BS EN 755-7:2016

BSI Standards Publication

Aluminium and aluminium alloys — Extruded rod/bar, tube and profiles

Part 7: Seamless tubes, tolerances on dimensions and form

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National foreword

This British Standard is the UK implementation of EN 755-7:2016. It supersedes BS EN 755-7:2008 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee NFE/35, Light metals and their alloys.

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

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Published by BSI Standards Limited 2016

ISBN 978 0 580 91003 6

ICS 77.150.10

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

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 June 2016.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 755-7

June 2016

ICS 77.150.10

Supersedes EN 755-7:2008

English Version

Aluminium and aluminium alloys - Extruded rod/bar, tube and profiles - Part 7: Seamless tubes, tolerances on dimensions and form

Aluminium et alliages d'aluminium - Barres, tubes et profilés filés - Partie 7 : Tubes filés sur aiguille, tolérances sur dimensions et forme

Aluminium und Aluminiumlegierungen - Stranggepresste Stangen, Rohre und Profile - Teil 7: Nahtlose Rohre, Grenzabmaße und Formtoleranzen

This European Standard was approved by CEN on 11 April 2016.

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Ref. No. EN 755-7:2016 E

Contents

Page

European foreword

This document (EN 755-7:2016) has been prepared by Technical Committee CEN/TC 132 “Aluminium and aluminium alloys”, the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by December 2016, and conflicting national standards shall be withdrawn at the latest by December 2016.

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 755-7:2008.

The following technical modifications have been introduced during the revision:

— Subclause 4.2, Diameter - Round tube.

EN 755 comprises the following parts under the general title *Aluminium and aluminium alloys — Extruded rod/bar, tube and profiles*:

— *Part 1: Technical conditions for inspection and delivery*;

— *Part 2: Mechanical properties*;

— *Part 3: Round bars, tolerances on dimensions and form*;

— *Part 4: Square bars, tolerances on dimensions and form*;

— *Part 5: Rectangular bars, tolerances on dimensions and form*;

— *Part 6: Hexagonal bars, tolerances on dimensions and form*;

— *Part 7: Seamless tubes, tolerances on dimensions and form*;

— *Part 8: Porthole tubes, tolerances on dimensions and form*;

— *Part 9: Profiles, tolerances on dimensions and form*.

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1 Scope

This European Standard specifies the tolerances on dimensions and form for aluminium and aluminium alloy extruded seamless tubes with an outside diameter (*OD*) from 8 mm to 450 mm (round tube, see Figure 1) or with a cross section contained within a circumscribing circle (*CD*) from 10 mm to 350 mm (other than round tube, see Figure 2), supplied in straight lengths.

This European Standard only applies to tube produced by the seamless die/mandrel method of extrusion. This standard applies to extruded seamless tube for general engineering applications only.

The temper designations used in this part are according to EN 515.

This European Standard does not apply to:

— extruded tubes produced by porthole/bridge method (EN 755-8),

— tubes delivered in coils (EN 13957),

— coiled tubes cut to length (EN 13957).

