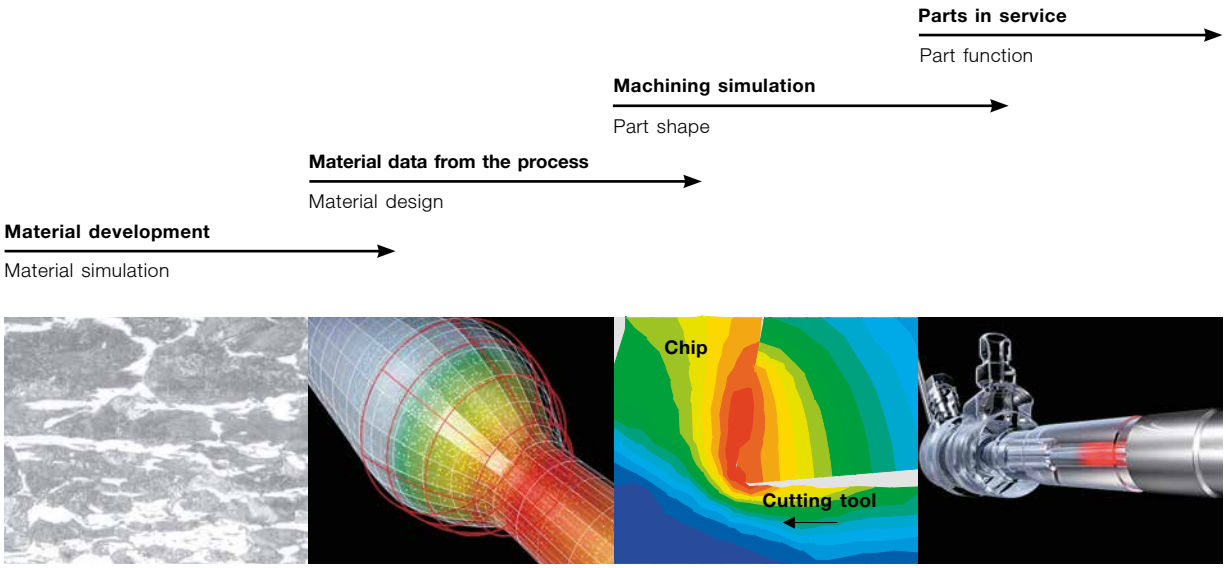
Steeltec
HSX® 110/130/Z12

SCHMOLZ + BICKENBACH GROUP

STEELTEC

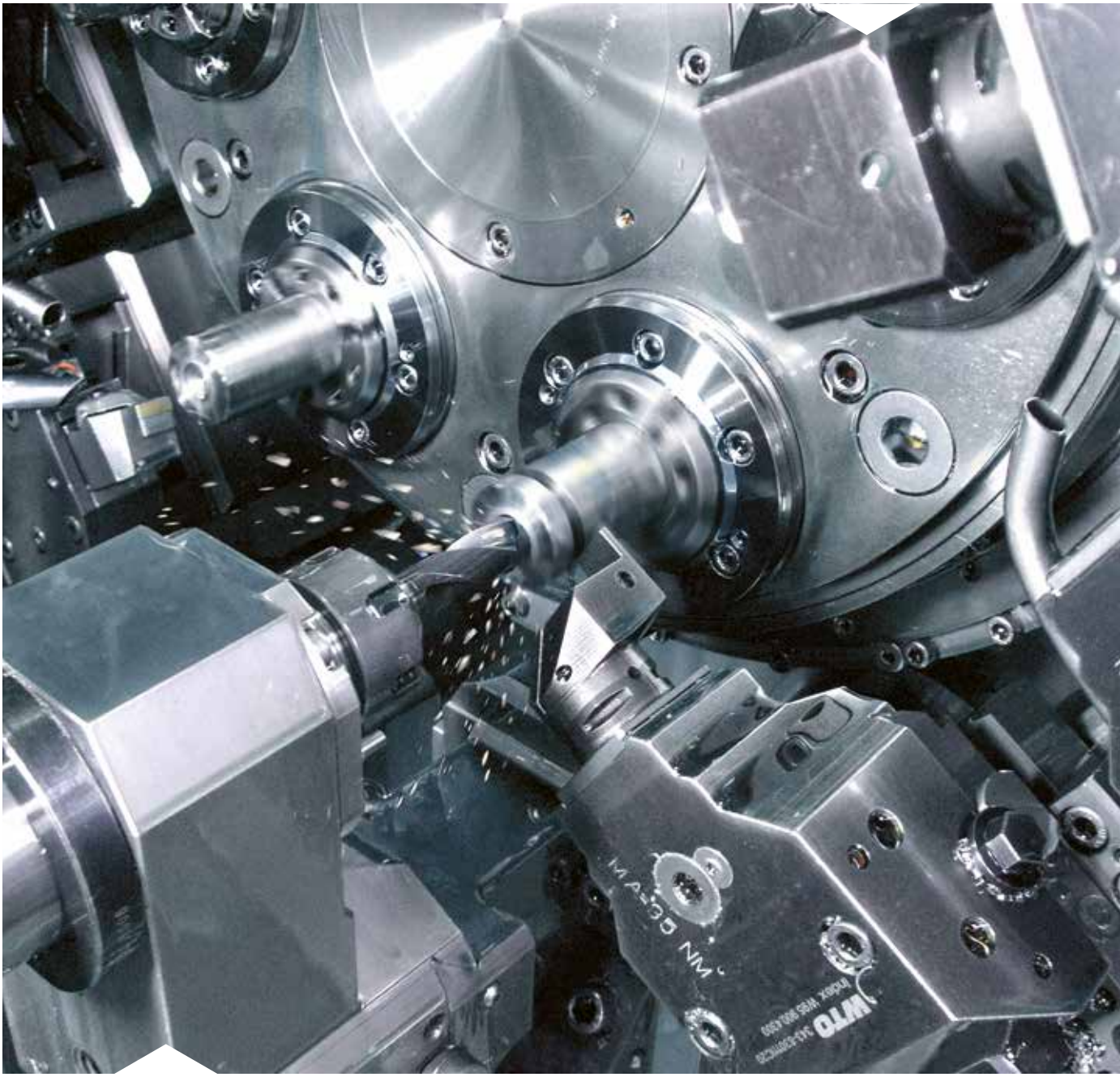


Steel for that competitive edge

Steel has been one of the most important materials for many centuries. We produce it in grades and qualities which enable our customers to succeed in an increasingly harsh competitive environment. Steel from Steeltec is used wherever precision parts are required to satisfy highly stringent demands, millions of times over, both safely and reliably, for years on end. Parts which have to be produced both efficiently and at a very low cost. While the requirements placed on steel may vary, our past, present and future passion for continually optimising the way we fulfil them remains unchanged.

Innovation through development partnerships

Using the very latest material developments and innovative production technologies, the potential offered by steel has been further tapped in projects involving several different companies. The challenge here lay in finding a way of reconciling what are generally conflicting material properties, such as toughness and strength. Material development is supported by the latest simulation tools.



HSX® marks the outcome of an innovative approach and the optimum blend of know-how and production resources.

