

Hollow bars for machining — Technical delivery conditions —

Part 1: Non alloy and alloy steels

The European Standard EN 10294-1:2005 has the status of a
British Standard

ICS 77.140.75

National foreword

This British Standard is the official English language version of EN 10294-1:2005. It partially replaces BS 6258:1988 which will remain current until BS EN 10294-2 is published. The reader should be aware that work has not yet begun on BS EN 10294-2.

The UK participation in its preparation was entrusted to Technical Committee ISE/8, Steel pipes, which has the responsibility to:

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- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep UK interests informed;
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English Version

Hollow bars for machining - Technical delivery conditions - Part 1: Non alloy and alloy steels

Barres creuses pour usinage - Conditions techniques de
livraison - Partie 1 : Aciers non alliés et alliés

Stahlrohre für die spanende Bearbeitung (Drehteilrohre) -
Technische Lieferbedingungen - Teil 1: Unlegierte und
legierte Stähle

This European Standard was approved by CEN on 29 August 2005.

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Foreword

This European Standard (EN 10294-1:2005) has been prepared by Technical Committee ECISS/TC 29 “steel tubes and fittings for steel tubes”, the secretariat of which is held by UNI.

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of an identical text or by endorsement, at the latest by April 2006, and conflicting national standards shall be withdrawn at the latest by April 2006.

This European Standard differs from ISO 2938, *Hollow bars for machining*.

Another part of EN 10294 in course of preparation is:

— Part 2: *Stainless steels*.

Other European Standard series covering tubes for mechanical and general engineering purposes are:

— EN 10296, *Welded steel tubes for mechanical and general engineering purposes*,

— EN 10297, *Seamless steel tubes for mechanical and general engineering purposes*.

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1 Scope

This part of EN 10294 specifies the technical delivery conditions for seamless steel hollow bars intended for the manufacture of engineering components by machining.

Machinability requirements are defined and a list of hollow bar size codes is given with the related dimensions achievable after machining when centring on the outside diameter.

NOTE Dimensional requirements for other products, for example, applying when centring on the inside diameter may be agreed between purchaser and manufacturer at the time of enquiry and order (see Options 3 and 4).

2 Normative references

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

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

EN 10020:2000, *Definition and classification of grades of steel.*

EN 10021:1993, *General technical delivery requirements for steel and iron products.*

EN 10045-1, *Metallic materials – Charpy impact test – Part 1: Test method.*

EN 10052:1993, *Vocabulary of heat treatment terms for ferrous products.*

EN 10168, *Steel products – Inspection documents – List of information and description.*

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

EN 10266:2003, *Steel tubes, fittings and structural hollow sections – Symbols and definitions of terms for use in product standards.*

EN ISO 377, *Steel and steel products – Location and preparation of samples and test pieces for mechanical testing (ISO 377:1997).*

EN ISO 2566-1, *Steel – Conversion of elongation values – Part 1: Carbon and low alloy steels (ISO 2566-1:1984).*

ISO 3685, *Tool-life testing with single-point turning tools.*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 10020:2000, EN 10021:1993, EN 10052:1993 and EN 10266:2003 and the following apply.

3.1

hollow bar

circular long product made by a seamless tube manufacturing process or by drilling a bore into a rolled or forged bar

These products are characterized by special dimensions and material properties which confer machinability, suitability for heat treatment and surface condition suitable for final machining of the component

3.2

centering on outside diameter

first chucking is made on the outside diameter and machining is performed on the outside surface and/or on the inside surface

3.3

centering on the inside diameter

first chucking is made on the inside diameter and machining is performed on the outside surface and/or on the inside surface

3.4

normalizing forming

rolling process in which the final deformation is carried out in a certain temperature range leading to a material condition equivalent to that obtained after normalizing so that the specified values of the mechanical properties are retained even after normalizing

NOTE When throughout this European Standard the term tube is used, it is synonymous to hollow bar.

4 Symbols

In addition to (or deviating from) the symbols defined in EN 10266:2003 the following symbols apply:

CS Cutting speed, in metres per minute

D_e Maximum achievable outside diameter when centring on the outside diameter; in millimetres

Di_e Minimum achievable inside diameter when centring on the outside diameter, in millimetres

D_d Manufacturer's specific outside diameter of the delivered product, in millimetres

T_d Manufacturer's specific wall thickness of the delivered product, in millimetres

$T_{0,3}$ Time to obtain a 0,3 mm tool wear, in minutes

T_N Nominal wall thickness, calculated as the half difference between the maximum achievable outside diameter D_e and the minimum achievable inside diameter Di_e , in millimetres

5 Classification and designation

5.1 Classification

In accordance with the classification system in EN 10020, all steel grades except E590K2 are non-alloy quality steels; the steel grade E590K2 is a non-alloy special steel.

5.2 Designation

For tubes covered by this part of EN 10294 the steel designation consists of:

— number of this part of this European standard (EN 10294-1);

plus either:

— steel name in accordance with EN 10027-1;

or

— steel number in accordance with EN 10027-2.

