The world's first ready heat-treated tool steel. Ready hardened to approximately 45 HRC.

Hardened tool steel, originally developed for plastic molds, is excellent for polishing and photoetching. Due to its extraordinary toughness, excellent temperature resistance, and minimal distortion, Toolox® 44 is now widely used for metal die-casting molds, bending and forming tools, tough machine blades, high-strength machine parts, wear-resistant slide guides, wear plates, fixtures, and precision components. The remarkable damping properties recommend Toolox® 44 round material, especially for vibration-critical machine spindles.

Surprisingly, Toolox® 44 is easy to machine, while remaining remarkably dimensionally stable. New manufacturing concepts are possible because heat treatment and subsequent adjustments are eliminated with this ready-hardened material. You save time, reduce technical effort, gain safety, and extend the lifespan of your components.

Nitriding treatment or PVD coating is easily possible, and further heat treatment is unnecessary and not recommended.

As an "Approved Dealer," Gebr. Recknagel is the authorized distribution partner for the Swedish manufacturer SSAB in Germany.

Color coding:
Red (Toolox® 44)

Toolox 44

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TOOLOX® 44

TOOLOX® ENGINEERING & TOOL STEEL

PräziPlan® - Precision flat steel (according to DIN 59350)

Execution:
hardened to 410–475 HB (41–47 HRC), thickness ground with Ra = 6 µm, width finely machined, decarburization-free machining on all sides.

Toolox 44

Tolerances:

width:	+0.2 / -0 mm
thickness:	+0.2 / -0 mm
length:	+40.0 / -0 mm

length: 1,000 mm — price per piece

width [mm] \ *thickness [mm]*	*4.2*	*5.2*	*6.2*	*8.2*	*10.4*	*12.4*	*15.4*	*20.4*	*25.4*	*30.4*	*40.4*	*50.4*	*60.4*
20.3	46	55	55	55	58	62	66						
25.3	48	56	56	58	62	66	73	99					
30.3	50	59	59	62	66	73	78	106	126				
40.3	60	66	66	73	81	84	92	122	137	164			
50.3	78	86	92	100	102	119	139	150	158	169	178		
60.3	88	99	106	116	121	130	150	158	164	171	194	228	
70.3	96	108	110	125	126	136	158	164	167	173	217	236	256
80.3	102	117	121	144	146	153	164	169	174	178	218	241	270
100.3	106	139	144	154	158	165	173	187	207	225	256	292	332
120.3							208	218	228	244	297	330	
150.3				187	193	211	236	264	279	309	350	370	418
200.3				272	278	286	309	321	321	384	454	489	598
250.3				307	313	363	400	412	412	454	537	583	
300.3				337	344	374	430	473	473	504	581	657	
400.3							492	509	509	613	711	854	
500.3				454	472	527	544	583	583	709	825	969	

square, length: 1,000 mm — price per piece

10.4	*12.4*	*15.4*	*20.4*	*25.4*	*30.4*	*40.4*	*50.4*	*60.4*
83	86	88	88	114	146	174	188	255

Special designs delivered quickly and affordably.

TOOLOX® 44

TOOLOX®
ENGINEERING & TOOL STEEL

EcoPlan® 150 / 400 / 800 - Precision flat steel

(according to DIN 59350) **in favorable short lengths**

Execution:

Hardened to 410–475 HB (41–47 HRC),

Thickness ground with Ra = 6 µm, Width finely machined, Decarburization-free machining on all sides.