HSX® opens up new perspectives in part manufacture:

» greater safety
» higher quality
» lower costs

The use of HSX® optimises production processes. The material is tailored to the process employed by the machinist and the function of the part within the system.

= Considerable cost savings throughout the process chain

HSX®: the state-of-the-art material for shorter processes and lower part costs.

New grades of steel for highly stressed parts

HSX® 110, HSX® 130, HSX® Z12. High-Strength Special Steels satisfying the most stringent requirements.

Up to 85 % of the costs of manufacturing components are process costs. It thus makes sense to set about reducing process costs rather than buying in cheaper materials.

Steeltec's customers, and particularly the automotive industry, are increasingly calling for new materials that can be used to produce highly stressed parts. The steel required for this must display:
» high strength
» good toughness
» outstanding processing properties

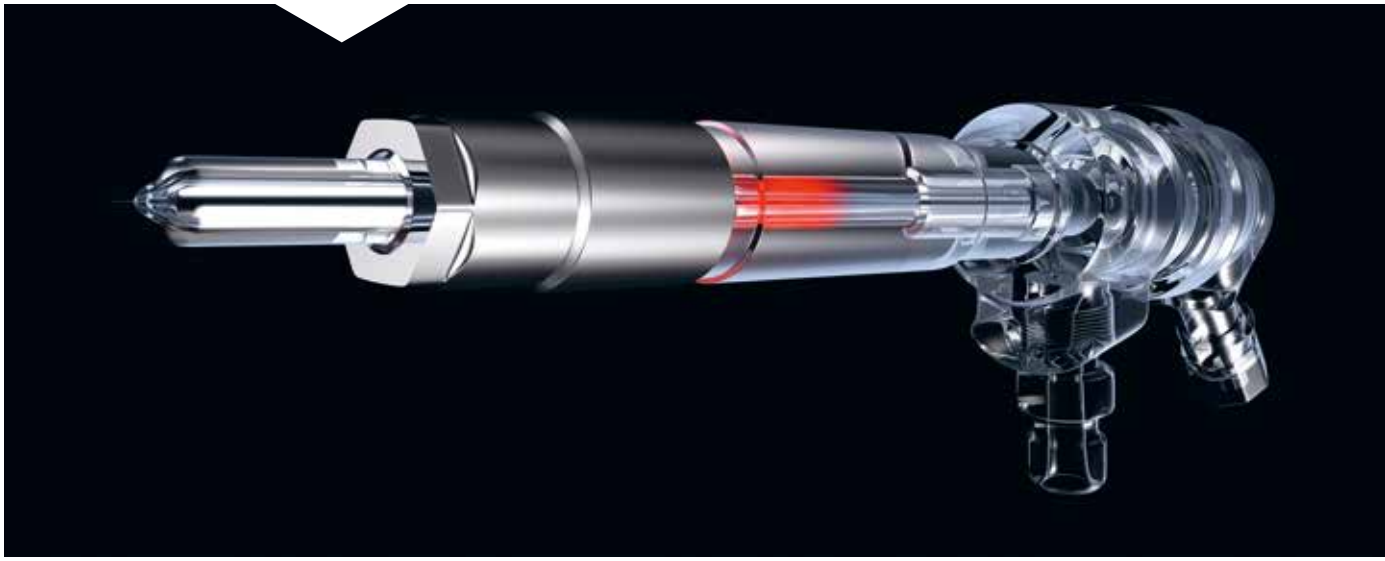
Steeltec offers its customers a whole series of unique, High-Strength Special Steels with properties that can be aligned to the specific applications and production conditions of the individual customers. These are the steel grades of the ETG® and HSX® families.

