



**Steel pipes for oil collection and water injection pipelines with cement mortar lining**

<b>Contents .....</b>	<b>Page</b>
<b>Foreword .....</b>	<b>2</b>
<b>1 Scope .....</b>	<b>4</b>
<b>2 Normative reference .....</b>	<b>4</b>
<b>3 Terms and definitions.....</b>	<b>5</b>
<b>4 General .....</b>	<b>6</b>
<b>5 Designation and ordering information .....</b>	<b>6</b>
<b>6 Pipes .....</b>	<b>9</b>
<b>7 Fittings.....</b>	<b>9</b>
<b>8 Dimensions and tolerances.....</b>	<b>9</b>
<b>9 Joints for pipes and fittings.....</b>	<b>10</b>
<b>10 Linings .....</b>	<b>10</b>
<b>11 Coatings.....</b>	<b>12</b>
<b>12 Inspection certificates.....</b>	<b>12</b>
<b>13 Marking .....</b>	<b>12</b>
<b>Appendix A (normative) Steel Grades According to Applicable Standards.....</b>	<b>13</b>
<b>Appendix B (informative) Steel Pipe Wall Thickness Calculation for Internal Pressure .....</b>	<b>15</b>

issued: Q. Dr. Kocks Von Hans-Jürgen Kocks, 4:09, 10/23/17 Date: 19.09.2017 	controlled: LFQ, Dr. Lötbe Von Hendrik Lötbe, 4:31, 10/23/17 Date: 	approved: Q. Well Von Christoph Well, 16:10, 23/10/2017 Date: 
---	--	---



**Steel pipes for oil collection and water injection pipelines with cement mortar lining**

## **Foreword**

This mill standard has been issued for steel pipes for oil collection and water injection pipelines with cement mortar lining used during the oil exploration. In secondary oil recovery, water is injected into the reservoir to keep up the pressure and increase the recovery rate. The media transported vary significantly in terms of their chemical composition and properties. The cement mortar lining must be adjusted to the medium transported. A corrosion allowance for the wall thickness is not necessary.

Sudden pressure relief could cause spalling of the lining, which can be prevented by a limitation of the inside pressure load to half of the yield strength of the pipe material.



**MANNESMANN**  
**LINE PIPE**  
A Member of the Salzgitter Group

**Mill Standard**

**T 10.00.003\_HS\_W\_E**

Dated 10/2017

Rev. 0

Page 3 /16

**Steel pipes for oil collection and water injection pipelines with cement mortar lining**

## **Previous Editions**

- none



**Steel pipes for oil collection and water injection pipelines with cement mortar lining**

## 1 Scope

This standard defines the design requirements of steel pipe and fittings for oil collection and water injection lines in the oil exploration under static and operating conditions.

The dimensions of pipes in accordance with this standard are calculated for the permissible operating pressures specified for a given pipeline component. The wall thicknesses of components made using steel grades listed in the Tables do not need to be specially calculated if the intended service pressure does not exceed the appropriate values specified in the Tables, or if the wall thickness does not fall short of the specified minimum wall thickness. In all other cases, an appropriate stress-strain analysis is required.

## 2 Normative reference

The documents below are required in the context of this standard for the application of this document. For dated references, only the referenced edition shall apply. Undated references shall be understood to be references to the latest version of the quoted document (including all amendments).

API 5L: 2012 Ed. 45 Specification for Line Pipe

DIN 30670 -2012 Polyethylene coatings of steel pipes and fittings. Requirements and testings.

DIN 30678 – 2013. Polypropylene coatings of steel pipes and fittings. Requirements and testings.