Tolerances:

width:	+0.2 / -0 mm
thickness:	+0.2 / -0 mm
length:	+0.4 / -0 mm

length: 400.3 mm — price per piece

400	thickness [mm]											
width [mm]	8.4	10.4	12.4	15.4	20.4	25.4	30.4	40.4	50.4	60.4	80.4	100.4
20.3	24	26	28	29	40							
25.3	26	28	29	32	44	51						
30.3	28	29	32	34	48	57	65					
40.3	32	37	38	41	55	61	72	72				
50.3	45	46	53	56	60	65	76	80	84			
60.3	52	55	58	60	64	69	76	87	100	113		
80.3	63	63	64	66	72	78	80	98	109	121	166	
100.3	69	69	70	72	82	93	101	115	131	149	197	232
120.3	74	75	76	80	92	102	110	134	148	187	227	269
150.3	82	82	85	92	105	122	138	157	167	188	274	325
200.3	98	98	103	111	130	144	172	204	220	269	350	417
250.3	115	115	121	130	153	181	204	241	262	345	428	510
300.3	132	132	138	150	178	209	226	261	295	406	505	604
400.3	165	165	174	189	225	229	276	320	384	528	659	789

length: 150.3 mm — price per piece

150	thickness [mm]								
width [mm]	8.4	10.4	12.4	15.4	20.4	25.4	30.4	40.4	50.4
20.3	13	14	15	16	22				
25.3	14	15	16	19	25	28			
30.3	15	16	19	20	27	31	37		
40.3	19	21	21	23	30	34	41	44	
50.3	25	26	30	34	38	40	42	44	47
60.3	29	30	32	38	40	41	42	48	57
80.3	35	37	39	41	42	44	44	55	60
100.3	39	40	41	43	47	51	57	64	73
120.3	43	44	45	52	55	57	61	73	81
150.3	47	48	52	59	63	67	77	84	93

length: 800.3 mm — price per piece

800	thickness [mm]											
width [mm]	8.4	10.4	12.4	15.4	20.4	25.4	30.4	40.4	50.4	60.4	80.4	100.4
80.3	92	92	95	112	126	139	141	174	192	216	288	
100.3	100	100	104	123	140	161	180	204	234	265	339	399
120.3	110	110	114	136	155	179	196	238	263	320	391	461
150.3	122	122	128	154	179	207	243	280	296	346	468	555
200.3	145	145	152	184	216	253	300	355	391	479	596	711
250.3	167	167	175	214	253	299	356	426	467	583	724	867
300.3	189	189	200	243	291	346	403	465	525	685	854	1022
400.3	233	233	247	303	366	408	490	569	683	888	1110	1335
500.3	277	277	299	363	440	486	567	687	804	1090	1368	1647
600.3	322	322	352	422	516	625	752	922	1095	1293	1625	1959