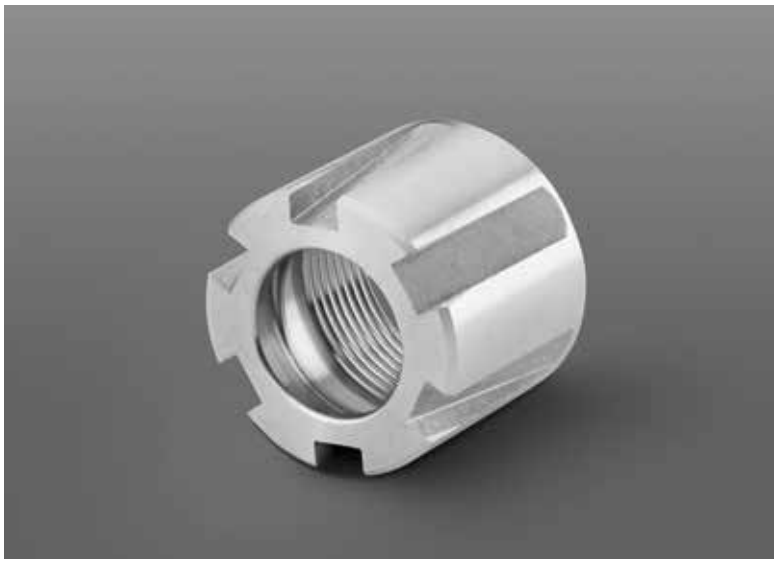
The High-Strength HSX® Special Steels are noted for their outstanding machinability

These steels have a short chipping length, and tool life is 50 – 70 % of that for ETG® 88 using comparable cutting parameters. Machinability and tool life are thus considerably improved in comparison to standard quenched and tempered steels.

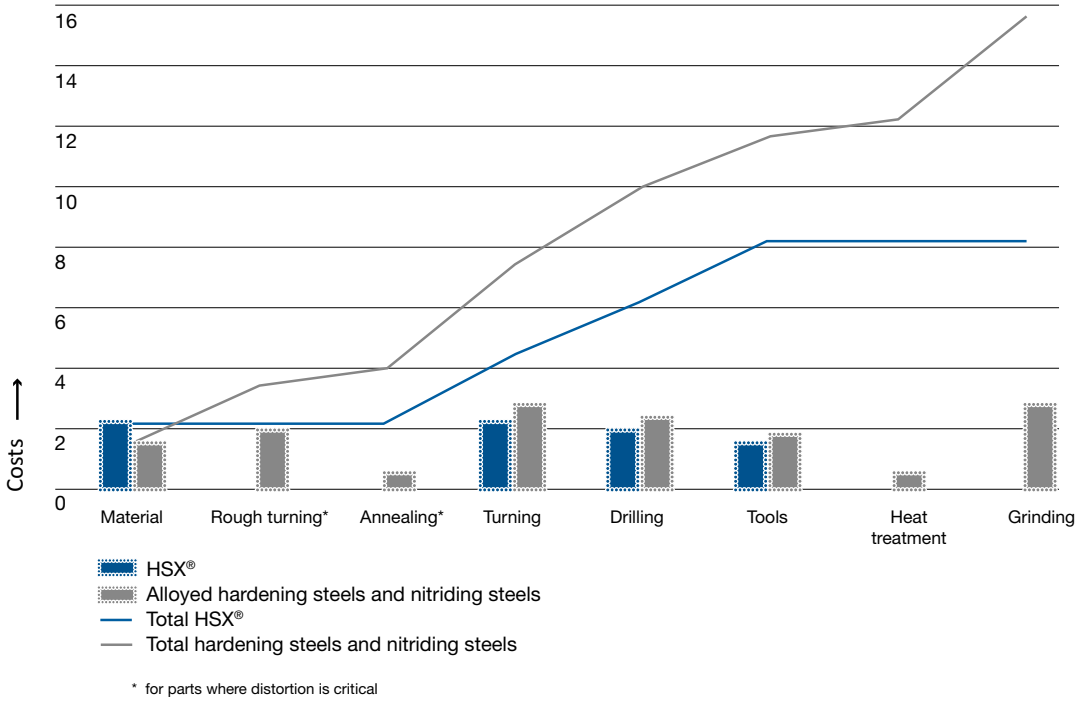
HSX® for a shorter and safer production process, bringing cost benefits over the entire production process:

» consistent, high quality and therefore a high process reliability
» higher machining capacity and shorter machining times compared with quenched and tempered steels
» no additional operations such as quenching and tempering, straightening, grinding or deburring
» shorter process cycles
» uniform mechanical properties over the entire cross-section and size range, permitting optimum dimensioning, i. e. smaller part sizes and hence weight savings
» process-friendly chipping
» higher tool life
» shorter machine down-times
» several machines per operator/unmanned shifts