EN 10204: 2005 Metallic products - Types of inspection documents

EN 10217-1: 2005 Welded steel tubes for pressure purposes. Non-alloy steel tubes with specified room temperature properties

EN 10217-3:2002 + A1:2005 Welded steel tubes for pressure purposes. Alloy fine grain steel tubes

EN 10220: 2003 Seamless and welded steel tubes - Dimensions and masses per unit length

EN 10224: 2005 Non-alloy steel tubes and fittings for water and other aqueous liquids - Technical delivery conditions

EN 10253-1: 1999 Butt-welding pipe fittings. Part 1: Wrought carbon steel for general use and without specific inspection requirements

EN 10253-2: 2007 Butt-welding pipe fittings - Part 2: Non-alloy and ferritic alloy steels with specific inspection requirements

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

EN 10298: 2005 Steel tubes and fittings for onshore and offshore pipelines - Internal lining with cement mortar

EN 10311:2005 Joints for the connection of steel tubes and fittings for water and other aqueous liquids

ISO 3183:2013 Petroleum and natural gas industries - Steel pipe for pipeline transportation systems

ISO 21809-1: 2011 Petroleum and natural gas industries - External coatings for buried or submerged pipelines used in pipeline



**Steel pipes for oil collection and water injection pipelines with cement mortar lining**

### **3 Terms and definitions**

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

#### **3.1 Flange**

Flattened, circular pipe or fitting end perpendicular to the pipe or fitting axis with a bolt circle of equispaced holes.

#### **3.2 Spigot end**

Cylindrical end of a pipe or fitting.

#### **3.3 Socket**

Flared end of a pipe or fitting into which the spigot end of a pipe or fitting is inserted to form a connection between the two components.

#### **3.4 Random length**

Delivery length, specified by the purchaser, with a unilateral or a bilateral tolerance as specified in the product standard.

[EN 10266: 2003-12, Term 2.13]

#### **3.5 Approximate length**

Delivery length, specified by the purchaser, with a unilateral or a bilateral tolerance as specified in the product standard.

[EN 10266: 2003-12, Term 2.14]

#### **3.6 Exact length**

Delivery length, specified by the purchaser, with a restricted unilateral tolerance as specified in the product standard.

[EN 10266: 2003-12, Term 2.16]

#### **3.7 Effective length**

The real length contributed by a correctly installed pipe to the length of a pipe string.

[EN 10224: 2005, Term 3.2]

#### **3.8 Nominal size DN**

An alphanumerical designation indicating the size of components in a pipe system. The designation is used for reference purposes and comprises the letters DN, followed by a dimensionless integer which is indirectly related to the physical size of the inside diameter or the outside diameter of the connections, expressed in millimetres.

**NOTE 1** The figure following the letters DN is not a measurable value and should not be used in design calculations, except when specified in the applicable standard.

**NOTE 2** Standards using the DN designation system should indicate the dimension to which the DN designation is related, e.g. DN/OD or DN/ID.

[ISO 6708:1995-09, Term DN]



**Steel pipes for oil collection and water injection pipelines with cement mortar lining**

### 3.9 Maximum allowable operating pressure PMA

The maximum hydrostatic pressure, including surge, which a component can safely withstand in service

[EN 805:2000-03, Term 3.1.1]

### 3.10 Allowable operating pressure PFA

The maximum hydrostatic pressure a component is capable of withstanding in continuous service.

NOTE PFA replaces the former designation PN.

[EN 805:2000-03, Term 3.1.2]

### 3.11 Allowable test pressure PEA

The maximum hydrostatic pressure which a component newly installed in a pipeline (buried or laid above ground) can withstand for a relatively short duration in order to measure the integrity and leak tightness of the pipeline.

[EN 805:2000-03, Term 3.1.3]

## 4 General

Pipes and fittings are supplied in compliance with the delivery conditions of ISO 3183 or EN 10253-1/2. Equivalent steel grades in accordance with the technical delivery conditions of the standards API 5L, EN 10224 and EN 10217-1/3) may also be agreed (see Table A.1, Appendix A) both for pipes and fittings. For fittings, steel grades in accordance with EN 10253-1 can also be agreed. The functional requirements of the connection technologies used are laid down in EN 10311.