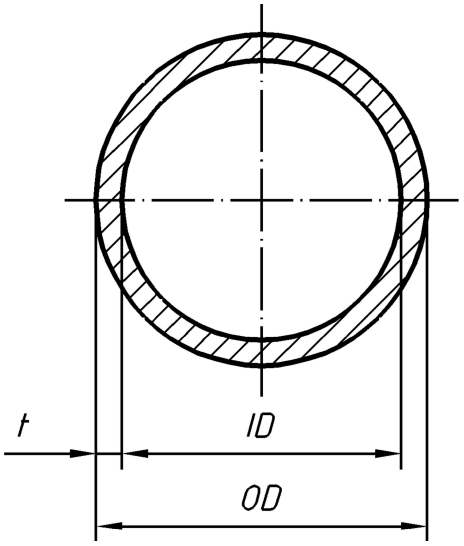


Figure 1 — Round tube

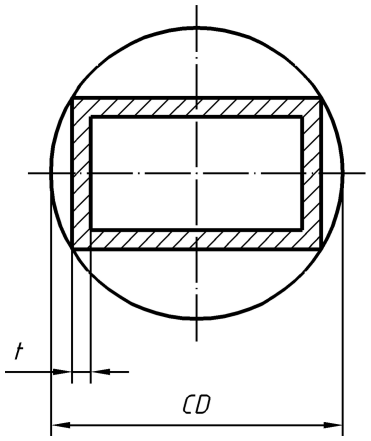


Figure 2 — Circumscribing circle for other than round tube

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 755-1:2016, *Aluminium and aluminium alloys — Extruded rod/bar, tube and profiles — Part 1: Technical conditions for inspection and delivery*

3 Alloy groups

For the purposes of this European Standard, the alloys are distributed into two groups which correspond to varying degrees of difficulty when manufacturing the products.

The division into group I and group II of the most commonly used general engineering alloys is specified in Table 1. Grouping of other alloys is subject to agreement between supplier and purchaser.

Table 1 — Alloy groups

Group I	EN AW-1050A, EN AW-1070A, EN AW-1200, EN AW-1350 EN AW-3102, EN AW-3003, EN AW-3103 EN AW-5005, EN AW-5005A EN AW-6101A, EN AW-6101B, EN AW-6005, EN AW-6005A, EN AW-6106, EN AW-6008 EN AW-6014, EN AW-6060, EN AW-6360, EN AW-6063, EN AW-6063A, EN AW-6463
Group II	EN AW-2007, EN AW-2011, EN AW-2011A, EN AW-2014, EN AW-2014A, EN AW-2017A, EN AW-2024, EN AW-2030 EN AW-5019, EN AW-5049, EN AW-5051A, EN AW-5251, EN AW-5052, EN AW-5154A, EN AW-5454, EN AW-5754, EN AW-5083, EN AW-5086 EN AW-6110A, EN AW-6012, EN AW-6018, EN AW-6023, EN AW-6351, EN AW-6061, EN AW-6261, EN AW-6262, EN AW-6081, EN AW-6082 EN AW-7003, EN AW-7005, EN AW-7108, EN AW-7108A, EN AW-7020, EN AW-7021, EN AW-7022, EN AW-7049A, EN AW-7075

4 Tolerances on dimensions

4.1 General

When outside diameter *OD,* inside diameter *ID,* and wall thickness *t,* (or their equivalent dimensions in other than round tube) are all specified, standard tolerances shall apply to any two of these dimensions, but not to all three. As a result, the purchaser shall only state two nominal dimensions on any given order.

4.2 Diameter - Round tube

Mean diameter is defined as the average of two diameter measurements taken at right angles to each other at any position along the length.

The maximum allowable deviation of diameter at any point from the specified diameter is the maximum difference measured at any point along the length of the tube ie it is inclusive of any ovality in the cross section.

The tolerances on diameter are specified in Table 2.

As detailed in EN 755-1:2016, Clause 4, if the original order does not make clear the nature of the diameter tolerances required, the supplier shall interpret them as inclusive of any ovality (i.e. maximum allowable deviation at any point from the specified diameter in Table 2). However, the diameter tolerances may be expressed as both mean and inclusive of ovality if this is specifically requested by the purchaser.

Table 2 — Tolerances on diameter for round tube

Dimensions in millimetres

Diameter (*OD* or *ID)*		Tolerance on diameter			
		Maximum allowable deviation of mean diameter from specified diameter [d]	Maximum allowable deviation of diameter at any point from specified diameter [a]		
Over	Up to and including		Tempers F and H112	Heat treated tube [b]	Tempers O, H111 and Tx510
≥ 8	18	±0,25 [c]	±0,40 [c]	±0,60 [c]	±1,5 [c]
18	30	±0,30	±0,50	±0,70	±1,8
30	50	±0,35	±0,60	±0,90	±2,2
50	80	±0,40	±0,70	±1,1	±2,6
80	120	±0,60	±0,90	±1,4	±3,6
120	200	±0,90	±1,4	±2,0	±5,0
200	350	±1,4	±1,9	±3,0	±7,6
350	450	±1,9	±2,8	±4,0	±10,0