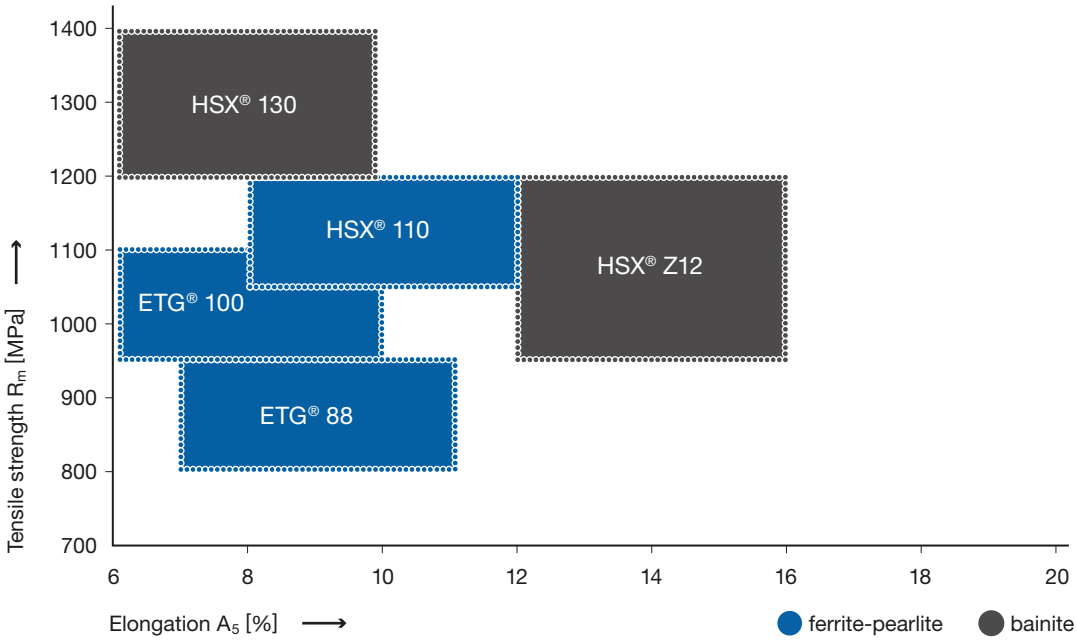
COMPARISON OF PART COSTS HSX®/ALLOYED HARDENING STEELS AND NITRIDING STEELS



* for parts where distortion is critical

‘When it comes to steel, we have the expertise, the experience and the knowledge. We can supply each and every one of our customers with the steel they need to move forward. Globally. In what-ever quantity. Whenever needed. It’s the way we ensure our own success and that of our customers. Our mission is to deliver the best **high-performance steel solution** to our customers. Every time.‘

TENSILE STRENGTH VS. ELONGATION AT FRACTURE



HSX® 110: higher strength, improved toughness
HSX® 130: significantly higher strength, good toughness
HSX® Z12: significantly higher toughness, good strength

HSX® 110/130/Z12 for parts with complex requirements

Due to their expanded range of material properties, the HSX® 110, HSX® 130 and HSX® Z12 High-Strength Special Steels are particularly suitable for highly-loaded or stressed parts. The higher strength of HSX® 110 and HSX® 130 is particularly suitable for parts subject to high static and dynamic loading, such as transmission components, camshafts, drive shafts and hydraulic and pneumatic components.

The significantly increased toughness of HSX® Z12 is most advantageous when used in parts required to withstand a combination of dynamic and static loading and subject to impact loads in addition to the transmission of forces. These can include hydraulic components and also screw joints with a defined torque moment, or parts under high compressive stress.

CHEMICAL COMPOSITION
MELT ANALYSIS % BY WEIGHT (TYPICAL VALUES)

	C	Si	Mn	S	Cr	Mo
HSX® 110	0.39	0.75	1.40	0.035	-	-
HSX® 130	0.18	1.20	1.60	0.15	1.20	0.30
HSX® Z12	0.18	1.20	1.60	0.15	1.20	0.30

MECHANICAL PROPERTIES
TYPICAL VALUES

Static				HSX® 110	HSX® 130	HSX® Z12
Proof stress	$R_{p0.2}$	N/mm²	min.	950	1200	800
Tensile strength	R_m	N/mm²	min.	1050	1250	950
		N/mm²	max.	1200	1400	1200
Elongation	A_5	%	min.	8	6	12
Hardness						
HRC			ap.	35	42	31
HB			ap.	330	395	300
Notched impact energy	Av_{RT}	J	ap.	10	20	40
	$Av_{-20\,°C}$	J	ap.	8	16	20
Dynamic						
Tension/compression	σ_w	N/mm²	ap.	485	545	485
Pulsating	σ_{sch}	N/mm²	ap.	385	445	385
Reverse bending	σ_{bw}	N/mm²	ap.	515	585	525

The fatigue limits were established on smooth specimens.
1 N/mm² = 1 MPa

PRODUCT RANGE

Steel category	Processes	Size range mm	Tolerance
HSX® 110	drawn, round	8 – 50	h11
HSX® 130	drawn, round	17 – 55	h11
HSX® Z12	peeled, round	18 – 62	h11

» Bar lengths: standard 3 m, other lengths upon request
» Colour coding end face: HSX® 110 traffic orange, HSX® 130 ruby red, HSX® Z12 traffic purple

Other categories to meet special requirements (e.g. mechanical properties) are available to special order.