TOOLOX® 44

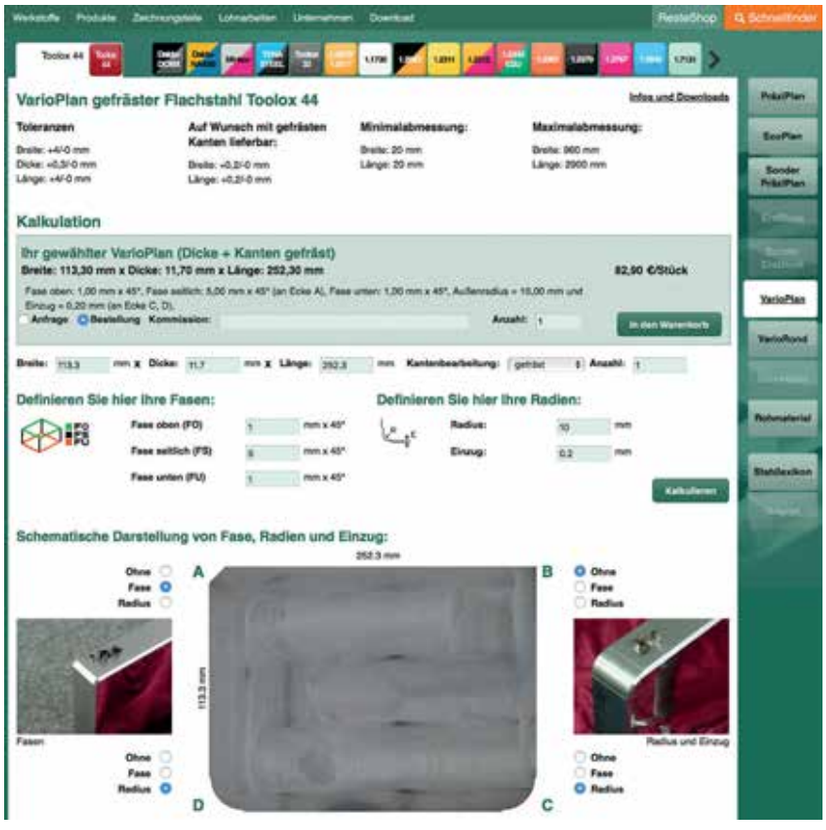
TOOLOX®
ENGINEERING & TOOL STEEL

VarioPlan®

Finely milled semi-finished products in freely selectable dimensions.

- Flexible in width, thickness, and length
- Edges sawn or milled
- Optionally with chamfers and/or corner radii
- Production in 2 to 3 days
- Easy calculation

Use our online calculation tool on the WebShop: **www.varioplan.de**



TOOLOX® 44

TOOLOX®
ENGINEERING & TOOL STEEL

VarioRond®

Round stock sections with freely selectable length at unit price

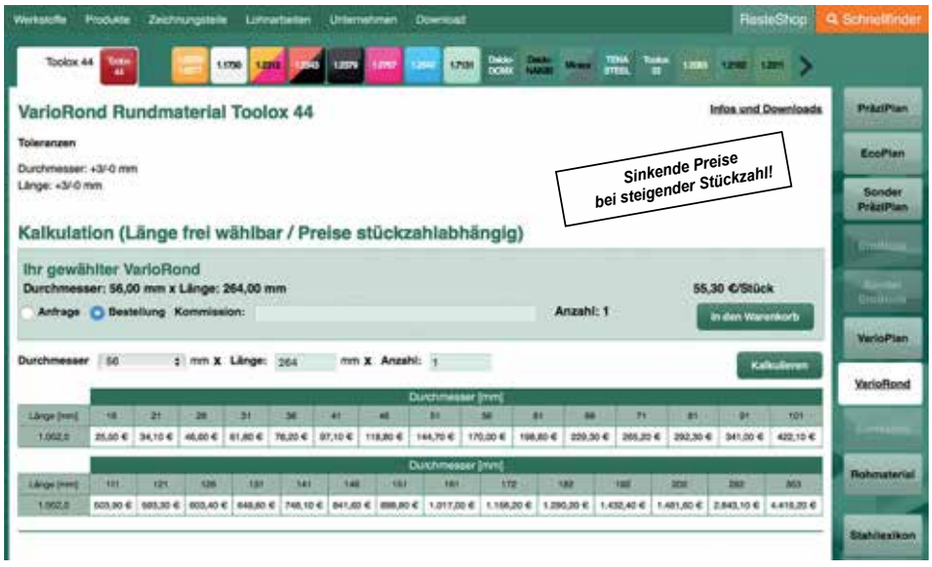
Execution and tolerances:

length, sawn	+3.0 / -0mm
diameter:	
16–121mm	+3.0 / -0mm
126–162mm	+4.0 / -0mm
172–202mm	+5.0 / -0mm
>202mm	+8.0 / -0mm
diameter range:	16–353mm

Flexible Online Calculation:

www.variorond.de

- Desired length is freely selectable.
- Unit prices for your desired length.
- Sawing costs included.
- No additional surcharges.



Toolox 44

TOOLOX® 44

TOOLOX®
ENGINEERING & TOOL STEEL

Raw material

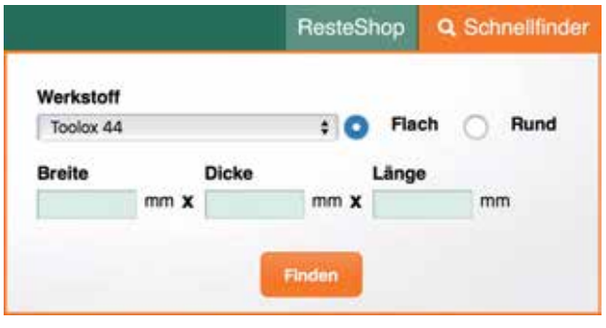
Plates or forged parts and cuttings therefrom, hardened to 410 - 475 HB (41 - 47 HRC), plate surface shot-blasted and primed.