[a] Not applicable to tubes having a wall thickness less than 2,5 % of the specified outside diameter. The tolerance for tubes with wall thickness less than 2,5 % of the specified outside diameter shall be determined by multiplying the applicable tolerance as follows:
— wall thickness over 2,0 % up to and including 2,5 % of outside diameter: 1,5 × tolerance;
— wall thickness over 1,5 % up to and including 2,0 % of outside diameter: 2,0 × tolerance;
— wall thickness over 1,0 % up to and including 1,5 % of outside diameter: 3,0 × tolerance;
— wall thickness over 0,5 % up to and including 1,0 % of outside diameter: 4,0 × tolerance.

[b] Applies to all alloys in T4, T5, T6, T64, T66 and Tx511 tempers.

[c] This tolerance applies for outside diameter only, i.e. tube in this size range can only be specified as “Outside Diameter x Wall Thickness”.

[d] Not applicable to Tx510 or Tx511 tempers.

4.3 Width, depth or width across flats - squares, rectangles, hexagons, octagons

The tolerances on width, depth or width across flats are specified in Table 3.

Table 3 — Tolerances on width, depth or width across flats

Dimensions in millimetres

Width, depth or width across flats		Tolerances on width, depth or width across flats [a, b]							
		CD ≤ 100		100 < *CD* ≤ 200		200 < *CD* ≤ 300		300 < *CD* ≤ 350	
Over	Up to and including	Alloy group I	Alloy group II	Alloy group I	Alloy group II	Alloy group I	Alloy group II	Alloy group I	Alloy group II
-	10	±0,25	±0,40	±0,30	±0,50	±0,35	±0,55	±0,40	±0,60
10	25	±0,30	±0,50	±0,40	±0,70	±0,50	±0,80	±0,60	±0,90
25	50	±0,50	±0,80	±0,60	±0,90	±0,80	±1,0	±0,90	±1,2
50	100	±0,70	±1,0	±0,90	±1,2	±1,1	±1,3	±1,3	±1,6
100	150	-	-	±1,1	±1,5	±1,3	±1,7	±1,5	±1,8
150	200	-	-	±1,3	±1,9	±1,5	±2,2	±1,8	±2,4
200	300	-	-	-	-	±1,7	±2,5	±2,1	±2,8
300	350	-	-	-	-	-	-	±2,8	±3,5

[a] Not applicable to tubes having a wall thickness less than 2,5 % of the specified outside width, depth or width across flats. The tolerance for tubes with wall thickness less than 2,5 % of the specified width, depth or width across flats shall be determined by multiplying the applicable tolerance as follows:
— wall thickness over 2,0 % up to and including 2,5 % of outside parameter: 1,5 × tolerance;
— wall thickness over 1,5 % up to and including 2,0 % of outside parameter: 2,0 × tolerance;
— wall thickness over 1,0 % up to and including 1,5 % of outside parameter: 3,0 × tolerance;
— wall thickness over 0,5 % up to and including 1,0 % of outside parameter: 4,0 × tolerance.

[b] These tolerances do not apply to tempers O and Tx510. For these tempers the tolerances shall be subject to agreement between supplier and purchaser.

4.4 Wall thickness variation (eccentricity)

The tolerances on wall thickness variation (eccentricity) are specified in Table 4 for round tubes and in Table 5 for other than round tubes.

Table 4 — Tolerances on wall thickness variation (eccentricity) for round tubes

Nominal wall thickness *t* mm		Tolerance on of wall thickness variation (eccentricity) %[a]
Over	Up to and including	
-	3	±10
3	5	±9
5	-	±8
NOTE Round tube dimensions can be expressed in three different ways i.e. outside diameter (*OD*) × wall thickness (*t*), inside diameter (*ID*) × *t* (where *t* is the nominal wall thickness) and *OD* × *ID*. Depending of the way of ordering the tube the values in Table 4 should be understood as follows (see Annex A for further explanation): — for tubes specified as *OD* x *t* or *ID* x *t* the values are allowable variation at any point; — for tubes specified as *OD* x *ID* the above values are allowable variation from the calculated mean wall thickness.		
[a] For *OD* greater than 150 mm together with and *OD*/*t* ratio of more than 10, the tolerance on wall thickness variation shall be subjected to agreement between supplier and purchaser.		