The steel name is defined by:

— capital letter E for engineering purposes;

— indication of the specified minimum yield strength for thicknesses ≤ 16 mm, expressed in MPa.

6 Information to be supplied by the purchaser

6.1 Mandatory information

The following information shall be supplied by the purchaser at the time of enquiry and order:

- a) quantity (mass or total length or number);
- b) term "hollow bar";
- c) hollow bar size code;
- d) reference to this European Standard;
- e) steel grade (steel name or steel number);
- f) mechanical properties for tubes with wall thickness T_N greater than 50 mm.

6.2 Options

A number of options are specified in this European Standard and these are listed below. In the event that the purchaser does not indicate a wish to implement any of these options at the time of enquiry and order, the hollow bars shall be supplied in accordance with the basic specification (see 6.1).

- 1) supply of machinability data to the purchaser (see 8.4);
- 2) special criteria for surface condition (see 8.5);
- 3) clean turned sizes when centring on the inside diameter(see 8.8.3);
- 4) exact lengths (see 8.8.4);
- 5) inspection document 3.2 (see 9.2.1);
- 6) temporary corrosion protection (see clause 13).

6.3 Example of an order

50 t of hollow bars in accordance with EN 10294-1, hollow bar size code 9065, made of steel grade E470:

50 t hollow bars – 9065 – EN 10294-1 – E470

7 Manufacturing process

7.1 Steelmaking process

The steels covered by this European Standard are characterized by their suitability for machining (see 8.4). The steelmaking process is left at the discretion of the manufacturer provided all requirements defined in clause 8 can be fulfilled with the material produced.

7.2 Deoxidation process

Steels shall be fully killed.

7.3 Tube manufacture and delivery conditions

The products shall be manufactured by a seamless process or by machining from round bars. At the discretion of the manufacturer the tubes may be hot finished or cold finished before any heat treatment in accordance with Table 1 is applied.

Cold finished products in grades E355 and E470 shall subsequently be either stress relieved or annealed or normalized. The method is left at the discretion of the manufacturer.

The delivery conditions are given in Table 1.

Table 1 – Delivery condition

| Steel name | Delivery condition ^a |
|---|----------------------------------|
| E355 | No heat treatment required |
| E355J2 | Normalized or normalizing-formed |
| E470 | No heat treatment required |
| E420J2 | Normalized or normalizing-formed |
| E590K2 | Quenched + tempered |
| ^a See requirements for cold finished products in 7.3 | |

8 Requirements

8.1 General

The hollow bars, when supplied in a delivery condition according to 7.3 and inspected in accordance with clauses 9, 10 and 11, shall comply with the requirements of this part of EN 10294.

In addition, the general technical delivery conditions specified in EN 10021 shall apply.

8.2 Chemical composition

The cast analysis reported by the steel producer shall apply and conform to the requirements of Table 2.

In case of dispute the permissible deviations of a product analysis from the limits of cast analysis specified in Table 2 are given in table 3.

NOTE When welding products produced from hollow bars according to this European Standard, account should be taken of the fact that the behaviour of the steel during and after welding is dependent not only on the steel, but also on the material thickness and the conditions of preparing for and carrying out welding.

Table 2 – Chemical composition (cast analysis) ^a in % by mass

| Steel grade | C | | Si | | Mn | | P max | S | | Cr max | Mo max | Ni max | Al | | Cu max | N Max | Nb ^b max | Ti ^b | | V ^c | |
|-------------------|------|------|------|------|------|------|----------|-------|-------|-----------|-----------|-----------|-------|-------|-----------|----------|------------------------|-----------------|------|----------------|------|
| | min | max | min | max | min | max | | min | max | | | | min | max | | | | min | max | | |
| E355 ^d | - | 0,22 | - | 0,55 | - | 1,60 | 0,030 | 0,015 | 0,050 | - | - | - | - | - | - | - | - | - | - | - | - |
| E355J2 | - | 0,22 | - | 0,55 | - | 1,60 | 0,030 | 0,015 | 0,050 | 0,30 | 0,08 | 0,30 | 0,010 | 0,060 | 0,30 | 0,020 | 0,05 | 0,05 | - | - | 0,10 |
| E420J2 | 0,16 | 0,22 | 0,10 | 0,50 | 1,30 | 1,70 | 0,030 | 0,015 | 0,050 | 0,30 | 0,08 | 0,40 | 0,010 | - | 0,30 | 0,020 | 0,07 | 0,05 | 0,08 | 0,08 | 0,15 |
| E470 | 0,16 | 0,22 | 0,10 | 0,50 | 1,30 | 1,70 | 0,030 | 0,015 | 0,050 | - | - | - | 0,010 | - | - | 0,020 | 0,07 | - | 0,08 | 0,08 | 0,15 |
| E590K2 | 0,16 | 0,22 | 0,10 | 0,50 | 1,30 | 1,70 | 0,030 | 0,015 | 0,050 | 0,30 | 0,08 | 0,40 | 0,010 | - | 0,30 | 0,020 | 0,07 | 0,05 | 0,08 | 0,08 | 0,15 |

^a Elements not included in this table shall not be intentionally added to the steel without the agreement of the purchaser, except for elements which may be added for finishing the cast. All appropriate measures shall be taken to prevent the addition of undesirable elements from scrap or other materials used in the steelmaking process.

