INDUCTOHEAT
EUROPE
An Inductotherm Group Company

Contract hardening

INDUCTOTHERM® GROUP

Leading Manufacturers of Melting, Thermal Processing &
Production Systems for the Metals & Materials Industry Worldwide

The company

Hardening quality – tested and documented

INDUCTOHEAT Europe, known since 1951 as a manufacturer of inductive heat treatment, also operates two contract hardening shops at its Darmstadt-Mühltal and Stuttgart-Reichenbach locations. Here, we not only provide customers with practical proof of the efficiency of our innovative plant technology, but also provide individual, customer-focused solutions to their contract hardening assignments: quickly and reliably to the requisite standard of quality.

Working in cooperation with our process development team, we are also able to offer machine-capable solutions and perform series contract hardening for the most complex and demanding hardening tasks. Documentation of the required quality characteristics is performed in our modern DIN ISO 9001: 2008-compliant testing and measurement labs.

Why inductive hardening?
Inductive hardening is a tried and tested method of enhancing the quality of all important construction components.

The main benefit of this technique is the evenness it achieves in terms of hardness values and the hardening process.Suitable hardening processes and hardness penetration depths can be programmed for accurate future reproduction. It is also possible to concentrate the heating process selectively on one or more restricted areas of the overall surface. The hardness penetration depth is limited during this process to the zones which actually require hardening. Additional characteristics are a marked reduction of scale formation and workpiece warping, helping to save considerable costs for preliminary and subsequent treatment processes.

When is inductive hardening recommended?

All workpieces which are electrically conductive can be inductively heated. However, the carbon content of the material plays a decisive role when it comes to hardening. Where an appreciable increase in hardness is required, the C component should be no less than 0.35%.

It makes most sense for inductive hardening technology to be used on workpieces whose skin is required to demonstrate good wear resistance, while the core calls for a high degree of toughness. However, a high degree of abrasion resistance can be achieved alongside good torsional and alternate bending strength. Different hardening processes exist such as stationary hardening, progressive hardening, stationary spin hardening and progressive spin hardening

The clean, fast supply of heat to workpiece is fully in step with increasingly stringent demands for effective environmental protection.

Our consultancy services

Training events held in our Academy
- “Fundamentals of induction heating”
- “Why is inductive hearing economically interesting for companies”

Material selection/
feasibility of technical application/execution

Converting to a different heat treatment method
for economic reasons

Our contract hardening services

High-frequency range	Rotationally symmetrical parts Axles, bolts, shafts and similar or e.g. discs	 dia. to 120 x 1 200 mm dia. max. 300 x 15 mm
Medium-frequency range	Rotationally symmetrical parts Axles, bolts, shafts, rollers Surface hardening	 dia. to 300 x 2 500 mm* max. 200 x 2 500 mm*
Special applications	• Gears, bevel gears and sprockets using an all-over surface Heating method with subsequent quenching using the whirlpool method Gears and bevel gears up to modulus = 5 (with m = 5 tooth height max. 50 mm) Sprockets up to pitch 1˝ Individual tooth hardening from modulus = 5	 dia. max. 500 mm dia. max. 500 mm dia. max. 3 000/ TW max. 200 mm
	• Racks, straight and helical geared In feed mode up to modulus= 5 In single tooth mode from modulus = 5	 max. 50 x 50 x 4 000 mm Tooth width max. 200 mm*
	• Worm gear shafts, tooth flank hardening Single and multi-start from modulus = 5	
	• Peripheral feed hardening of rings, discs, plates etc. Profiles of driving or rope pulleys	 dia. max. 3 000 x 200 mm
	• Mating track hardening e.g. disk cams, track cams, Positive curves etc.*	
	• For other special hardening processes / heating problems please speak to our specialist team.	
Tempering / Stress relief	• in modern recirculating air ovens up to max. 2 000 mm Workpiece length	
Quality assurance	• Crack testing: Using the magnetic method (fluxing) in a state-of-the-art plant and using the powder method (penetration) • Documentation: Test records using PC-controlled measuring devices Measuring devices for HRC, HRA corresponding to DIN 51224/DIN 51225 Verification of hardened zones by etched workpiece specimens and microsections Microscope with photographic facility for microsection observation Hardness testing in accordance with DIN 50103/DIN 50133 Hardness profile tests with documentation in accordance with DIN 10328 • Our company is continuously certified to DIN ISO 9001.	