Table 5 — Tolerances on wall thickness for other than round tubes

Dimensions in millimetres

Nominal wall thickness *t*		Tolerances on wall thickness for circumscribing circle *CD*					
		CD ≤ 100		100 < *CD* ≤ 300		300 < *CD* ≤ 350	
Over	Up to and including	Alloy group I	Alloy group II	Alloy group I	Alloy group II	Alloy group I	Alloy group II
≥ 0,5	1,5	±0,25	±0,35	±0,35	±0,50	-	-
1,5	3	±0,30	±0,45	±0,50	±0,65	±0,75	±0,90
3	6	±0,50	±0,60	±0,75	±0,90	±1,0	±1,2
6	10	±0,75	±1,0	±1,0	±1,3	±1,2	±1,5
10	15	±1,0	±1,3	±1,2	±1,7	±1,5	±1,9
15	20	±1,5	±1,9	±1,9	±2,2	±2,0	±2,5
20	30	±1,9	±2,2	±2,2	±2,7	±2,5	±3,1
30	40	-	-	±2,5	-	±2,7	-

4.5 Length

If fixed lengths are to be supplied, this shall be stated on the order. The maximum allowable tolerances on fixed length are specified in Table 6.

Table 6 — Tolerances on fixed length

Dimensions in millimetres

Outside diameter or diameter of circumscribing circle		Tolerances on fixed length				
Over	Up to and including	$L \leq 2\,000$	$2\,000 < L \leq 5\,000$	$5\,000 < L \leq 10\,000$	$10\,000 < L \leq 15\,000$	$15\,000 < L \leq 25\,000$
≥ 8	100	+5 0	+7 0	+10 0	+16 0	+22 0
100	200	+7 0	+9 0	+12 0	+18 0	+24 0
200	450	+8 0	+11 0	+14 0	+20 0	+28 0

If no fixed length is specified in the order, seamless tubes may be delivered in random lengths. The length range and the tolerances on the random length shall be subject to agreement between supplier and purchaser.

4.6 Squareness of cut ends

The squareness of cut ends shall be within half of the fixed-length tolerance range specified in Table 6 for both fixed and random lengths (e.g. for a fixed-length tolerance of $^{+10}_{0}$ mm, the squareness of cut ends shall be within 5 mm).

5 Tolerances on form

5.1 General

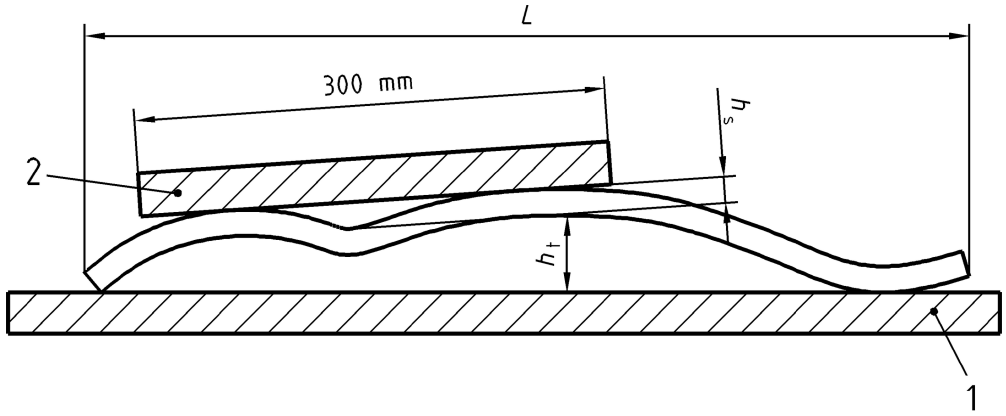
Tolerances on form for O and Tx510 tempers shall be subject to agreement between supplier and purchaser.

