

Quality	C45E	Quenching and Tempering Steel	<i>Technical card Lucefin Group rev. 2018</i>
According to standards	ISO 683-1: 2018		
Number	1.1191		

Chemical composition

C%	Si%	Mn%	P% max	S% max	Cr%	Mo%	Ni%	Cu%	
0,42-0,50 ± 0.02	0,10-0,40 ± 0.03	0,50-0,80 ± 0.04	0,020 + 0.005	0,035 ± 0.005	0,40 +0.05	0,10 +0.03	0,40 +0.03	0,30 +0.05	Product deviations are allowed

Cr+Mo+Ni max 0.63%

For C45R n° 1.1201, S% 0.020-0.040 product deviation ± 0.005

On request, it may be supplied (Ca) treated and with the addition of lead Pb 0.15-0.35%

Temperature °C

Hot-forming	Normalizing +N	Quenching +Q	Quenching +Q	Tempering +T	Stress-relieving +SR		
1100-850	840-880 air	820 water	860 oil or polymer	550-660 air	50° under the temperature of tempering		
Soft annealing +A	Isothermal annealing +I	Natural state +U	End quench hardenability test	Pre-heating welding	Stress-relieving after welding		
690 cooling 10 °C/h to 600, then air (HB max 207)	810 furnace cooling to 660, then air (HB 160-216)	(~ HB 169-245)	850 water	250	550 furnace cooling		
				Ac1 735	Ac3 780	Ms 350	Mf 120

Mechanical properties

C45E C45R Hot-rolled mechanical properties in **normalized** condition ISO 683-1: 2018

size d / t Testing at room temperature (longitudinal)

mm	R	Re _H ^{a)}	A%	Z%	Kv ₂	HB for information
from to	N/mm ² min	N/mm ² min.	min.	min.	J min.	min
16/16	620	340	14	-	-	190
16/16 100/100	580	305	16	-	-	172
100/100 250/250	560	275	16	-	-	162

^{a)} Re_H upper yield strength or, if no yield phenomenon occurs, Rp_{0.2} has to be considered

d = diameter t = thickness

C45E C45R Hot-rolled mechanical properties in **quenched and tempered** condition EN 10083-1: 2006

size d / t Testing at room temperature (longitudinal)

mm	R	Re _H ^{a)}	A%	Z%	Kv ₂	HB
from to	N/mm ²	N/mm ² min	min.	min.	J min	for information
16/8	700-850	490	14	35	15	213-253
16/8 40/20	650-800	430	16	40	15	200-240
40/20 100/60	630-780	370	17	45	15	192-232

^{a)} Re_H upper yield strength or, if no yield phenomenon occurs, Rp_{0.2} has to be considered

d = diameter t = thickness

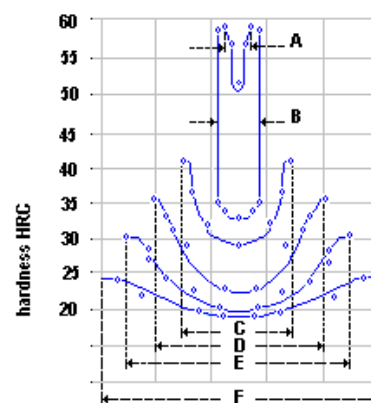
Table of tempering values obtained at room temperature on rounds of Ø 10 mm after quenching at 850 °C in water

°C	R N/mm ²	HRC	HB
100	2330	58	615
200	2240	57	597
300	1880	52	510
400	1390	43	401
500	1030	33	311
600	810	23	242
°C	R N/mm ²	Rp _{0.2} N/mm ²	A %
620	740	480	22
650	600	400	23
700	540	320	24

Hardness condition
on bars quenched in water

- A = diameter 13 mm
- B = diameter 25 mm
- C = diameter 50 mm
- D = diameter 75 mm
- E = diameter 100 mm
- F = diameter 130 mm

• hardness check points



C45E 1.1191 - C45R 1.1201 EN 10277: 2018
Lucefin Group

Cold-drawn +C ^{c)}						Hot-rolled and Peeled +SH ^{d)}			
size mm		Testing at room temperature (longitudinal)				Testing at room temperature (longitudinal)			
from	to	R ^{a)}	Rp 0.2 ^{a)}	A%	HBW	R	Rp 0.2	A%	HBW
		N/mm ²	N/mm ² min	min	<i>for inform.</i>	N/mm ²	N/mm ² min	min	
5 ^{b)}	10	750-1050	565	5	225-319	-	-	-	-
10	16	710-1030	500	6	218-311	-	-	-	-
16	40	650-1000	410	7	200-298	580-820	-	-	172-241
40	63	630-900	360	8	192-271	580-820	-	-	172-241
63	100	580-850	310	8	172-253	580-820	-	-	172-241

^{a)} for flats and special sections, yield point can be -10% and tensile strength can be ± 10%
^{b)} for thickness < 5 mm, mechanical properties should be agreed before order placement
^{c)} values valid also for +C+G
^{d)} values valid also for +SH+G