## 5 Designation and ordering information

### 5.1 Designation

Example designation of a DN 250 pipe:

Pipe T 10.00.003\_HS\_W\_E — DN 250

Example designation of a DN 250 fitting:

Elbow T 10.00.003\_HS\_W\_E — DN 250

### 5.2 Ordering information

#### 5.2.1 General

When ordering, it is important to differentiate between the information required per 5.2.2 (pipes) and 5.2.3 (fittings), as well as additional information per 5.2.4. Short designations and symbols of ordering information are listed in Table 1.



**Steel pipes for oil collection and water injection pipelines with cement mortar lining**

### 5.2.2 Required ordering information for pipe

Inquiries and orders for pipe must contain the following information:

- Quantity, e.g. number of pipes, total pipe length;
- Designation: Pipe;
- Standard number: EN, API or ISO;
- Nominal diameter/nominal size DN
- Wall thickness
- Steel grade

EXAMPLE of required ordering information:

3 200 m pipes DN 250 with wall thickness of 5 mm, steel grade L245N per ISO 3183, in random lengths to the manufacturer's discretion in accordance with ISO 3183, bare, with inspection certificate 3.1 according to EN 10204.

3 200 m Pipe T 10.00.003\_HS\_W\_E — DN 250 – 5 – L245N – ISO 3183

### 5.2.3 Required ordering information for fittings

- Quantity;
- Description: Fitting type;
- Standard number: T 10.00.003\_HS\_W\_E
- Nominal diameter/nominal size DN;
- Wall thickness;
- Steel grade
- Fitting design: e.g. 90° (elbow)
- Fitting type: e.g. 3D; (Art)
- Allowable operating pressure;
- Fitting, e.g. in accordance ISO 3183 or/and EN 10253-1/2.

EXAMPLE of required ordering information:

5 elbows DN 250 with a wall thickness  $t = 5$  mm (5), design 90° (90), design type 3 D (3) in accordance with EN 10224, for an allowable operating pressure of 50 bar (50), black, in steel grade L245N per ISO 3183, with inspection certificate 3.1 according to EN 10204

5 Elbows T 10.00.003\_HS\_W\_E — DN 250 — 5 — L245N - ISO 3183— 90 — 3 — 50 — EN 10224



**Steel pipes for oil collection and water injection pipelines with cement mortar lining**

5.3 Additional ordering information

If no additional information is specified in the order, the pipes and fittings shall be supplied in accordance with the required ordering information. Additional ordering information shall be given using the symbols listed in Table 1. Additional ordering information just completes, but not substitutes the required ordering information.

Table 1 — Symbols for additional ordering information

Symbol	Description	
St	Product analysis is mandatory	Chemical analysis
PT	Dye penetrant test	Non-destructive testing of pipes and fittings
MP	Magnetic particle inspection	
UT	Ultrasonic test	
ET	Eddy current test	
RT	Through-transmission test	
NL... to NL...	Random length range	Length Table A.2
AL	Approximate length	
EL	Exact length	
SWJ	Slip welding joint	Pipe end design
F	Flange	
CML	Cement mortar lining	Lining
PE	Polyethylene (Class B), layer thicknesses B1 – B3 according to ISO 21809-1 or Polyethylene (LD or HD), layer thickness N or S according to DIN 30670	Coating
PP	Polypropylene (Class C), layer thicknesses C1 – C3 B3 according to ISO 21809-1 or Polypropylene, layer thickness N or S according to DIN 30678	
2.2	Works certificate 2.2	Inspection certificate
3.2	Inspection certificate 3.2	

- Length type and range (ch.8.3); no information: random length to the manufacturer's discretion per ISO 3183;
- End design (joining technology); no information: Slip welding joint
- Product analysis;
- Works certificate 2.2 or inspection certificate 3.2 per EN 10204; no information: inspection certificate 3.1;
- Specification of non-destructive test method for fittings;
- Lining

EXAMPLE of additional ordering information:

3 200 m welded pipes DN 250 in approximate lengths of 12 m (AL 12), ends prepared for slip welding joints (SWJ) and with cement mortar lining per EN 10298 (CML) and polyethylene coating per ISO 21809-1,-Class B1