* max. workpiece weight 2 000 kg

Inductively hardable steels

DIN-term	material-number	HRc-values	analysis									
			C	Si	Mn	P	S	Cr	Mo	Ni	V	C
			%	≤ %	≤ %	≤ %	≤ %	%	%	%	%	%
heat-treatable steels												
C 35	1.0501	51 – 57	0,35	0,35	0,80	0,045	0,045					
35 S 20 [1]	1.0726	50 – 55	0,35	0,40	0,90	0,060	0,250					
Ck 35	1.1181	51 – 57	0,35	0,35	0,80	0,035	0,035					
Cf 35	1.1183	51 – 57	0,35	0,35	0,80	0,025	0,035					
C 45	1.0503	56 – 61	0,45	0,35	0,80	0,045	0,045					
45 S 20 [1]	1.0727	55 – 60	0,45	0,40	0,90	0,060	0,250					
Ck 45	1.1191	56 – 61	0,45	0,35	0,80	0,035	0,035					
Cf 45	1.1193	56 – 61	0,45	0,35	0,80	0,025	0,035					
Cf 53	1.1213	58 – 63	0,53	0,35	0,70	0,025	0,035					
60 S 20 [1]	1.0728	58 – 62	0,60	0,40	0,90	0,060	0,250					
Ck 60	1.1221	59 – 64	0,60	0,35	0,90	0,035	0,035					
Cf 70	1.1249	60 – 64	0,70	0,35	0,35	0,025	0,035					
79 Ni 1	1.6971	60 – 64	0,79	0,30	0,55	0,025	0,025	0,15		0,15	0,05	
36 Mn 5	1.5067	52 – 56	0,36	0,35	1,50	0,035	0,035					
40 Mn 4	1.5038	53 – 58	0,40	0,50	1,10	0,035	0,035					
37 MnSi 5 [2]	1.5122	55 – 58	0,37	1,40	1,40	0,035	0,035					
38 MnSi 4 [2]	1.5120	54 – 58	0,38	0,90	1,20	0,035	0,035					
46 MnSi 4 [2]	1.5121	57 – 60	0,46	0,90	1,20	0,035	0,035					
53 MnSi 4 [2]	1.5141	58 – 62	0,53	1,00	1,20	0,035	0,035					
45 Cr 2	1.7005	56 – 60	0,45	0,40	0,80	0,025	0,035	0,50				
34 Cr 4	1.7033	51 – 55	0,34	0,40	0,90	0,035	0,035	1,05				
37 Cr 4	1.7034	53 – 58	0,37	0,40	0,90	0,035	0,035	1,05				
38 Cr 4	1.7043	53 – 58	0,38	0,40	0,90	0,025	0,035	1,05				
41 Cr 4	1.7035	54 – 58	0,41	0,40	0,80	0,035	0,035	1,05				
42 Cr 4	1.7045	54 – 58	0,42	0,40	0,80	0,025	0,035	1,05				
34 CrMo 4	1.7220	52 – 56	0,34	0,40	0,80	0,035	0,035	1,05	0,25			
41 CrMo 4	1.7223	54 – 58	0,41	0,40	0,80	0,025	0,035	1,05	0,25			
42 CrMo 4	1.7225	54 – 58	0,42	0,40	0,80	0,035	0,035	1,05	0,25			
49 CrMo 4	1.7238	57 – 62	0,49	0,40	0,80	0,025	0,035	1,05	0,25			
50 CrMo 4	1.7228	57 – 62	0,50	0,40	0,80	0,035	0,035	1,05	0,25			
50 Cr V 4	1.8159	57 – 62	0,50	0,40	1,10	0,035	0,035	1,05			0,15	
58 Cr V 4	1.8161	58 – 63	0,58	0,35	1,10	0,035	0,035	1,05			0,09	
30 CrNiMo 8	1.6580	50 – 54	0,30	0,40	0,60	0,035	0,035	2,00	0,35	2,00		
34 CrNiMo 6	1.6582	53 – 56	0,34	0,40	0,70	0,035	0,035	1,55	0,25	1,55		
36 CrNiMo 4	1.6511	54 – 57	0,36	0,40	0,80	0,035	0,035	1,05	0,25	1,05		
tool steels												
X 41 CrMo V 5,1	1.2344	55 – 59	0,41	1,00	0,40	0,015	0,010	5,00	1,30		0,50	
86 CrMo V 7	1.2327	60 – 64	0,86	0,35	0,45	0,030	0,030	1,75	0,30	0,10		
X 20 Cr 13	1.2082	48 – 53	0,20	0,50	0,40	0,035	0,035	13,00				
X 40 Cr 13	1.2083	55 – 58	0,40	0,50	0,40	0,030	0,030	13,00				
stainless steels												
X 90 CrMo V 18	1.4112	55 – 58	0,90	1,00	1,00	0,045	0,030	18,00	1,15			
X 90 CrCoMo V 17	1.4535	55 – 58	0,90	1,00	1,00	0,045	0,030	16,50	0,50	0,25	0,25	ca. 1,5
X 105 CrMo 17	1.4125	56 – 60	1,05	1,00	1,00	0,045	0,030	17,00	0,60		0,10	
rolling bearing steels												
100 Cr 6	1.3505	62 – 65	1,00	0,35	0,40	0,030	0,025	1,55				
valve steel												
X 45 CrSi 9-3	1.4718	56 – 60	0,45	3,50	0,50	0,030	0,025	9,50				
X 80 CrNiSi 20	1.4747	52 –55	0,80	2,75	1,00	0,030	0,030	20,00		1,50		
casting material												
GG-25	0.6025	48 – 52										
GTS-45		51 – 57										
GTS-65		56 – 59										
GGG-60	0.7060	53 – 59										
GGG-70	0.7070	56 – 62										