5.2 Straightness

Deviations from straightness, h_s and h_t, shall be measured as shown in Figure 3 with the tube placed on a horizontal baseplate so that its mass decreases the deviation.

The straightness tolerances of round tubes are specified in Table 7 (The straightness tolerance h_t applies to the whole length, e.g. for a length of 6 m the maximum deviation from straightness h_t is the value given in the table multiplied by 6 m).

The straightness tolerance h_t of other than round tubes shall not exceed 1,5 mm/m length. Local deviations h_s from straightness shall not exceed 0,6 mm/300 mm length.



Key

1 base plate

2 straight edge

Figure 3 — Measurement of the deviation from straightness

Table 7 — Straightness tolerances of round tube

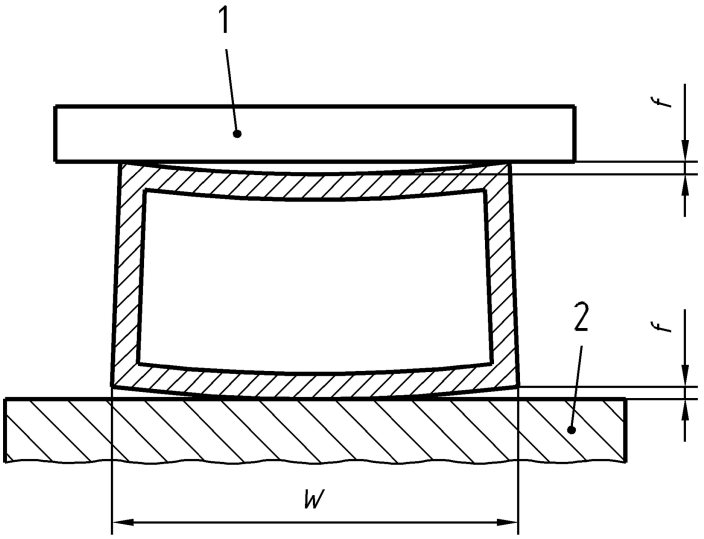
Dimensions in millimetres

Outside diameter		Maximum deviation from straightness per metre length h_t/*length* mm/m	Maximum localized kink in any 300 mm portion h_s
Over	Up to and including		
≥ 8	150	1,5	0,8
150	250	2,5	1,3
250	450	3,5	1,8

The straightness tolerances for tubes having a wall thickness less than 1,5 % of the specified outside diameter shall be subject to agreement between supplier and purchaser.

5.3 Convexity-Concavity

The convexity-concavity of other than round tube shall be measured as shown in Figure 4. The convexity-concavity tolerances are specified in Table 8.