Material properties and surface finish

The properties of HSX® steels mark the outcome of know-how combined with the appropriate production facilities. These include:

» state-of-the-art processing plants allowing different manufacturing processes to be linked into a single production system. The melting, shaping and manufacturing of components can be controlled as a whole.
» use of the latest testing procedures in all stages of processing.
» The surface finish and surface quality class 3 as per EN 10277-1.

GUARANTEED PROOF STRESS

$R_{p0.2}$ [N/mm²] TO EN 10277-5, EN 10083-3* AND EN 10085**

Material number	EN Reference	Process	Size range mm			
			5 – 10	> 10 – 16	> 16 – 40	> 40 – 62
1.7034	34CrS4	+C+QT	-	-	590	460
		+QT+C	700	700	580	510
1.7039	41CrS4	+C+QT	-	-	660	560
		+QT+C	750	670	570	570
1.7213	25CrMoS4	+C+QT	-	-	600	450
		+QT+C	700	700	600	520
1.7227	42CrMoS4	+C+QT	-	-	750	650
		+QT+C	770	750	720	650
1.6582	34CrNiMo6	+C+QT	-	-	900	800
		+QT+C	770	750	720	650
1.8159*	51CrV4	+QT	-	900	800	700
1.6580*	30CrNiMo8	+QT	-	1050	1050	900
1.8519**	31CrMoV9	+QT	-	-	900	800

HSX® 110	drawn, round	←	950 →
HSX® 130	drawn, round	←	1200 →
HSX® Z12	peeled, round	←	800 →

1 N/mm² = 1 MPa

GUARANTEED TENSILE STRENGTH

R_m [N/mm²] TO EN 10277-5, EN 10083-3* AND EN 10085**

Material number	EN Reference	Process	Size range mm			
			5 – 10	> 10 – 16	> 16 – 40	> 40 – 62
1.7034	34CrS4	+C+QT	-	-	800 – 950	700 – 850
		+QT+C	900 – 1100	900 – 1100	800 – 950	700 – 850
1.7039	41CrS4	+C+QT	-	-	900 – 1100	800 – 950
		+QT+C	1000 – 1200	1000 – 1200	900 – 1100	800 – 950
1.7213	25CrMoS4	+C+QT	-	-	800 – 950	700 – 850
		+QT+C	900 – 1100	900 – 1100	800 – 950	700 – 850
1.7227	42CrMoS4	+C+QT	-	-	1000 – 1200	900 – 1100
		+QT+C	1000 – 1200	1000 – 1200	1000 – 1200	900 – 1100
1.6582	34CrNiMo6	+C+QT	-	-	1100 – 1300	1000 – 1200
		+QT+C	1000 – 1200	1000 – 1200	1000 – 1200	1000 – 1200
1.8159*	51CrV4	+QT	-	1100 – 1300	1000 – 1200	900 – 1100
1.6580*	30CrNiMo8	+QT	-	1250 – 1450	1250 – 1450	1000 – 1300
1.8519**	31CrMoV9	+QT	-	-	1100 – 1300	1000 – 1200

HSX® 110	drawn, round	←	1050 – 1200 →
HSX® 130	drawn, round	←	1250 – 1400 →
HSX® Z12	peeled, round	←	950 – 1200 →

1 N/mm² = 1 MPa

GUARANTEED ELONGATION
A_5 [%] TO EN 10277-5, EN 10083-3* AND EN 10085**

Material number	EN Reference	Process	Size range mm			
			5 – 10	> 10 – 16	> 16 – 40	> 40 – 62
1.7034	34CrS4	+C+QT	-	-	14	15
		+QT+C	8	9	9	10
1.7039	41CrS4	+C+QT	-	-	12	14
		+QT+C	8	8	9	10
1.7213	25CrMoS4	+C+QT	-	-	14	15
		+QT+C	9	9	10	11
1.7227	42CrMoS4	+C+QT	-	-	11	12
		+QT+C	8	8	9	10
1.6582	34CrNiMo6	+C+QT	-	-	10	11
		+QT+C	8	8	9	10
1.8159*	51CrV4	+QT	-	9	10	12
1.6580*	30CrNiMo8	+QT	-	9	9	10
1.8519**	31CrMoV9	+QT	-	-	9	10

HSX® 110	drawn, round	← 8 →
HSX® 130	drawn, round	← 6 →
HSX® Z12	peeled, round	← 12 →

GUARANTEED NOTCHED IMPACT ENERGY
A_V [J] AS PER KEY TO STEEL, EN 10083-3* AND EN 10085**

Material number	EN References	Process	Size range mm		
			> 10 – 16	> 16 – 40	> 40 – 62
1.7034	34CrS4	+QT	30	35	35
1.7039	41CrS4	+QT	30	35	35
1.7213	25CrMoS4	+QT	45	50	50
1.7227	42CrMoS4	+QT	30	35	35
1.6582	34CrNiMo6	+QT	35	45	45
1.8159*	51CrV4	+QT	-	30	30
1.6580*	30CrNiMo8	+QT	-	30	35
1.8519**	31CrMoV9	+QT	-	25	30