[1] higher hardening variations are possible [2] good transmutations, but danger of cracks for strong shaped pieces

Carburized steels suitable for partial hardening, e.g. Ck 15, 16 MnCr 5, 20 MnCr 5, 15 CrNi 6, 20 MoCr 4 etc.

Dry powdered metals iron-carbon basis hardening is possible

Key for hardening depths:

- max. 2 mm
- max. 4 mm
- max. 6 mm
- über 6 mm

Hardness testing methods

Fields of application for the processes

- **Rockwell: Series testing**
  Most widespread method, used everywhere, thermal treatment, toolmaking
- **Brinell: Raw material testing**
  Steel plants, foundries
- **Vickers: Quality assurance**
  Most precise method, used everywhere, laboratory test, small parts

Conversion table tensile strength – hardening values

Extract from DIN 50150

Tensile testing N/mm²	Brinell hardness HB	Vickers hardness HV	Rockwell hardness HRC	Rockwell hardness HRA
400	119	125	–	
510	152	160	–	
610	181	190	–	
705	209	220	–	
770	228	240	20,3	60,7
800	238	250	22,2	61,6
850	252	265	24,8	62,7
900	266	280	27,1	63,8
950	280	295	29,2	64,8
995	295	310	31,0	65,8
1095	323	340	34,4	67,6
1190	352	370	37,7	69,2
1290	380	400	40,8	70,8
1385	409	430	43,6	72,3
1485	437	460	46,1	73,6
1595	(466)	490	48,4	74,9
1700	(494)	520	50,5	76,1
1810	(523)	550	52,3	77,0
1920	(551)	580	54,1	78,0
2030	(580)	610	55,7	78,9
2180	(618)	650	57,8	80,0
		700	60,1	81,3
		740	61,8	82,2
		800	64,0	83,4
		840	65,3	84,1
		860	65,9	84,4
		900	67,0	85,0
		940	68,0	85,6

The values are applicable as approximations. Different deviations occur with different materials.

Minimum strength levels when testing according to Rockwell A, B, C, D, F, G, N, T

The penetration depth may not exceed $^{1}/_{10}$ of the material thickness.