^b The content of these elements need not to be reported unless intentionally added to the cast.

^c V may be replaced by Nb or Ti percent for percent provided that the V content shall be at least 0,05 % and the sum V + Nb + Ti is ≤ 0,21 %.

^d Additions of Nb, V or Ti are permitted and left at the discretion of the manufacturer. The content of these elements shall be reported

Table 3 – Permissible deviations of the product analysis from specified limits on cast analysis given in Table 2

| Element | Limiting value for the cast analysis according to Table 2 | Permissible deviation of the product analysis |
|---------|---|---|
| C | ≤ 0,22 | ± 0,02 |
| Si | ≤ 0,55 | ± 0,05 |
| Mn | ≤ 1,70 | - 0,05 / + 0,10 |
| P | ≤ 0,030 | + 0,005 |
| S | ≤ 0,050 | - 0,003/+ 0,005 |
| Cr | ≤ 0,30 | + 0,05 |
| Ni | ≤ 0,40 | + 0,05 |
| Mo | ≤ 0,08 | + 0,02 |
| Cu | ≤ 0,30 | + 0,05 |
| N | ≤ 0,020 | + 0,002 |
| Al | ≤ 0,060 | ± 0,005 |
| Nb | ≤ 0,07 | + 0,01 |
| V | ≤ 0,15 | ± 0,02 |
| Ti | ≤ 0,05 | + 0,01 |

8.3 Mechanical properties

The mechanical properties of the tubes shall conform to the requirements of Table 4.

Table 4 – Mechanical properties ^a

| Steel grade | | Upper yield strength ReH min MPa For T_N in mm | | | | Tensile strength Rm min Mpa For T_N in mm | | | | Elongation in the longitudinal direction | Minimum average absorbed energy KV, in. J at a test temperature of - 20 °C |
|-------------|--------|---|--------------------|--------------------|--------------------|--|--------------------|--------------------|--------------------|--|--|
| Name | Number | $T_N \leq 16$ | 16 < $T_N \leq 25$ | 25 < $T_N \leq 40$ | 40 < $T_N \leq 50$ | $T_N \leq 16$ | 16 < $T_N \leq 25$ | 25 < $T_N \leq 40$ | 40 < $T_N \leq 50$ | A min % | |
| E355 | 1,0580 | 355 | 345 | 335 | 335 | 490 | 490 | 470 | 470 | 18 | - |
| E355J2 | 1,0592 | 355 | 345 | 335 | 335 | 490 | 490 | 470 | 470 | 20 | 27 |
| E420J2 | 1,0599 | 420 | 400 | 380 | 380 | 600 | 560 | 530 | 530 | 19 | 27 |
| E470 | 1,0536 | 470 | 460 | 430 | 430 | 650 | 620 | 600 | 550 | 17 | - |
| E590K2 | 1,0644 | 590 | 540 | 480 | 480 | 700 | 650 | 570 | 570 | 16 | 40 |

^a At the discretion of the manufacturer the elongation may also be determined in the transverse direction. In this case the minimum values to be achieved shall be those for the longitudinal direction minus 2 points.

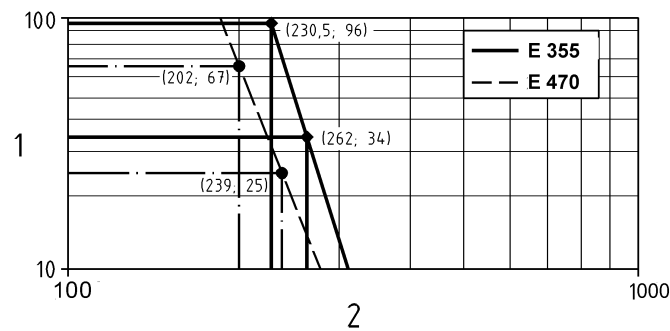
For nominal wall thicknesses T_N greater than 50 mm, the mechanical properties shall be agreed between the manufacturer and the purchaser.

8.4 Machinability

The machinability of a steel grade is in part characterized by the time necessary to obtain a determined tool wear as a function of the cutting speed. This logarithmic representation is usually called "TAYLOR curve". When Taylor curves are established this shall be done in accordance with Annex A.

For steel grades E355 and E470 the Taylor curves to be satisfied for conformity to the requirements of this part of EN 10294 are given in Figure 1.

Option 1 For grades E355 and E470 machinability data representative of the grade shall be given to the purchaser.