## Steel pipes for oil collection and water injection pipelines with cement mortar lining

EXAMPLE of additional ordering information:

5 elbows DN 250 with a wall thickness of  $t = 5$  mm, design  $90^\circ$  (90), design type 3 D (3) in accordance with EN 10253-1/2, for an allowable operating pressure of 50 bar (50), ends prepared for slip welding joints (SWJ) and with cement mortar lining (CML) and polyethylene coating according to

5 Elbows T 10.00.003\_HS\_W\_E — DN 250 — 5 — 90 — 3 — 50 — SWJ — CML — PE - DIN 30670, S, v

## 6 Pipes

The pipe used is required to comply with the specifications mentioned in Section 4. Unless otherwise specified, welded pipe will be supplied in steel grades per-ISO 3183. The weld area in electrically welded pipes must be heat treated. Pipe made from other steel grades as given in Table A.1 Appendix A, or in compliance with other standards as mentioned in Section 4 may also be used. When ordering such pipe, the requirements of the technical delivery conditions to be agreed must fulfil at least the requirements of this standard.

## 7 Fittings

Fittings are required to comply with the standards mentioned in Section 4 and must meet the requirements laid down in EN 10253-1/2 unless otherwise specified in the order-

## 8 Dimensions and tolerances

### 8.1 General

The dimensions and tolerances must be in accordance with the applicable delivery conditions and with the definitions in 8.2 and 8.3.

### 8.2 Outside diameter and wall thickness

Table 2 shows the samples of dimension ranges of pipes required for different operating pressures.

Other diameters as shown can be agreed in range of DN100 – DN600, especially in case of higher transportation rates. The calculation of possible working pressures must be carried out.

Intermediate wall thicknesses and/or other steel grades may also be defined for pipes, especially in the case of higher nominal pressures (cf. Section 6 for deliveries in accordance with other technical delivery conditions). Calculation of applicable operating pressures is carried out without consideration of allowed negative wall thickness tolerance ( $c_1 = 0$  in Equation B – 1, Attachment B).

The deviations of outer diameter and out-of-roundness are per table 10 ISO 3183 or other applicable standards listed in Section 4 in regards of steel pipes.

The deviations of the wall thickness are per table 11 ISO 3183 2013 or other applicable standards listed in Section 4 in regards of steel pipes.



## **Steel pipes for oil collection and water injection pipelines with cement mortar lining**

### 8.3 Lengths

Pipes in accordance with this standard are supplied in random lengths or in approximate lengths, if it is agreed per 9.11.1.3, 9.11.3.3, table 12 ISO 3183 or other applicable standards listed in Section 4 in regards of steel pipes.

The exact lengths of the pipes can be agreed per table A.5.

In the case of socket pipes, it must be considered that the effective length (cf. 3.7) is equal to the ordered length minus the inserted length.

## **9 Joints for pipes and fittings**

### 9.1 General

The functional requirements of the joints are described in EN 10311. In addition, application specific requirements are defined under 9.2 and 9.3 below.

### 9.2 Pipe ends

The cut face at the pipe ends is perpendicular to the pipe axis and free from burrs. The out-of-squareness shall be  $\leq 1,6$  mm.

### 9.3 Slip welding joint

The pipes and fittings generally must be supplied with a slip welding joint per Fig. 1. The inserted lengths "t" and the joint play "f" for slip welding joints up to DN 300 are given in Table 2. The inserted length and joint play for larger nominal sizes are subject to special agreement.

### 9.4 Other pipe joints

Other pipe joints in accordance with EN 10311 may also be agreed upon. The pipe end design must then be defined individually in each case. The joint execution must ensure the reliable protection of the pipe and fitting inner surface against corrosion.

## **10 Linings**

Pipes and fittings must be lined with cement mortar. The application and quality of this factory lining is standardized in EN 10298 and depends on the medium transported.

The application of oil resistant rubber ring for protection of cement mortar lining while handling, transportation and laying is obligatory. The construction of the rubber ring must ensure the tight and reliable connection with cement mortar lining.



