottom of the test piece. In fact, the quantity of metal used for the test (in the order of 1 400 mm^3) is superabundant and some metal remains at the bottom of the test piece. Therefore it may be advisable to measure the rise height from the bottom of the meniscus which indicates the boundary of the molten metal located at the bottom of the test piece and which does not participate in the rise.

Parent metal :

Test No. :

Chemical composition of filler metal :

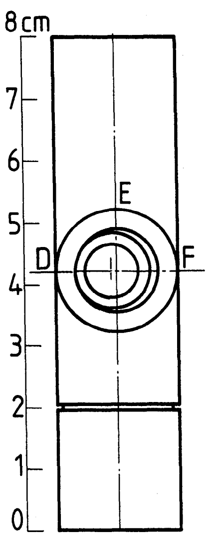
Liquidus-solidus :

Type of flux :

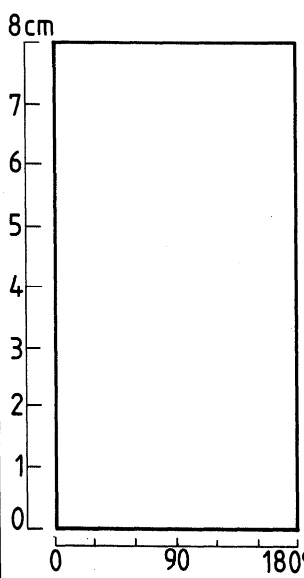
Brazing temperature :

Method of heating :

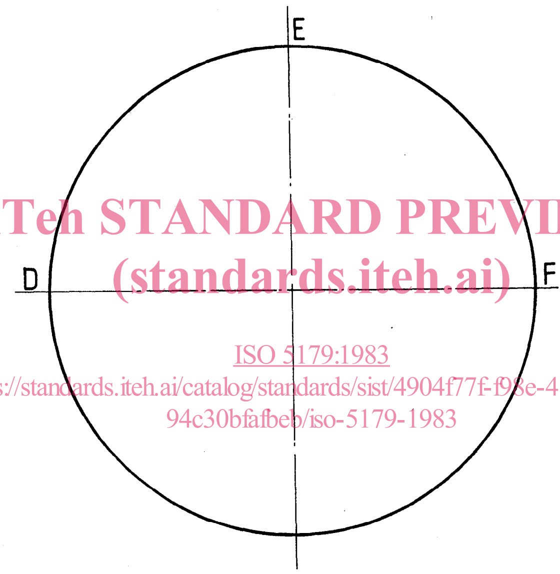
Visual inspection



X-ray inspection



Size and hardness inspection



Zone	Thickness, µm			Hardness : HV 100	
	Initial gap	Melted metal	Intercrystalline penetration	Parent metal	Melted metal
D	0				
E	244				
F	500				

Micrographic inspection

Zone area F

Zone area D

Figure 5 — Typical test report form

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