	thickness *[mm]*														
	6	8	9.2	10	11,6	12	13.6	14	16	16.7	17.6	18	20	22	25
	27	28	30	32.5	35	40	43	45	50	53.5	55	60	63.5	65	
	70	74	80	84	90	100	104	110	120	125	130				

Toolox 44

Select affordable raw materials online, including as cut-to-size.

www.ResteShop.de
Fast, clear, and transparent:
Offcut Shop and Quick Finder at www.stahlnetz.de



Offcut Shop

- All materials
- With cutting service
- Available from stock
- Special discounted prices for remnants
- While supplies last

Quick finder

- All products in comparison
- Your special parts fully calculated
- Easy selection of the optimal solution

TOOLOX® 44

TOOLOX® ENGINEERING & TOOL STEEL

Material specification sheet

Toolox® 44 is a hardened and tempered tool steel designed to have minimal residual stresses. As a result, this material exhibits excellent dimensional stability during machining. Despite having a hardness of 45 HRC, Toolox® 44 offers good machinability.
This tool steel is specifically intended for plastic molds and is exceptionally well-suited for polishing and achieving a smooth surface finish.
It can also be used in other applications, including sheet metal forming tools, wear parts, structural components, and machine spindles.

hardness (guaranteed value)	HBW 410–475 (corresponds to 41–47 HRC)	
Impact toughness (guaranteed value)	testing temperature 20°C	impact toughness Charpy-V in traverse direction ≤ 130mm mind. 18 J
tensile strength (equivalent value)	tensile strength approx. 1450 MPa	
ultrasonic testing (guaranteed value)	In accordance with EN 10160 (plates) or EN 10228-3 (forgings) and additional requirements per SSAB V6.	
etching properties (warranty obligation)	Toolox® 44 meets the requirements as per NADCA 207-2006.	
dimensions	Toolox® 44 is supplied in plate thicknesses ranging from 6 to 130mm.	
delivery condition	It is hardened and tempered at a minimum of 590°C..	
heat treatment	Nitriding or coating is possible at temperatures below 590°C. Toolox® 44 is not intended for further heat treatment. If this material is subjected to further heat treatment above 590°C, the properties are no longer guaranteed.	
testing	Testing in accordance with EN 10025 and EN ISO 6506-1. Hardness tested on a machined surface 0.5 - 2mm below the plate surface.	
tolerances	For plates: According to SSAB's standard for tool steels. For forgings: According to DIN 7527. For round steel: EN 10060.	
welding	Please refer to page 73 for additional information..	
products	Precision flat steel (standard and special dimensions), EcoPlan®, VarioPlan®, VarioRond®, and raw material cuttings. Machine parts and guide rails manufactured to your specifications and drawings.	

TOOLOX® 44

TOOLOX® ENGINEERING & TOOL STEEL

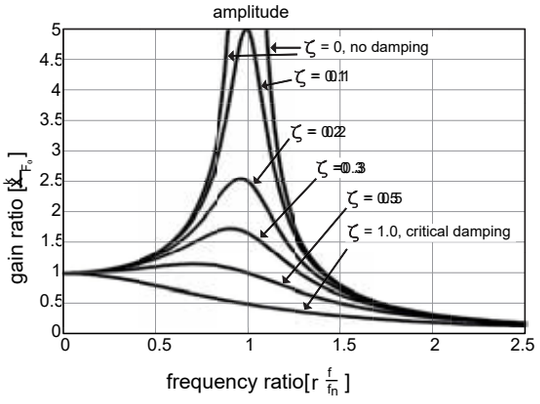
damping characteristics

Toolox® 44 was early on successfully used in Sweden as a base material for high-quality cutting tools such as WP drills, milling cutters, and grooving tools. In doing so, it demonstrated smooth operation and extended tool life, especially when compared to traditional materials. Several scientific studies, including those conducted at the Royal Institute of Technology in Stockholm and by Dr. Svenningsson, attribute these benefits to the excellent damping properties of the material.