**Steel pipes for oil collection and water injection pipelines with cement mortar lining**

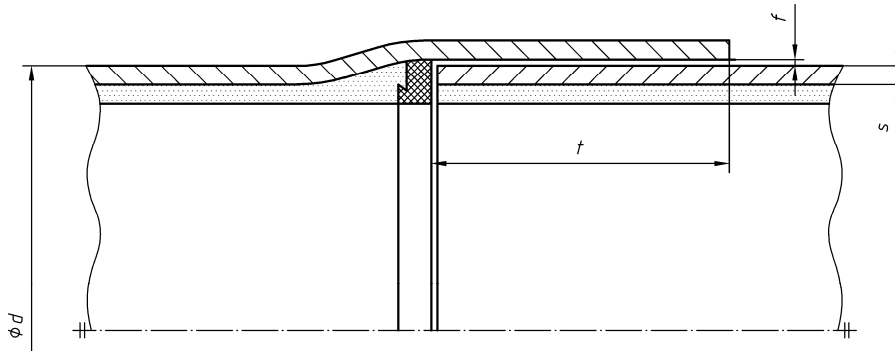


Fig. 1 — Slip welding joint

Table 2 — Ranges of dimensions, mass per unit length and allowable operating pressure of welded steel pipes with slip welding joints

Nominal width DN	Pipe outside diameter $d$ mm	Nominal wall thickness $s^a$ mm	Mass per unit length <sup>b</sup> kg/m	Inserted length $t^c$ mm	Joint play $f^d$ mm	Allowable pipeline operating pressure PFA <sup>a</sup>	
						L245N <sup>e</sup> with $v_n = 0,7$ and acceptance certificate 3.1 bar	L360N <sup>e</sup> with $v_n = 0,7$ and acceptance certificate 3.1 bar
150	168.3	4,0 – 10,0	16.2 – 39,0	50	1.5	54 - 119	77 - 192
200	219.1	4,5 – 13,0	23.8 – 66,1	60	2	47 - 119	66 - 192
250	273	5,0 – 16,0	33,1 – 101,4	70	2	42 - 117	59 - 189
300	323.9	5,6 - 16,0	44,0 – 121,5	85	2	40 - 99	59 - 160

<sup>a</sup> Calculated per Appendix B using the following safety coefficients:  $S = 1,5$  for grades < L360N,  $S = 1,56$  for L360N, both with inspection certificates 3.1, without any allowance for corrosion and/or wear and without consideration of negative wall thickness tolerance ( $c_1 = 0$ , in case of allowed negative tolerances these have to be considered by addition). As a rule, no corrosion allowance is required for pipes that are both coated and lined. The quoted pressure PFA applies to pipelines with slip welding joints, traffic loads up to SLW 60, a cover height over the pipe of 0.6 to 6 m, and a possible internal pressure drop to an absolute pressure of  $p_{abs} = 0.2$  bar. Simultaneous consideration of safety coefficient of 1,5 – 1,56 and weld seam factor  $v_n = 0,7$  for circumferential concave filled weld seam ensures a limitation of the inside pressure load to half of the yield strength of the pipe material and prevents spalling of the lining in case of sudden pressure relief.

<sup>b</sup> Mass per unit length of bare pipe.

<sup>c</sup> Real values can be changed depending on pipe diameter and have to be foreseen for determination of the effective pipe length.

<sup>d</sup> Guide values – have to be hold with a view to pipe laying under consideration of tolerances and out-of-roundness of outer diameter obtained the maximum possible outer diameter.

<sup>e</sup> Steel grades according to ISO 3183. Similar steel grades per alternative standards are applicable.



## **Steel pipes for oil collection and water injection pipelines with cement mortar lining**

### **11 Coatings**

#### **11.1 General requirements**

If pipes must be supplied coated, the coating type and procedure must be specified in the order. Steel pipes for buried pipelines must be protected against corrosion.

As a rule, fittings are supplied bare, i.e. without a coating or lining, because they are coated or lined after onsite installation.