Key

- 1 Time, in minutes
- 2 Speed, in meters per minute

Figure 1 – Taylor curves

8.5 Appearance

The surface condition of the tubes shall be such that imperfections requiring further investigation with respect to depth can be detected by visual inspection.

Surface imperfections which will impair the specified dimensions after final machining shall be considered defects and the tubes shall be free of them.

It shall be permissible to dress surface imperfections provided that only grinding or machining is used for rectification work and that the specified dimensions after final machining are not impaired. All dressed areas shall blend smoothly into the contour of the tube.

Option 2 Special requirements for either the outside or the inside surface when not intended for machining shall apply as specified by the purchaser.

8.6 Straightness

8.6.1 Except as provided in 8.6.2, the deviation from straightness of any tube length L shall not exceed $0,001 L$. Deviations from straightness over any 1 m length shall not exceed 1 mm.

8.6.2 For steel grade E590K2 the deviation from straightness of any tube length L shall not exceed $0,0015 L$. Deviations from straightness over any 1 m length shall not exceed 1,5 mm.

8.7 Preparation of ends

Tubes shall be delivered with square cut ends. The ends shall be free from burrs that may be harmful during handling.

8.8 Dimensions, masses and tolerances

8.8.1 Hollow bar size code

The hollow bar size code consists of:

— maximum achievable outside diameter D_e

followed by:

— minimum achievable inside diameter D_{ie}

as shown in Table 5.

Preferred size codes of hollow bars covered by this part of EN 10294 are given in Table 5.

NOTE Hollow bar size codes for centring on the outside diameter which are different from those in Table 5 may be agreed but should not be used for new designs.

8.8.2 Dimensions and masses of the delivered products

The dimensions of the delivered products may vary depending on the tube manufacturing process and/or the manufacturer. The manufacturer shall report at the time of enquiry and order his specific values for the outside diameter D_d and the wall thickness T_d of the delivered product and its average delivered mass per metre (For tolerances see 8.8.5.1).

8.8.3 Dimensions achievable after machining

Table 5 gives, for each hollow bar size code and when centring on the outside diameter, the specified clean turned sizes which can be machined without non clean-up surface from each hollow bar size, i.e.:

— maximum achievable outside diameter D_e ;

— minimum achievable inside diameter D_{ie} ;

The maximum length of the machined part for which these values are achievable is three times the delivered outside diameter D_d or 200 mm, whichever is smaller.

NOTE When subsequent heat treatment has to be carried out at any stage of the processing of the products after delivery, dimensional variations may happen which may affect the final clean turned sizes. In this case, the purchaser should contact the manufacturer before ordering for further advice.

Table 5 – Dimensions achievable after machining when centring on the outside diameter

| Hollow bar size code | Maximum achievable outside diameter D_e mm | Minimum achievable inside diameter D_i mm |
|--------------------------|--|---|
| 3020 | 30 | 20 |
| 3015 | 30 | 15 |
| 3010 | 30 | 10 |
| 3525 | 35 | 25 |
| 3520 | 35 | 20 |
| 3515 | 35 | 15 |
| 3510 | 35 | 10 |
| 4030 | 40 | 30 |
| 4025 | 40 | 25 |
| 4020 | 40 | 20 |
| 4015 | 40 | 15 |
| 4535 | 45 | 35 |
| 4530 | 45 | 30 |
| 4525 | 45 | 25 |
| 4520 | 45 | 20 |
| 4515 | 45 | 15 |
| 5040 | 50 | 40 |
| 5035 | 50 | 35 |
| 5030 | 50 | 30 |
| 5025 | 50 | 25 |
| 5545 | 55 | 45 |
| 5540 | 55 | 40 |
| 5535 | 55 | 35 |
| 5530 | 55 | 30 |
| 5525 | 55 | 25 |
| 6050 | 60 | 50 |
| 6045 | 60 | 45 |
| 6040 | 60 | 40 |
| 6035 | 60 | 35 |
| 6030 | 60 | 30 |
| 6555 | 65 | 55 |
| 6550 | 65 | 50 |
| 6545 | 65 | 45 |
| <i>(to be continued)</i> | | |

Table 5 (continued)

| Hollow bar size code | Maximum achievable outside diameter D_e mm | Minimum achievable inside diameter D_i mm |
|--------------------------|--|---|
| 6540 | 65 | 40 |
| 6535 | 65 | 35 |
| 6530 | 65 | 30 |
| 7060 | 70 | 60 |
| 7055 | 70 | 55 |
| 7050 | 70 | 50 |
| 7045 | 70 | 45 |
| 7040 | 70 | 40 |
| 7035 | 70 | 35 |
| 7030 | 70 | 30 |
| 7565 | 75 | 65 |
| 7560 | 75 | 60 |
| 7555 | 75 | 55 |
| 7550 | 75 | 50 |
| 7545 | 75 | 45 |
| 7540 | 75 | 40 |
| 7535 | 75 | 35 |
| 8070 | 80 | 70 |
| 8065 | 80 | 65 |
| 8060 | 80 | 60 |
| 8055 | 80 | 55 |
| 8050 | 80 | 50 |
| 8045 | 80 | 45 |
| 8040 | 80 | 40 |
| 8570 | 85 | 70 |
| 8565 | 85 | 65 |
| 8560 | 85 | 60 |
| 8555 | 85 | 55 |
| 8550 | 85 | 50 |
| 8545 | 85 | 45 |
| 9075 | 90 | 75 |
| 9070 | 90 | 70 |
| 9065 | 90 | 65 |
| <i>(to be continued)</i> | | |