Hardness Rockwell A, C, D (diamond)		20	30	40	50	60	70	80
Hardness Rockwell B, F, G (ball)	40	50	60	70	80	90	100	
Minimum thickness mm	1,8	1,6	1,4	1,2	1,0	0,8	0,6	0,4

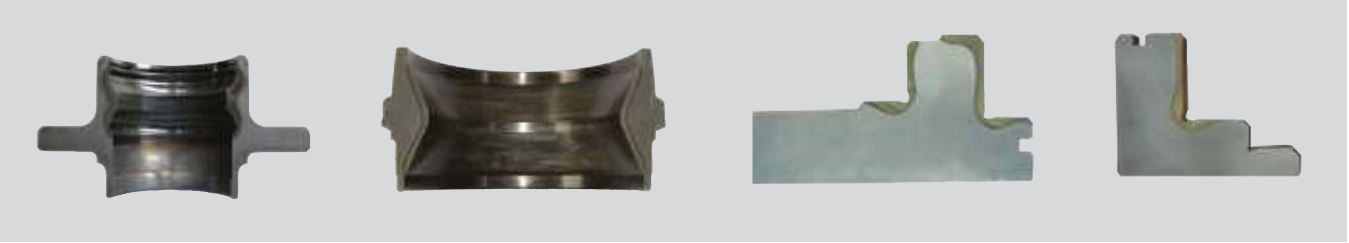
Test force level	Minimum thickness with a hardness HV of				
	100	200	300	500	800
1	0,20	0,16	0,12	0,09	0,07
2	0,29	0,20	0,17	0,13	0,10
3	0,35	0,25	0,20	0,16	0,13
5	0,45	0,32	0,27	0,21	0,16
10	0,65	0,46	0,37	0,29	0,23
20	0,91	0,65	0,53	0,41	0,32
30	1,1	0,79	0,65	0,50	0,40
40	1,3	0,91	0,75	0,58	0,46
60	1,5	1,1	0,91	0,70	0,56
100	2,0	1,4	1,2	0,92	0,72

Influence of the alloying elements on steel

	Aluminium **Al**	Cobalt **Co**	Chrome **Cr**	Copper **Cu**	Manganese **Mn**	Molybdenum **Mo**	Nickel **Ni**	Phosphorus **P**	Sulphur **S**	Silicon **Si**	Titanium **Ti**	Vanadium **V**	Tungsten **W (Tu)**
Carbide-forming elements	<	<	++	<	~	++	<	<	<	<	++	++	++
Nitride-forming elements	++	<	++	<	~	+	<	<	<	<	++	+	+
Critical cooling rate	~	+	≪		≪	≪	≪			<		≪	≪
Hardness	~	+	++	+	+	+	+	+		+		+	+
Yield strength		+	++	+	+	+	++	+		++		+	+
Strength		+	++	+	+	+	+	+		+	~	+	+
Elongation	<	<	~	~	~	<	~	<	<	~		~	<
Local contraction	<	<		~		<	~	<	<				
High-temperature strength	~	++	+	+	~	++	+	+		+	+	++	++
Notch impact strength	~	<	<	~	+	+	+		<	<	~	+	
Rust resistance	~		++	+				+	<				
Scale resistance	+		+	~	~					++			<
Machinability	~	~	~	~	~	<	<	++	++	<		~	<
Wear resistance	~	++	+		~	++	≪				+	++	++

~ Approximately the same/ constant
\+ Increase
++ Marked increase
< Reduction
≪ Marked reduction

Clients who trust in our expertise



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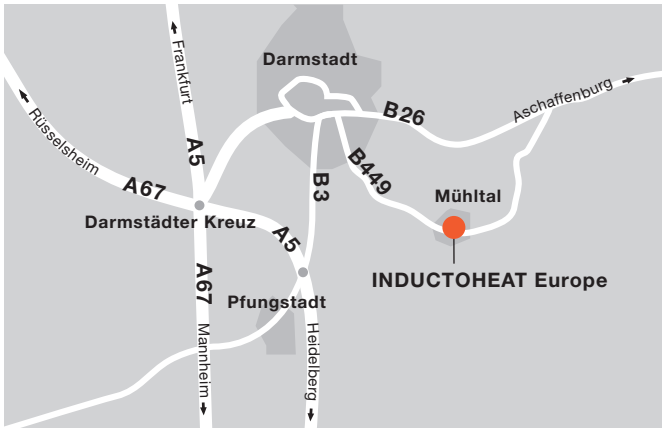

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