+C cold drawn
+C+QT cold drawn and quenched and tempered
+QT+C quenched and tempered and cold drawn
+QT quenched and tempered

HSX® 110	drawn, round	← ap. 15 →
HSX® 130	drawn, round	← ap. 20 →
HSX® Z12	peeled, round	← ap. 40 →

HSX® High-Strength Special Steels to substitute standard grade steels

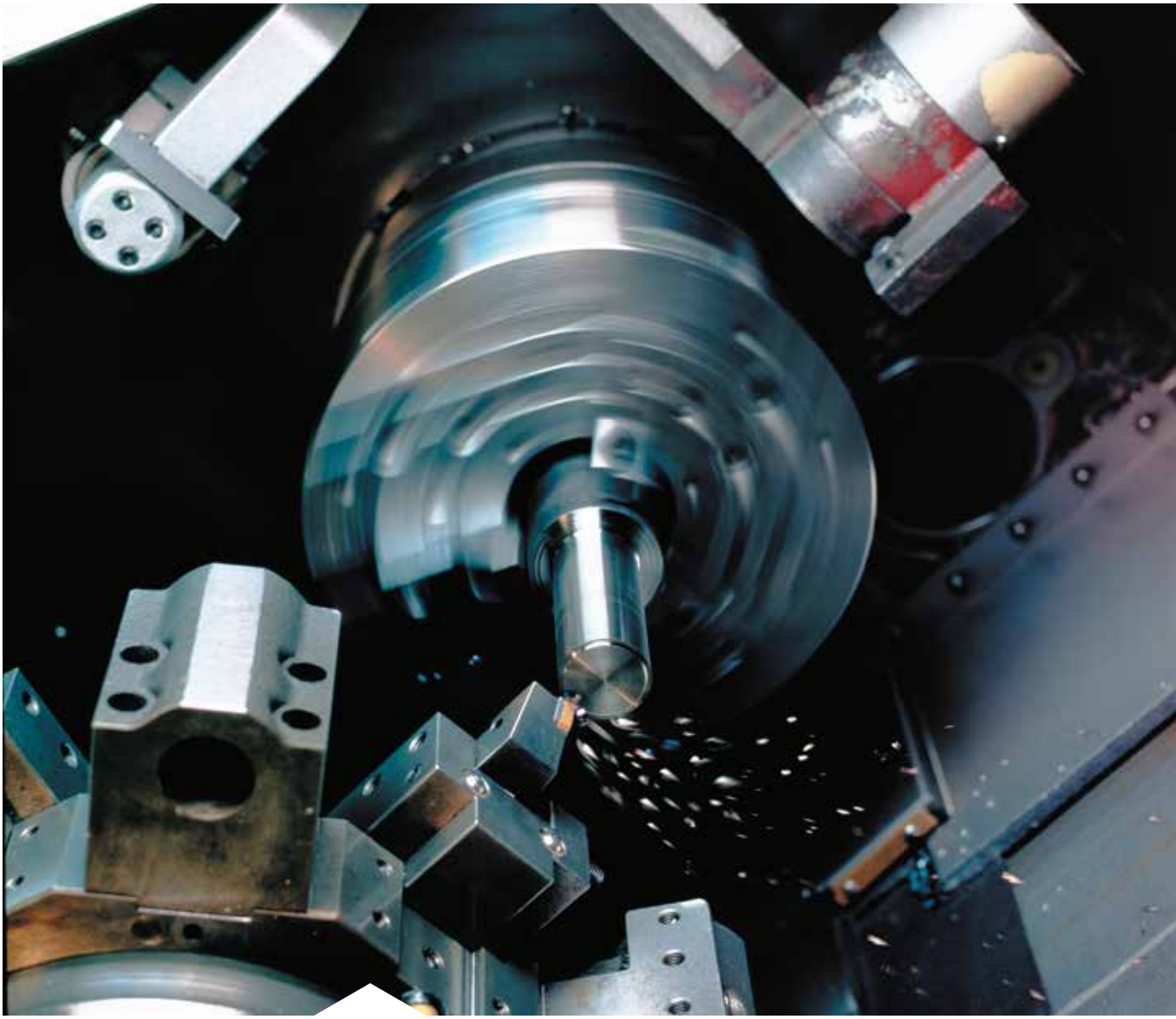
HSX® steels can be used for a wide range of applications due to their mechanical properties which remain consistent over the entire size range. A series of standard grade steels can be replaced with HSX® High-Strength Special Steels. By ordering optimised sizes, significant weight and cost reductions can be achieved.

