

**Steel tube for precision applications – seamless cold drawn tubes for hydraulic and pneumatic power systems**

**Material data sheet**

Steel designation:	Name	Material-No.
	<b>E235</b>	<b>1.0308</b>
	<b>E355</b>	<b>1.0580</b>

**Scope**

This data sheet applies for seamless cold drawn steel tubes of circular cross section used in hydraulic and pneumatic power systems with specified outside diameter  $D \leq 80$  mm.

**Application**

These steels are standard for engineering and general technical purposes.

The allowed pressure rates and upper temperatures are the responsibility of the customer in accordance with the state of the art and in application of the safety coefficients specified in the applicable regulations, codes or standards. Concerning the lower temperature range applicability the impact energy requirements are given at 0 °C.

**Chemical composition (Heat analysis in %)<sup>1)</sup>**

Steel grade	C	Si	Mn	P	S <sup>2)</sup>	Al <sub>total</sub> <sup>2)</sup>
E235	≤ 0,17	≤ 0,35	≤ 1,20	≤ 0,025	≤ 0,015	≥ 0,015
E355	≤ 0,22	≤ 0,55	≤ 1,60	≤ 0,025	≤ 0,015	≥ 0,020

<sup>1)</sup> Elements not included in this table (but see footnote <sup>2)</sup>) shall not be intentionally added to the steel without the agreement of the purchaser, except for elements which may be added for the purposes of deoxidation and/or nitrogen binding. All appropriate measures shall be taken to prevent the addition of undesirable elements from scrap or other materials used in the steel making process.

<sup>2)</sup> This requirement is not applicable provided the steel contains a sufficient amount of other nitrogen binding elements, such as Ti, Nb or V. When using titanium, the manufacturer shall verify that  $(Al + Ti/2) \geq 0,020$ . Additions of Nb, Ti and V are permitted at the discretion of the manufacturer. The content of these elements shall be reported.

**Mechanical properties at room temperature (delivery conditions +N<sup>1)</sup>)**

Steel grade	Yield strength <sup>1)</sup> R <sub>eH</sub> min. N/mm <sup>2</sup>	Tensile strength R <sub>m</sub> N/mm <sup>2</sup>	Elongation after fracture A min. %
E235	235	340 - 480	25
E355	355	490 - 630	22

The steel grades have an intrinsic minimum transverse impact energy of 27 J at 0 °C.

<sup>1)</sup> +N = normalized

<sup>2)</sup> For tubes with outside diameter ≤ 30 mm and wall thickness ≤ 3 mm the R<sub>eH</sub> minimum values are 10 N/mm<sup>2</sup> lower than the values given in this table..

## Reference data for some physical properties

Density at 20 °C Kg/dm <sup>3</sup>	Modulus of elasticity kN/mm <sup>2</sup> at				Thermal conductivity at 20 °C W/m K	spec. thermal capacity at 20 °C J/kg K	spec. electrical resistivity at 20 °C Ω mm <sup>2</sup> /m
	20 °C	100 °C	200 °C	300 °C			
7,85	210	205	197	190	54	461	0,15

Linear coefficient 10<sup>-6</sup> K<sup>-1</sup> of thermal expansion between 20 °C and

100 °C	200 °C	300 °C
11,1	12,1	12,9

## Hot forming / Heat treatment (for guidance only)

Hot forming		Heat treatment		
Temperature °C	Type of cooling	Normalizing <sup>1)</sup>	Stress relieving anneal <sup>2)</sup>	Type of cooling
700-750	Air	850 – 950 °C	580 – 630 °C	Air

<sup>1)</sup> Normalizing: Holding time 1 minute per mm wall thickness, minimum 30 minutes

<sup>2)</sup> Stress relieving anneal: Holding time 1-2 minutes per mm wall thickness, minimum 30 minutes

## Processing / Welding

Standard welding processes for these steel grades are:

TIG– welding

Arc welding (E)

MAG– welding massive wire

Submerged arc welding (SAW)

MAG– welding cored wire

For these steel grades as filler metal the following electrodes and welding wires are recommended:

Process	Filler metal
TIG	Union I 52
MAG solid wire	Union K 52 Union K56
MAG cored wire	Union MV 70 Union BA 70 (Union RV 71)
Arc welding (E)	Phoenix 120K Phoenix Special D
SAW	Wire
	Union S 2 (Union S 2)
	Powder
	UV 400 (UV 306)

These steels can be welded within all thickness ranges according to the afore mentioned welding processes considering the general rules of technology by hand and automatically welding.

The mentioned filler metals apply for highest demands. The details in brackets are for lower demands.

Burning, preheating, welding and stress relieving annealing should occur under consideration of Stahl-Eisen-Material bulletin 088.

Specifications and standards concerning stress relieving annealing have to be observed.

### **Remark**

The material is magnetizable.

### **References**

ThyssenKrupp  
DIN EN 10305-4:2011-04

### **Important Hint**

Information given in this data sheet about property or applicability of materials respective products are no assurance of characteristics but serve for description.

Information, with which we like to advise you, relate to the experience of the producers and our own. Warranty for the results of the treatment and application of the products cannot be granted.