Table 5 (continued)

| Hollow bar size code | Maximum achievable outside diameter D_e mm | Minimum achievable inside diameter D_i mm |
|--------------------------|--|---|
| 9060 | 90 | 60 |
| 9055 | 90 | 55 |
| 9050 | 90 | 50 |
| 9045 | 90 | 45 |
| 9580 | 95 | 80 |
| 9575 | 95 | 75 |
| 9570 | 95 | 70 |
| 9565 | 95 | 65 |
| 9560 | 95 | 60 |
| 9555 | 95 | 55 |
| 9550 | 95 | 50 |
| 9545 | 95 | 45 |
| 10085 | 100 | 85 |
| 10080 | 100 | 80 |
| 10075 | 100 | 75 |
| 10070 | 100 | 70 |
| 10065 | 100 | 65 |
| 10060 | 100 | 60 |
| 10055 | 100 | 55 |
| 10050 | 100 | 50 |
| 10045 | 100 | 45 |
| 10590 | 105 | 90 |
| 10585 | 105 | 85 |
| 10580 | 105 | 80 |
| 10575 | 105 | 75 |
| 10570 | 105 | 70 |
| 10565 | 105 | 65 |
| 10560 | 105 | 60 |
| 10555 | 105 | 55 |
| 10550 | 105 | 50 |
| 11095 | 110 | 95 |
| 11090 | 110 | 90 |
| 11085 | 110 | 85 |
| <i>(to be continued)</i> | | |

Table 5 (continued)

| Hollow bar size code | Maximum achievable outside diameter D_e mm | Minimum achievable inside diameter D_i mm |
|--------------------------|--|---|
| 11080 | 110 | 80 |
| 11075 | 110 | 75 |
| 11070 | 110 | 70 |
| 11065 | 110 | 65 |
| 11060 | 110 | 60 |
| 115100 | 115 | 100 |
| 11595 | 115 | 95 |
| 11590 | 115 | 90 |
| 11585 | 115 | 85 |
| 11580 | 115 | 80 |
| 11575 | 115 | 75 |
| 11570 | 115 | 70 |
| 11565 | 115 | 65 |
| 120100 | 120 | 100 |
| 12095 | 120 | 95 |
| 12090 | 120 | 90 |
| 12085 | 120 | 85 |
| 12080 | 120 | 80 |
| 12075 | 120 | 75 |
| 12070 | 120 | 70 |
| 125105 | 125 | 105 |
| 125100 | 125 | 100 |
| 12595 | 125 | 95 |
| 12590 | 125 | 90 |
| 12585 | 125 | 85 |
| 12580 | 125 | 80 |
| 12575 | 125 | 75 |
| 12570 | 125 | 70 |
| 130110 | 130 | 110 |
| 130105 | 130 | 105 |
| 130100 | 130 | 100 |
| 13095 | 130 | 95 |
| 13090 | 130 | 90 |
| <i>(to be continued)</i> | | |

Table 5 (continued)

| Hollow bar size code | Maximum achievable outside diameter D_e mm | Minimum achievable inside diameter D_i mm |
|-------------------------|---|--|
| 13085 | 130 | 85 |
| 13080 | 130 | 80 |
| 13075 | 130 | 75 |
| 140120 | 140 | 120 |
| 140115 | 140 | 115 |
| 140110 | 140 | 110 |
| 140105 | 140 | 105 |
| 140100 | 140 | 100 |
| 14095 | 140 | 95 |
| 14090 | 140 | 90 |
| 14085 | 140 | 85 |
| 14080 | 140 | 80 |
| 14075 | 140 | 75 |
| 150130 | 150 | 130 |
| 150125 | 150 | 125 |
| 150120 | 150 | 120 |
| 150115 | 150 | 115 |
| 150110 | 150 | 110 |
| 150105 | 150 | 105 |
| 150100 | 150 | 100 |
| 15095 | 150 | 95 |
| 15090 | 150 | 90 |
| 15085 | 150 | 85 |
| 160135 | 160 | 135 |
| 160130 | 160 | 130 |
| 160125 | 160 | 125 |
| 160120 | 160 | 120 |
| 160115 | 160 | 115 |
| 160110 | 160 | 110 |
| 160105 | 160 | 105 |
| 160100 | 160 | 100 |
| 16095 | 160 | 95 |
| 16090 | 160 | 90 |
| | | (to be continued) |