The outstanding damping characteristics of Toolox® have led to an increased critical depth of cut for Toolox® milling tools compared to conventional tools, enabling the use of slimmer and more overhanging tools. These properties make Toolox® 44 round material a suitable choice for shafts, spindles, and other machine components where external excitations influence the process and vibrations need to be minimized.

The faster attenuation of amplitudes due to higher damping significantly enhances the durability of the component, reducing material fatigue. Over a wide frequency range from 65Hz to 4,000Hz, damping is notably effective and increases with the excitation frequency. The damping factor ranges from 1.2% at 120Hz to 2.2% at 4,000Hz, significantly surpassing that of other steels and even approaching the level of cast iron in certain cases. While ongoing studies have not yet concluded, they effectively explain and confirm the observed advantages in practical use. Feel free to contact us; we are more than willing to support you in optimizing your components.

amplitudes at different relative damping values ζ



Amplitude

material	damping ratio ζ%
GG [cast iron]	≈2.1 – 2.3
Toolox 44	1.9
Toolox 33	1.0
S355 [St52]	0.8
high strength steels (heat treated)	≈0.1 – 0.3

TOOLOX® 44

chemical composition analysis [%]

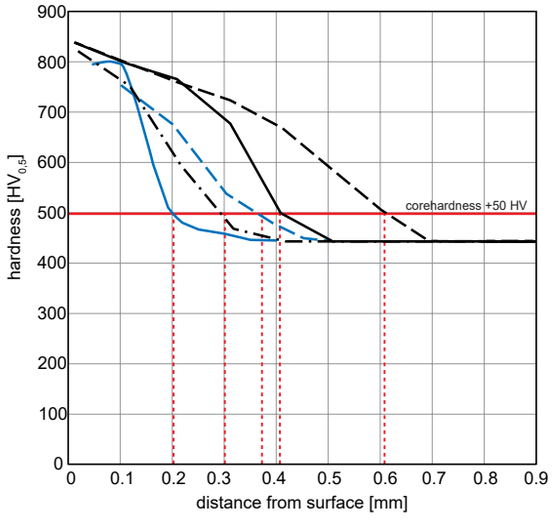
	C	Si	Mn	P	S	Cr	Mo	V	Ni
max.	0.32	1.1	0.8	0.01	0.003	1.35	0.8	0.14	1.0
min.		0.6							

metallurgical information

Hardness profile

Determination of nitriding depth NHD according to DIN 50190-3 at core hardness +50 HV

Note: The high core hardness of approximately 450 HV can lead to an underestimation of the effective nitriding depth compared to low-tempered materials.



Gas nitriding in an ammonia gas atmosphere, 36 hours, 510°C: NHD = 0.40mm
Gas nitriding in an ammonia gas atmosphere, 84 hours, 510°C: NHD = 0.60mm
Gas-nitro-carburizing, 5 hours, 580°C: NHD = 0.30mm
Plasma nitriding, short time: NHD = 0.23mm, VS = 7µm
Plasma nitriding, long time: NHD = 0.38mm, VS = 7µm.

inclusion content (typical values)

inclusion rating (equivalent diameter)	6 µm
area fraction	0,015 %
length-to-width ratio	1.2