Hot-rolled, quenched and tempered and Peeled +QT+SH ^{c)}						Quenched and tempered and Cold-drawn +QT+C			
size mm		Testing at room temperature (longitudinal)				Testing at room temperature (longitudinal)			
from	to	R	Rp 0.2	A%	Kv₂ +20 °C	R	Rp 0.2	A%	Kv₂ +20 °C
		N/mm ²	N/mm ² min	min	J min	N/mm ²	N/mm ² min	min	J min
5 ^{b)}	10	-	-	-	-	850-1050	595	8	-
10	16	-	-	-	-	810-1010	565	8	-
16	40	650-800	430	16	25	750-900	525	9	-
40	63	630-780	370	17	25	650-850	455	10	-
63	100	630-780	370	17	25	650-850	455	11	-

^{b)} for thickness < 5 mm, mechanical properties should be agreed before order placement
^{c)} values valid also for C+QT

Testing at room temperature (longitudinal) LUCEFIN experience									
		Cold-drawn +QT				Cold-drawn + QT + Cold-drawn			
diameter		R	Rp 0.2	A%	Kv + 20 °C	R	Rp 0.2	A%	Kv + 20 °C
mm		N/mm ²	N/mm ² min	min	J	N/mm ²	N/mm ² min	min	J
56		675	429	22,6	60-50-60	704	570	23,6	45-36-58

C45E 1.1191 Forged normalized UNI EN 10250-2: 2001

size mm		Testing at room temperature						
from	to	R	Re ^{c)}	A%	A%	Kv +20 °C	Kv +20 °C	HB
		N/mm ² min	N/mm ² min	min (L)	min (T)	J min (L)	J min (T)	<i>min</i>
	100	580	305	16				172
100	250	560	275	16	12	18	10	162
250	500	540	240	16	12	15	10	158
500	1000	530	230	15	11	12	10	156

C45E 1.1191 Forged quenched and tempered UNI EN 10250-2: 2001

size d / t		Testing at room temperature						
from	to	R	Re ^{c)}	A%	A%	Kv +20 °C	Kv +20 °C	HB
		N/mm ² min	N/mm ² min	min (L)	min (T)	J min (L)	J min (T)	<i>min</i>
	100/70	630	370	17	-	25	-	192
100/70	250/160	590	340	18	12	22	15	176
250/160	500/330	540	320	17	11	20	12	158

L = longitudinal T = tangential ^{c)} Re upper yield strength or, if no yield phenomenon occurs, Rp 0.2 has to be considered
d = diameter t = thickness

C45E C45R ISO 683-1: 201806 Jominy test HRC grain size 5 min.

mm distance from quenched end																	
	1	2	3	4	5	6	7	8	9	10	11	13	15	20	25	30	H
min	55	51	37	30	28	27	26	25	24	23	22	21	20	-	-	-	normal
max	62	61	61	60	57	51	44	37	34	33	32	31	30	-	-	-	

C45E		<i>Lucefin Group</i>						
Thermal Expansion	$10^{-6} \cdot K^{-1}$	►	11.1	12.1	12.9	13.5	13.9	14.1
Mod. of Elasticity long.		220	205	195	185	175	155	
Mod. of Elasticity tang.		88	78	74	71	67	59	
Specific Heat Capacity	J/(Kg•K)	460	486	519	586			
Thermal Conductivity	W/(m•K)	50	50.8					
Density	Kg/dm ³	7.85						
Specific Electric Resist.	Ohm•mm ² /m	0.12	0.22					
Electrical Conductivity	Siemens•m/mm ²	8.33	6.25	4.54				
°C		20	100	200	300	400	500	600

The symbol ► indicates temperature between 20 °C and 100 °C, 20 °C and 200 °C ...