Table 5 (continued)

| Hollow bar size code | Maximum achievable outside diameter D_e mm | Minimum achievable inside diameter D_i mm |
|--------------------------|--|---|
| 16085 | 160 | 85 |
| 170145 | 170 | 145 |
| 170140 | 170 | 140 |
| 170135 | 170 | 135 |
| 170130 | 170 | 130 |
| 170125 | 170 | 125 |
| 170120 | 170 | 120 |
| 170115 | 170 | 115 |
| 170110 | 170 | 110 |
| 170105 | 170 | 105 |
| 170100 | 170 | 100 |
| 17095 | 170 | 95 |
| 17090 | 170 | 90 |
| 17085 | 170 | 85 |
| 17080 | 170 | 80 |
| 180155 | 180 | 155 |
| 180150 | 180 | 150 |
| 180145 | 180 | 145 |
| 180140 | 180 | 140 |
| 180135 | 180 | 135 |
| 180130 | 180 | 130 |
| 180125 | 180 | 125 |
| 180120 | 180 | 120 |
| 180115 | 180 | 115 |
| 180110 | 180 | 110 |
| 180105 | 180 | 105 |
| 180100 | 180 | 100 |
| 18095 | 180 | 95 |
| 18090 | 180 | 90 |
| 18085 | 180 | 85 |
| 190170 | 190 | 170 |
| 190165 | 190 | 165 |
| 190160 | 190 | 160 |
| <i>(to be continued)</i> | | |

Table 5 (continued)

| Hollow bar size code | Maximum achievable outside diameter D_e mm | Minimum achievable inside diameter D_i mm |
|----------------------|--|---|
| 190155 | 190 | 155 |
| 190150 | 190 | 150 |
| 190145 | 190 | 145 |
| 190140 | 190 | 140 |
| 190135 | 190 | 135 |
| 190130 | 190 | 130 |
| 190125 | 190 | 125 |
| 190120 | 190 | 120 |
| 190115 | 190 | 115 |
| 190110 | 190 | 110 |
| 190105 | 190 | 105 |
| 190100 | 190 | 100 |
| 200175 | 200 | 175 |
| 200170 | 200 | 170 |
| 200165 | 200 | 165 |
| 200160 | 200 | 160 |
| 200155 | 200 | 155 |
| 200150 | 200 | 150 |
| 200145 | 200 | 145 |
| 200140 | 200 | 140 |
| 200135 | 200 | 135 |
| 200130 | 200 | 130 |
| 200125 | 200 | 125 |
| 200120 | 200 | 120 |
| 200115 | 200 | 115 |
| 200110 | 200 | 110 |
| 200105 | 200 | 105 |
| 200100 | 200 | 100 |
| 210185 | 210 | 185 |
| 210180 | 210 | 180 |
| 210175 | 210 | 175 |
| 210170 | 210 | 170 |
| 210165 | 210 | 165 |
| 210160 | 210 | 160 |

(to be continued)

Table 5 (continued)

| Hollow bar size code | Maximum achievable outside diameter D_e mm | Minimum achievable inside diameter D_i mm |
|--------------------------|---|--|
| 210155 | 210 | 155 |
| 210150 | 210 | 150 |
| 210145 | 210 | 145 |
| 210140 | 210 | 140 |
| 210135 | 210 | 135 |
| 210130 | 210 | 130 |
| 210125 | 210 | 125 |
| 210120 | 210 | 120 |
| 220180 | 220 | 180 |
| 220170 | 220 | 170 |
| 220160 | 220 | 160 |
| 220155 | 220 | 155 |
| 220150 | 220 | 150 |
| 220145 | 220 | 145 |
| 220140 | 220 | 140 |
| 220135 | 220 | 135 |
| 220130 | 220 | 130 |
| 220125 | 220 | 125 |
| 220120 | 220 | 120 |
| 230190 | 230 | 190 |
| 230180 | 230 | 180 |
| 230170 | 230 | 170 |
| 230160 | 230 | 160 |
| 230155 | 230 | 155 |
| 230150 | 230 | 150 |
| 230145 | 230 | 145 |
| 230140 | 230 | 140 |
| 230135 | 230 | 135 |
| 230130 | 230 | 130 |
| 230125 | 230 | 125 |
| 250200 | 250 | 200 |
| 250190 | 250 | 190 |
| 250180 | 250 | 180 |
| <i>(to be continued)</i> | | |

Table 5 (conclusion)

| Hollow bar size code | Maximum achievable outside diameter D_e mm | Minimum achievable inside diameter D_{i_e} mm |
|----------------------|--|---|
| 250170 | 250 | 170 |
| 250160 | 250 | 160 |
| 250155 | 250 | 155 |
| 250150 | 250 | 150 |
| 250145 | 250 | 145 |
| 250140 | 250 | 140 |
| 250135 | 250 | 135 |
| 250130 | 250 | 130 |
| 250125 | 250 | 125 |
| 250120 | 250 | 120 |

Option 3 The ordered clean turned sizes apply for centring on the inside diameter. In this case the hollow bar size code shall be preceded by the letter B

Example: B8867 means that the achievable clean turned sizes when centring on the inside diameter are:

- Maximum outside diameter 88 mm;
- Minimum inside diameter 67 mm.