Key

1 straight edge

2 base plate

Figure 4 — Measurement of convexity–concavity

Table 8 — Convexity-Concavity tolerances

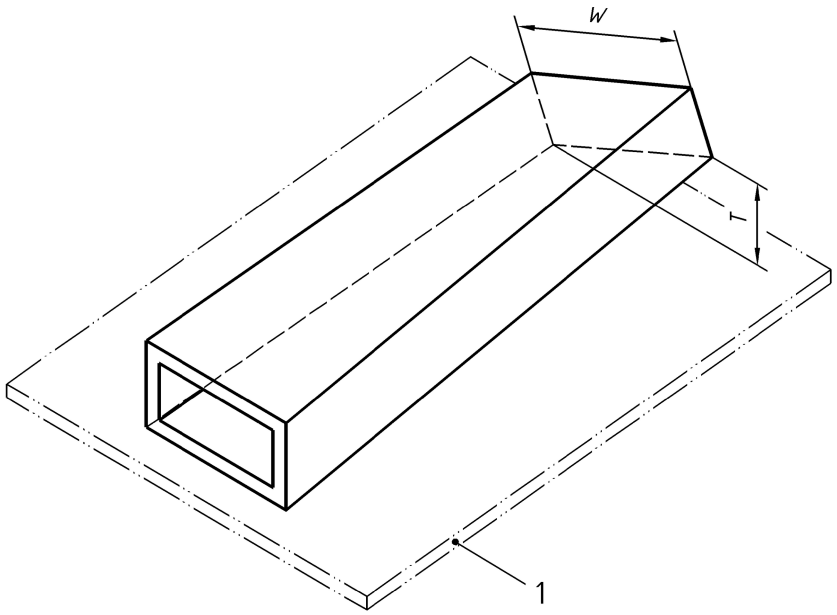
Dimensions in millimetres

Width *W*		Maximum allowable deviation *f*	
Over	Up to and including	Wall thickness ≤ 5	Wall thickness > 5
-	30	0,30	0,20
30	60	0,40	0,30
60	100	0,60	0,40
100	150	0,90	0,60
150	200	1,2	0,80
200	350	1,8	1,2

5.4 Twist

Twist *T* shall be measured as shown in Figure 5 by placing the tube on a flat base plate, the tube resting under its own mass and measuring the maximum distance at any point along the length between the bottom surface of the tube and the base plate surface.

Twist tolerances are specified in Table 9 as a function of the width *W* and the length *L* of the tube.



Key
1 base plate

Figure 5 — Measurement of twist

Table 9 — Twist tolerances

Dimensions in millimetres

Width *W*		Twist tolerance *T*		
		per 1 000 mm of length [a]	On total tube length *L*	
Over	Up to and including		up to and including 6 000	over 6 000
≥ 10	30	1,2	2,5	3,0
30	50	1,5	3,0	4,0
50	100	2,0	3,5	5,0
100	200	2,5	5,0	7,0
200	350	2,5	6,0	8,0

[a] Twist tolerances for lengths less than 1 000 mm shall be subject to agreement between supplier and purchaser.

5.5 Angularity

The deviation from square of square and rectangular tubes shall be measured as shown in Figure 6. The maximum allowable deviation from square is specified in Table 10 as a function of tube depth *B.* In case of rectangular tubes, the tolerance on squareness shall apply to the shorter side of the tube.

The maximum allowable deviation in an angle other than a right angle (hexagonal tubes, octagonal tubes) shall be included within the width across flats tolerances, see Table 3.

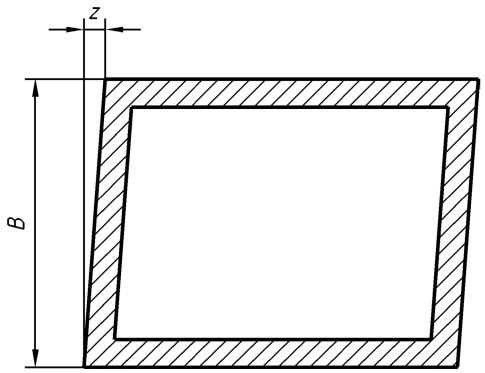


Figure 6 — Measurement of deviation from square

Table 10 — Squareness tolerances for square and rectangular tubes

Dimensions in millimetres

Depth *B*		Maximum allowable deviation *Z* from square
Over	Up to and including	
-	30	0,4
30	50	0,7
50	80	1,0
80	120	1,4
120	180	2,0
180	240	2,6
240	350	3,1

5.6 Corner and fillet radii

Sharp corners and fillet radii may be slightly rounded unless otherwise indicated on the drawing. The maximum allowable radii are specified in Table 11.

When corner or fillet radius is specified, the maximum allowable deviation from the nominal value is specified in Table 12.

Table 11 — Maximum allowable corner and fillet radii

Dimensions in millimetres

Wall thickness	Maximum allowable corner and fillet radii	
	Alloy group I	Alloy group II [a]
≤ 5	0,6	0,8
> 5	1,0	1,5

[a] These tolerances only apply to 6xxx series alloys in group II. The maximum allowable radii for the other alloys in group II shall be subject to agreement between supplier and purchaser.