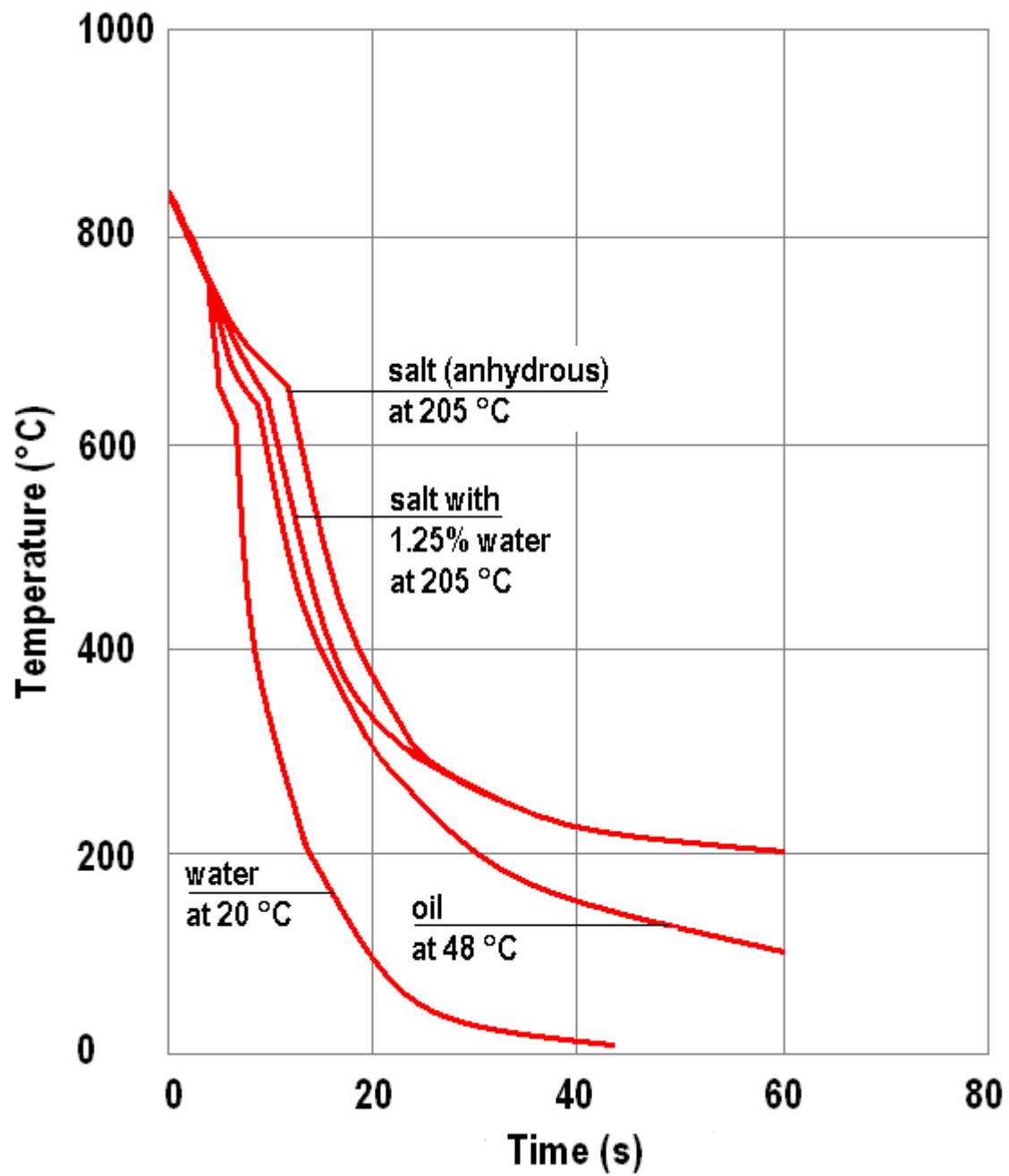
Heat treatment	Temperature (+ ... °C)		min. values					Data under fatigue
	20	200	300	350	450	500		
+QT Ø ≤ 150 mm		284	235	206			Yield stress R_p 0.2 N/mm ² EN 10269: 01	
+N					100	70	Creep rupture, 10.000 h N/mm ² ¹⁾	
+N					55	35	Creep rupture, 100.000 h N/mm ² ¹⁾	
+U	591						Cyclic yield strength, σ_y'	
+SR	336						N/mm ²	
+N	370						low cycle number	
+QT	462							
+U	0.23						Cyclic strength exponent, n'	
+SR	0.09						low cycle number	
+N	0.15							
+QT	0.13							
+U	2407						Cyclic strength coefficient, K'	
+SR	599						N/mm ²	
+N	952						low cycle number	
+QT	1078							
+U	774						Fatigue strength coefficient, σ_f'	
+SR	519						N/mm ²	
+N	1267						low cycle number	
+QT	1405							
+U	- 0.06						Fatigue strength exponent, b	
+SR	- 0.04						low cycle number	
+N	- 0.14							
+QT	- 0.11							
+U	0.11						Fatigue ductility coefficient, g_f'	
+SR	0.12						low cycle number	
+N	0.42							
+QT	0.61							
+U	- 0.37						Fatigue ductility exponent, c	
+SR	- 0.42						low cycle fatigue	
+N	- 0.53							
+QT	- 0.55							
+N	190						Fatigue limit, σ_L'	
+QT	265						N/mm ² high cycle fatigue	

¹⁾ Creep rupture strength

+U = natural +N = normalized +QT = quenched and tempered +SR = stress-relieved

K_v values obtained on hot-rolled 130 mm round; **LUCEFIN** experience

+QT induction for R 743 N/mm ² R _p 421 N/mm ² A% 26 C% 58							
J	50 - 57 - 60	36 - 33 - 40	32 - 41 - 28		14 - 24 - 24	16 - 26 - 14	
°C	+20	0	-20		-40	-60	
EUROPE	ITALY	CHINA	GERMANY	FRANCE	U.K.	RUSSIA	USA
EN	UNI	GB	DIN	AFNOR	B.S.	GOST	AISI/SAE
C45E	C45	45	Ck45	XC48	080M46	45	1045



Cooling curves for C45E steel; rounds from 25 to 100 mm quenched in salts, oil, water