8.8.4 Lengths

Unless option 4 is specified the tubes are delivered in random length. The length range may be agreed at the time of enquiry and order.

Option 4 The tubes shall be delivered in exact length, the length to be specified at the time of enquiry and order

8.8.5 Tolerances

8.8.5.1 Tolerances on outside diameter D_d and wall thickness T_d of the delivered product

The dimensions of the delivered product shall be within the tolerances given in Tables 6 and 7.

Table 6 – Tolerances on the outside diameter D_d of the delivered product

| Delivered outside diameter D_d mm | Tolerance |
|--|--------------|
| $D_d \leq 75$ | $\pm 0,5$ mm |
| $75 < D_d \leq 180$ | $\pm 0,75$ % |
| $D_d > 180$ | ± 1 % |

Table 7 – Tolerances on the wall thickness T_d of the delivered product

| $D_d \leq 180$ | | $D_d > 180$ | |
|--------------------------------------|--|--------------------------------------|---------------|
| Delivered wall thickness T_d mm | Tolerance | Delivered wall thickness T_d mm | Tolerance |
| ≤ 15 | $\pm 12,5 \%$ or $\pm 0,4$ mm, whichever is the greater | ≤ 30 | $\pm 12,5 \%$ |
| > 15 | $\pm 10 \%$ | > 30 | $\pm 10 \%$ |

8.8.5.2 Tolerances on exact length

The tolerances on exact length are given in table 8.

Table 8 – Tolerances on exact lengths

| Length L mm | Tolerance mm |
|-----------------------------|----------------------|
| $L < 2\,000$ | + :to be agreed 0 |
| $2\,000 \leq L \leq 6\,000$ | +10 0 |
| $6\,000 < L \leq 12\,000$ | +15 0 |
| $L > 12\,000$ | + :to be agreed 0 |

9 Inspection

9.1 Type of inspection

The compliance with the requirements of the order, for tubes in accordance with this part of EN 10294, shall be checked by specific inspection.

9.2 Inspection documents

9.2.1 Type of inspection document

Unless option 5 is specified an inspection certificate 3.1 in accordance with EN 10204 shall be issued.

Option 5 An inspection certificate 3.2 in accordance with EN 10204 as specified by the purchaser shall be issued.

If an inspection certificate 3.2 is specified, the purchaser shall notify the manufacturer of the name and address of the organisation or person who is to carry out the inspection and validate the inspection certificate. In case of inspection report 3.2, it shall additionally be agreed which party issues the certificate.

9.2.2 Content of inspection documents

The content of the inspection document shall be in accordance with EN 10168 and contain the following codes and information:

- A – Commercial transactions and parties involved;
- B – Description of products to which the inspection document applies;
- C02 – Direction of the test pieces;
- C10-C13 – Tensile test;
- C40-C43 – Impact test, where applicable;
- C71-C92 – Chemical composition of the cast analysis;
- D01 – Marking and identification, surface appearance and dimensional properties;
- Z – Validation.

9.3 Inspection and testing

Inspection and testing shall be carried out as stated in Table 9.

Table 9 – Summary of inspection and testing

| Type of inspection or test | Frequency of tests | Reference |
|--------------------------------|-----------------------|-----------|
| Cast analysis | One per cast | – |
| Tensile test | One per test unit | 11.1 |
| Impact test (where applicable) | One set per test unit | 11.2 |
| Dimensional inspection | Each tube | 11.3 |
| Visual examination | Each tube | 11.4 |

10 Sampling

10.1 Frequency of tests

10.1.1 Test unit

A test unit shall comprise hollow bars of the same size code, the same steel grade, the same cast, the same manufacturing process and, if applicable, the same heat treatment condition.

A test unit shall comprise a maximum of 200 mill lengths.

NOTE The mill length is the length of the as-rolled product.

10.1.2 Number of samples per test unit

One sample tube shall be taken from each test unit.

10.2 Preparation of samples and test pieces

10.2.1 General

Samples and test pieces shall be taken at the tube ends in accordance with the requirements of EN ISO 377.

10.2.2 Test piece for the tensile test

The test piece for the tensile test shall be taken in the longitudinal direction in accordance with the requirements of EN 10002-1.

10.2.3 Test piece for the impact test

Three standard Charpy-V notch test pieces in accordance with EN 10045-1 shall be taken in the longitudinal direction. If the thickness of the delivered product is such that standard test pieces cannot be produced, then test pieces of width less than 10 mm, but not less than 5 mm shall be prepared; the largest obtainable width shall be used.