Where fittings are to be supplied lined and/or coated, this must be specified in the order.

#### **11.2 Polyethylene coating**

Polyethylene coatings must be applied in accordance with ISO 21809-1. The application of DIN 30670 is possible alternatively.

#### **11.3 Polypropylene coating**

Polypropylene coatings must be applied in accordance with ISO 21809-1. The application of DIN 30678 is possible alternatively.

#### **11.4 Other coatings**

On special agreement, pipes can also be supplied with other coating types.

### **12 Inspection certificates**

Pipes and fittings are supplied with an inspection certificate per EN 10204. Deviating from this, the following test certificates per EN 10204 may also be supplied (cf. Tables 2 to 5):

- Works certificate — 2.2;
- Acceptance certificate — 3.2.

Test certificate requirements for linings and coatings are laid down in the relevant technical delivery conditions.

### **13 Marking**

Pipes and coatings must be marked in accordance with the requirements of the applicable standard.



**Steel pipes for oil collection and water injection pipelines with cement mortar lining**

**Appendix A  
(normative)**

**Steel Grades According to Applicable Standards**

**Table A.1 — Comparable steel grades**

ISO 3183:2013, PSL 2		API 5L:2013, PSL 2		EN 10224:2005		EN 10217-1:2005 and EN 10217-3: :2002 + A1:2005	
Steel grade	Material number	Steel grade	Material number	Steel grade	Material number	Steel grade	Material number
L245N or BN	1.8790	BN	1.8790	L235	1.0252	P235 TR2	1.0255
L290N or X42N	1.8791	X42N	1.8791	L275	1.0260	P265 TR2	1.0259
L360Nor X52N	1.8793	X52N	1.8793	L355	1.0419	P355N	1.0562

**Table A.2 —Length types, ranges and tolerances**

Length type	ISO 3183: 2013	API 5L: 2013	EN 10224: 2005	EN 10217-1: 2005 and EN 10217-3: 2002 + A1:2005
Random length	Table A.3	Table A.3	Table A.4	to be agreed
Approximate length	± 500 mm	± 500 mm	± 500 mm	—
Exact length	to be agreed	to be agreed	Table A.5	Table A.5

**Table A.3 — Random lengths according to ISO 3183:2013 and API 5L: 2013**

Random length designation, m	Minimum length, m	Minimum average length for each order item, m	Maximum length, m
6	2,74	5,33	6,86
9	4,11	8,00	10,29
12	4,27	10,67	13,72
15	5,33	13,35	16,76
18	6,40	16,00	19,81

NOTE The availability of a length range depends on the pipe production process.



**Steel pipes for oil collection and water injection pipelines with cement mortar lining**

**Table A.4— Random lengths according to EN 10224: 2005**

Length range m	Minimum average length of total delivery m
3 to 8	6
4 to 12	8
5.5 to 14	11
6.5 to 16.5	13.5
7.5 to 18	14.5
NOTE The availability of a length range depends on the pipe production process.	

**Table A.5 — Tolerances of exact lengths**

Length ranges m	EN 10224: 2005, EN 10217-1: 2005 and EN 10217-3: 2002 + A1: 2005	
	< 406 mm	≥ 406 mm
≤ 6	+10 0	+25 0
> 6 ≤12	+15 0	+50 0
> 12	on agreement	



**Steel pipes for oil collection and water injection pipelines with cement mortar lining**

**Appendix B**  
(informative)

**Steel Pipe Wall Thickness Calculation for Internal Pressure**

**B.1. General**

The calculation method below complies with the withdrawn DIN 2413-1:1993-10 standard under consideration of slip welding joints.

The formulae for calculating the wall thickness for internal pressure apply to circular pipes where the inside-to-outside diameter ratio  $u = d_a/d_i$  does not exceed the value 2.0 under predominantly static loading in the temperature range of 0 °C to 120 °C.

**B.2 Symbols and units**

The symbols and units used are listed in Table B.1 below.