ORIENTATION VALUES FOR VARIOUS MACHINING PROCESSES

MACHINING GUIDELINES v_c [m/min] AND f [mm/E]

Machining process	v_c/f	Process	HSX® 110	HSX® 130	HSX® Z12
Multi-spindle CNC turning (Carbide tooling, coated)	v_c	roughing	190 – 250	190 – 250	200 – 260
	f		0.20 – 0.60	0.20 – 0.60	0.20 – 0.60
	v_c	finishing	200 – 260	200 – 260	210 – 270
	f		0.10 – 0.30	0.10 – 0.30	0.10 – 0.30
	v_c	plunging/parting-off	120 – 200	120 – 200	140 – 220
	f		0.15 – 0.40	0.10 – 0.40	0.10 – 0.40
Multi-spindle CAM turning (Straight turning – Carbide tooling, coated)	v_c	roughing	150 – 210	130 – 190	160 – 220
	f		0.05 – 0.20	0.05 – 0.20	0.05 – 0.20
	v_c	finishing	160 – 220	140 – 200	170 – 230
	f		0.03 – 0.15	0.03 – 0.15	0.03 – 0.15
	v_c	plunging/parting-off	100 – 160	90 – 150	80 – 140
	f		0.10 – 0.35	0.10 – 0.35	0.10 – 0.35
Short-bed turning CNC (Carbide tooling, coated)	v_c	roughing	190 – 250	190 – 250	200 – 260
	f		0.20 – 0.60	0.20 – 0.60	0.20 – 0.60
	v_c	finishing	200 – 260	200 – 260	210 – 270
	f		0.10 – 0.30	0.10 – 0.30	0.10 – 0.30
	v_c	plunging/parting-off	120 – 200	120 – 200	140 – 220
	f		0.15 – 0.40	0.10 – 0.40	0.10 – 0.40
Plain turning CNC (Carbide tooling, coated)	v_c	roughing	130 – 190	110 – 170	140 – 200
	f		0.05 – 0.25	0.05 – 0.25	0.05 – 0.25
	v_c	finishing	140 – 200	120 – 180	150 – 210
	f		0.05 – 0.25	0.05 – 0.25	0.05 – 0.25
	v_c	plunging/parting-off	50 – 90	40 – 80	30 – 70
	f		0.05 – 0.30	0.05 – 0.30	0.05 – 0.30
Drilling (Insert drill bit – Carbide tooling, coated)	v_c		110 – 170	90 – 150	100 – 160
	f		0.10 – 0.30	0.10 – 0.30	0.10 – 0.30
Drilling (HSS, coated)	v_c		30 – 70	25 – 65	20 – 60
	f		0.05 – 0.20	0.05 – 0.20	0.05 – 0.20
Reaming (Carbide tooling, coated)	v_c		25 – 30	25 – 30	25 – 30
	f		0.10 – 0.30	0.10 – 0.30	0.10 – 0.30
Thread (Internal/External threading)					
Chase threading – carbide tooling, coated	v_c		60 – 150	50 – 140	40 – 130
Cutting – carbide tooling, coated	v_c		6 – 9	6 – 9	6 – 9
Forming – HSS, coated	v_c		8 – 20	8 – 20	8 – 20

Values depending on the machine statics, cutting edge geometry, cooling lubricant, dimensions and drill diameter



Short-breaking chips make machining processes safer

Surface finish and processing advice on surface finishing

Surface finish

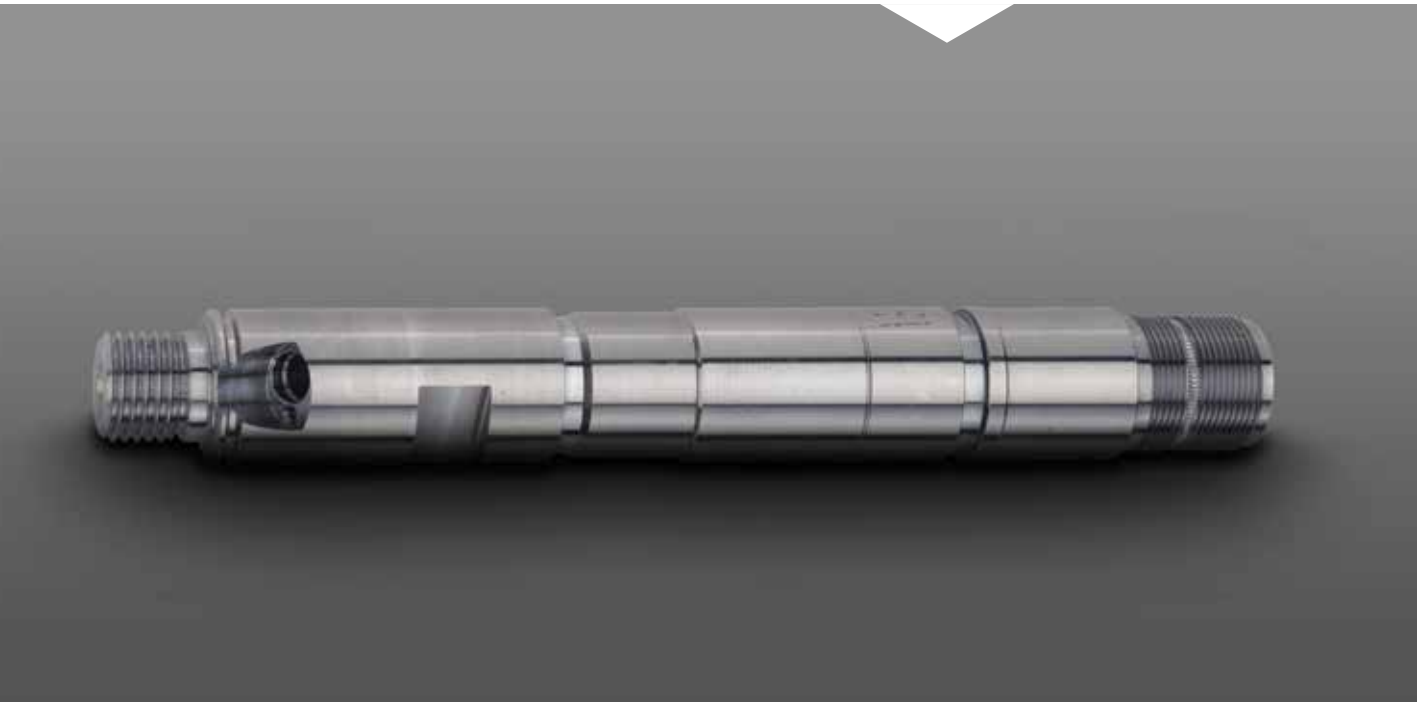
The surface finish of HSX® corresponds to the EN 10277-1 specification. HSX® steels are tested for cracks as standard. We guarantee a surface finish of class 3. Please note that, for standard bars, the ends of the bar (up to 50 mm) cannot be tested.