Table 12 — Maximum allowable deviation from specified corner and fillet radii

Specified radius mm	Maximum allowable deviation from nominal value of the radius
≤ 5	±0,5 mm
> 5	±10 %

5.7 Depth of dents for round tube

It is recognized in certain applications that the depth of surface dents can be an important factor particularly for round tube with large diameter to wall thickness ratios. In such cases, the maximum allowable depth of dents shall be subject to agreement between supplier and purchaser.

Annex A
(informative)

Wall thickness variation (eccentricity)

A.1 General

Wall thickness variation tolerances for round tube can be the source of a lot of confusion. In particular as to whether quoted values are based on the nominal or mean wall thickness. This present section is included in the standard to provide some guidelines as to when each of these possibilities is more appropriate.

A.2 Specifying round tube sizes and tolerances

A.2.1 General

It is evident that round tube dimensions can be expressed in three different ways i.e. outside diameter (*OD*) × wall thickness (*t*), inside diameter (*ID*) × *t* (where *t* is the nominal wall thickness) and *OD* × *ID*. Since all three dimensions interact in any given size tube, it is only possible to apply tolerances to any two of the parameters depending on which are the most important for the application of the tube in question. The choice of the dimensional parameters has a very significant effect on how the wall thickness variation is expressed.

The method of measuring wall thickness *t* is the same whether the given tube is specified as *OD* × *t*, *ID* × *t* or *OD* × *ID* and is shown in Figure A.1. The tube wall thickness is measured around the circumference of the tube and the maximum (t_{max}) and minimum (t_{min}) values established.

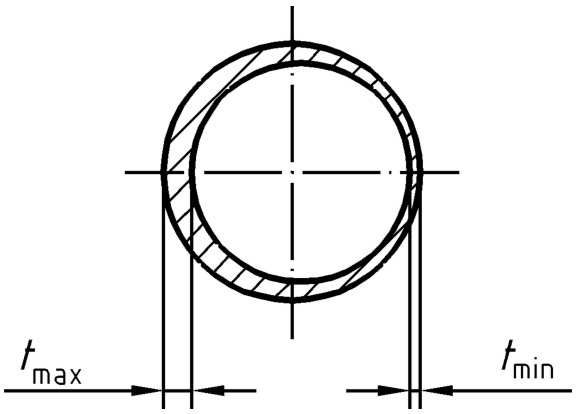


Figure A.1 — Minimum and maximum values of the tube wall thickness

A.2.2 Wall thickness variation for tubes specified as *OD* × *t* or *ID* × *t*

For tube that is specified as either *OD* × *t* or *ID* × *t*, the nominal wall thickness *t* can be used as the basis for calculating and expressing the wall thickness variation tolerance. The tolerance can be expressed as the difference (in millimetres) between the maximum and minimum values permissible for the tube i.e. at any point, maximum wall thickness variation, deviation or concentricity:

$$t_{max} - t_{min} \text{ in mm} \quad \text{(A.1)}$$

Alternatively, the difference can be expressed as a percentage of the nominal wall thickness which is normally divided by two to give a plus and minus tolerance. This percentage is normally expressed on a ± basis as follows:

$$\frac{t_{max} - t_{min}}{2t} \times 100\,\% \quad \text{(A.2)}$$

A.2.3 Wall thickness variation for tubes specified as *OD* × *ID*

In the case of tubes specified as *OD* × *ID*, there is no nominal wall thickness available to allow the same method of wall thickness variation calculation as that described in A.2.2. As a result, it is necessary to use the measured t_{max} and t_{min} values to give a wall thickness difference which is then used to calculate a percentage of the mean wall thickness.

$$\frac{t_{max} - t_{min}}{(t_{max} + t_{min})/2} \times 100\,\% \quad \text{(A.3)}$$

This value may then be divided by two to give a plus/ minus value for the tolerance.

Bibliography

[1] EN 515, *Aluminium and aluminium alloys — Wrought products — Temper designations*

[2] EN 755-8, *Aluminium and aluminium alloys — Extruded rod/bar, tube and profiles — Part 8: Porthole tubes, tolerances on dimensions and form*

[3] EN 13957, *Aluminium and aluminium alloys — Extruded round, coiled tube for general applications — Specification*

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