**Table B. 1 — Symbols, design parameters, units**

Symbol	Design parameter	Unit
$c = c_1 + c_2$	Allowance on the minimum wall thickness	mm
$c_1$	Allowance for negative wall thickness tolerance	mm
$c_1'$	Negative wall thickness tolerance	%
$c_2$	Allowance for corrosion and/or wear	mm
$d_a$	Pipe outside diameter	mm
$d_i$	Pipe inside diameter	mm
$P$	Design pressure	N/mm <sup>2</sup>
$S$	Required wall thickness including allowances	mm
$s_v$	Minimum wall thickness excluding allowances	mm
$u = d_a/d_i$	Inside-to-outside diameter ratio	—
$v_N$	Efficiency factor for circumferential concave filled weld seam (utilization of allowable design stress)	—
$A$	Elongation ( $L_0 = 5.65 \cdot \sqrt{S_0}$ )	%
$K$	Yield strength	N/mm <sup>2</sup>
$S$	Safety coefficient	—
$Y = 1/S$	Degree of yield strength utilization	—
$\sigma_{zul}$	Allowable stress under static loading	N/mm <sup>2</sup>
Secondary symbols		
$\wedge$	Maximum value (e.g. $\hat{p}$ = maximum pressure)	—
$\vee$	Minimum value (e.g. $\check{p}$ = minimum pressure)	—
$\bar{\quad}$	Mean value (e.g. $\bar{\sigma}$ = mean stress)	—



**Steel pipes for oil collection and water injection pipelines with cement mortar lining**

**B.3. Wall thickness calculation**

The required wall thickness is obtained by adding the minimum wall thickness  $s_v$  per Table B.2, allowance  $c_1$  for the negative wall thickness tolerance and, where applicable, allowance  $c_2$  for corrosion and/or wear in the case of pipes without external or internal corrosion protection.

The required wall thickness is thus:

$$s = s_v + c_1 + c_2 \tag{B-1}$$

Where the negative wall thickness tolerance  $c_1$  is given in %, the following holds:

$$s = (s_v + c_2) \frac{100}{100 - c_1} \tag{B-1a}$$

**Table B.2 — Determination of the minimum wall thickness  $s_v$**

Minimum wall thickness $s_v$	Yield strength $K$	Safety coefficient $S$ and degree of yield strength utilization $Y$ for pipes		
mm	N/mm <sup>2</sup>			
$\sigma_{zul} = K/S = y \cdot k$		$A^b$	$S^d$	$Y$
$s_v = \frac{d_a \cdot p}{2 \sigma_{zul} \cdot v_N}$ (B-2a)  $= \frac{d_i}{\frac{2 \sigma_{zul} \cdot v_N}{p} - 2}$ (B-2b) <sup>c</sup>	Yield strength / 0.2 % proof stress / 0.5 % proof stress Minimum values at 20 °C <sup>a</sup>	≥ 25 %	1.5	0.67
		= 20 %	1.6	0.63
		Values for pipelines buried in terrain without special additional stresses:		
		≥ 25 %	1.4	0.72
		= 20 %	1.5	0.67
		= 15 %	1.6	0.63
<sup>a</sup> The yield strength values specified in the applicable standards, rules, datasheets or specifications are to be used; if required, a value must be interpolated. For design temperatures < 20 °C the values for 20 °C are to be used.				
<sup>b</sup> Elongation $L_O = 5.65 \cdot \sqrt{S_O}$ . Intermediate values may be linearly interpolated or, in the case of small values, extrapolated to 15 %.				
<sup>c</sup> Equation (B-2b) is the mathematical transformation of equation (B-2a) and will yield the same result, if $d_a = d_i + 2 s_v$ .				
<sup>d</sup> Safety factor for oil collection and water injection line pipes is chosen for grades < L245N as 1,5, for L360N as 1,56 correspondingly based on real elongation values. (see table 2).				

The above described calculation of the wall thickness is carried out without of consideration of applicable national guidelines for devices worked under pressure, for example AD 2000 or DIN EN 13480-3: 2013