Where 5 mm wide minimum test pieces cannot be obtained, these tubes shall not be subject to impact testing.

The test pieces shall be taken and prepared such that the axis of the notch is perpendicular to the surface of the tube.

11 Test methods

11.1 Tensile test

The test shall be carried out at room temperature in accordance with EN 10002-1, and the following determined:

- tensile strength (R_m);
- upper yield strength (R_{eH});
If a yield phenomenon is not present, the 0,2 % proof strength ($R_{p0,2}$) or the 0,5% proof strength, total extension ($R_{t0,5}$) shall be determined. In case of dispute, the 0,2 % proof strength ($R_{p0,2}$) shall apply;
- percentage elongation after fracture with a reference to a gauge length (L_0) of $5,65\sqrt{S_0}$.
If a non proportional test piece is used, the percentage elongation value shall be converted to the value for a gauge length $L_0 = 5,65\sqrt{S_0}$. using the conversion tables in EN ISO 2566-1.

11.2 Impact test

11.2.1 The test shall be carried out in accordance with EN 10045-1 at $-20\text{ }^\circ\text{C}$.

11.2.2 The average value of the set of three test pieces shall be equal to or greater than the specified value given in Table 4. One individual value may be below the specified value, provided that it is not less than 70 % of that value.

11.2.3 If the width W of the test piece is less than 10 mm, the measured impact energy (KV_p) shall be converted to the calculated impact energy (KV_c) using the following equation:

$$KV_c = \frac{10 \times KV_p}{W} \quad (1)$$

where

KV_c is the calculated impact energy, in Joules;

KV_p is the measured impact energy, in Joules;

W is the width of the test piece, in millimetres.

The calculated impact energy KV_c shall conform to the requirements given in 11.2.2.

11.2.4 If the requirements of 11.2.2 are not met, then an additional set of three test pieces may be taken at the discretion of the manufacturer from the same sample and tested. To consider the test unit as conforming, after testing the second set, the following conditions shall be satisfied simultaneously:

- average value of six test pieces shall be equal to or greater than the specified value;
- not more than two of six individual values may be lower than the specified value;
- not more than one of the six individual values may be lower than 70 % of the specified value.

11.2.5 The dimensions in millimetres of test pieces, the measured energy values and the resulting average value shall be reported.

11.3 Dimensional inspection

The specified dimensions, including straightness, shall be verified for compliance with the requirements of 8.6 and 8.8.5.

11.4 Visual examination

Tubes shall be visually examined for compliance with the requirements of 8.5.

11.5 Retests, sorting and reprocessing

For retest, sorting and reprocessing, the requirements of EN 10021 shall apply.

12 Marking

Unless otherwise agreed each hollow bar shall be indelibly marked continuously over the tube length on one line parallel to the tube axis.

For hollow bars with size code below 45XX the marking on the product may be replaced by a marking on a label securely attached to the bundle or box.

The marking shall include the following information:

- manufacturer's name or trade mark;

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- designation of the steel grade;
- number of this European Standard;
- hollow bar size code.

In addition the mark of the inspection representative, a heat or code number and/or an identification number which permits the correlation of the product or delivery unit to the related document shall be marked at least at one end of the tube or on the label where labels are used.

13 Temporary corrosion protection

Unless option 6 is specified the tubes shall be delivered without temporary corrosion protection.

Option 6 Tubes shall be specially protected for transit and storage. The type of coating shall be agreed at the time of enquiry and order.

Annex A (normative)

Method for establishing machinability data

A.1 General

This annex specifies a method and the parameters which shall be used when determining the machinability of a steel grade.

The purpose of this test is to determine the life duration of a tool used for machining a steel grade under predetermined testing conditions.

The test shall be carried out in accordance with ISO 3685.

The tube to be tested shall be peeled before testing. The test shall be carried out without using any lubricant. The machining shall be carried out on the external surface of the tube.

All parameters used during the test shall be reported.

A.2 Tube sizes

The preferred sizes to be used for the tube to be machined are:

- outside diameter (after peeling): between 90 mm and 150 mm;
- wall thickness after peeling: greater than 10 mm;
- length: between 500 mm and 1 000 mm.

A.3 Machining parameters

The machining parameters shall be:

- tool: P15 coated;
- feed: 0,4 mm / rev;
- depth of cut: 2,5 mm;
- nose radius: 0,8 mm;
- setting angle: $(75 \pm 5)^\circ$;
- wear criterion: flank wear V_b 0,3 mm;
- tool geometry (shape in accordance with ISO 3685);
- tool rake angle: -6° ;
- clearance angle: $+6^\circ$.

Bibliography

- [1] EN 10027-1, *Designation systems for steel – Part 1: Steel names.*
- [2] EN 10027-2, *Designation systems for steels – Part 2: Numerical system.*
- [3] CR 10261, *ECISS Information Circular 11 – Iron and steel – Review of available methods of chemical analysis .*

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