If surface imperfections might cause problems (e. g. notch stress concentration effect with surface hardening), the surface of the material must be removed to at least the permitted depth of imperfection.

Surface finishing

Most surface finishes can be applied to HSX® 110. It can, for example, be hotgalvanised, chromated, chromium-plated, nickel-plated or alkaline-blackened without difficulty. Due to the manganese sulphide it contains, special care must be taken during pickling and neutralisation. The temperature at which surface finishing is carried out should not exceed 500 °C. An optimum result will only be obtained with ground material.

Due to the chemical composition of HSX® 130 and HSX® Z12, it is essential for the refining process and the surface preparation to be specifically coordinated.



Information on heat-treating HSX® steels

The high strength of HSX® steels is in the same range as that of tempered steels, which means that, in most cases, no additional heat treatment is necessary. If greater abrasion resistance or fatigue strength is needed, various surface hardening processes can be used. The high basic strength guarantees a good underlying structure and thus ideally fulfils the prerequisites for the following heat treatment processes:

» HSX® 110: induction hardening
nitrocarburising
» HSX® 130: nitrocarburising
» HSX® Z12: nitrocarburising

Induction hardening HSX® 110 (HF)

» Treatment temperature: 930 – 980 °C
» Quench medium: polymer
» Attainable hardness: 50 – 55 HRC

The depth of hardening should be kept to a minimum, generally not more than 1 mm. For complicated parts, an initial stress-relieving operation at 550 – 580 °C is recommended. Using water as a quench medium results in a higher hardness, although there is a danger that quench cracking may occur.

Recommendations for HSX®

» avoid hardening over sharp edges, keyways and lateral holes
» do not harden thin-walled components
» end faces or spherically-shaped areas should be stress-relieved at 180 – 200 °C before hardening
» like all rolled-and-drawn material, HSX® 110 has a slightly decarburised boundary zone, which means that the induction hardening effect in this zone is reduced
» hardening of the drawn surfaces should be avoided due to the possible presence of surface imperfections. Due to the notch effect, hardening stresses at the imperfections can cause cracks.
» when hardening gear wheels, the tooth root should also be hardened to a depth of 0.2 mm
» to avoid the occurrence of hardening cracks due to hardening stresses, the hardened components should be tempered (~140 °C, 1 h)

NITROCARBURISING

Process	Material	Surface hardness $HV_{0.5}$ [1)]	Core hardness $HV_{0.5}$	Nitriding hardness depth mm at limit hardness	
				24 h	48 h
Gas nitrocarburising	HSX® 110	450 – 600	300	0.40	0.50
Gas nitrocarburising	HSX® 130 HSX® Z12	600 – 800	330	0.40	0.45
Plasma nitrocarburising	HSX® 130 HSX® Z12	600 – 850	350	0.30	0.55

All values are typical values.
1) measured at a distance from 0.1 mm from the edge

Depending on the nitrocarburising process employed, tempering at 350 °C for at least 2 h may be necessary to remove the hydrogen that has been introduced.

Nitrocarburising improves the resistance of the steel to both wear and corrosion. It also increases the material's bending fatigue strength.

Gas nitrocarburising (two-stage)

» Treatment temperatures:
Stage 1: 500 – 520 °C
Stage 2: 530 – 550 °C
» Atmosphere:
Stage 1: 70 – 75 % NH_3
Stage 2: 50 – 80 % NH_3
» Treatment duration: 24 – 48 h
» Thickness of compound layer: approx. 15 µm
» Quench medium: gas cooling, water, oil

Nitrocarburising HSX® 110 and HSX® 130 typically results in a reduction in tensile strength of around 10 – 20 %.

Plasma nitrocarburising

» Treatment temperature: 480 – 510 °C
» Treatment duration: 20 – 36 h
» Thickness of compound layer: up to 10 µm

This process – glow-discharge nitrocarburising in a vacuum – has produced good results with HSX®. Due to the lower treatment temperature, there is less reduction in the core strength than with gas nitrocarburising.

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