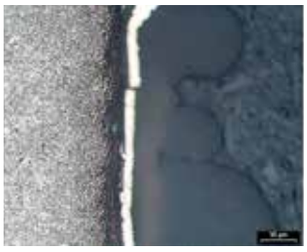
physical properties (typical values)

thermal expansion coefficient [10^{-6}/K]
at +20–200°C: 13.5

thermal conductivity

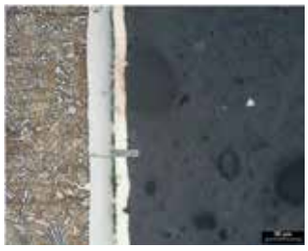
	34.0 W/mK
+200°C	32.0 W/mK
+400°C	31.0 W/mK
+600°C	21.0 W/mK

short time



diffusion zone,
no binding layer

long time

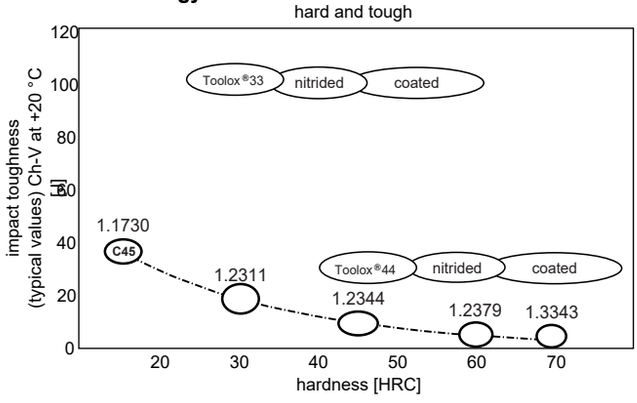


diffusion zone,
binding layer 34 µm

TOOLOX® 44

TOOLOX® ENGINEERING & TOOL STEEL

surface technology



Toolox 44

mechanical properties (typical values*)

	guaranteed hardness [HBW]	hardness typical [HRC]*	guaranteed impact toughness Min [J]	typical impact toughness [J]*	typical yield strength $R_{p0,2}$ [MPa]*	typical tensile strength R_m [MPa]*	typical elongation at break A_5 [%]*	typical compression yield strength MPa*	compression yield strength after 170 hours of dwell time MPa*	thickness [mm]
-40°C				14						6–130
-20°C				19						
+20°C	410–475	45	18	30	1300	1450	13	1250		
+200°C				60	1200	1380	10	1120		
+300°C				80				1120		
+400°C				80				1060	1060	
+500°C								930	910	

Toolox® is tested for hardness and impact toughness at room temperature.

All other provided values are from supplementary tests and are for informational purposes only, and they are not guaranteed.

* Reference values for information purposes only

Hardness comparison table for Toolox® and Hardox®

tensile strength MPa	715	790	820	861	935	995	1011	1090	1169	1245	1328	1412	1494	1580	1758	1940	2130
Vickers hardness HV	205	233	243	261	289	311	317	345	373	401	429	458	485	514	569	627	682
Brinell hardness HBW	225	250	260	275	300	320	325	350	375	400	425	450	475	500	550	600	650
Rockwell HRC	19	22.5	24	26	29	32	32.5	35.5	38	40	42.5	44.5	46.5	49	52.5	55	57.5

machining of Toolox®

All major tool manufacturers are now well-prepared for machining Toolox®. It is advisable to seek advice on suitable tools and cutting parameters. These recommendations should be strictly followed to achieve optimal results and productive performance. It is essential to avoid reducing the feed rate out of misplaced caution. Good chip formation leads to success, and Toolox® rewards you with extended tool life and faster machining.

Drilling

Drilling with HSS tools is reserved for less stable machines and low production quantities. HSS-Co tools with the cutting parameters provided below have proven to be effective. Ensure a continuous machine feed and use sharp tools. A pointed cross-edge would be advantageous to ensure optimal chip formation.

Drilling with solid carbide (VHM) tools is productive and efficient. It is recommended to use internal coolant supply with a higher concentration. Ensure that you drill with a continuous feed rate (not lower than the manufacturer's recommendation).

	Toolox® 33	***Toolox® 44***
cutting speed: v [m/min]	~ 15	~ 7
diameter [mm]	feed: f [mm/U] / rotational speed [1/min]	
5	0.10/950	0.05/445
10	0.10/475	0.09/220
15	0.16/325	0.15/150
20	0.23/235	0.20/110
25	0.30/195	0.25/90
30	0.35/165	0.30/75
*35	0.40/136	0.35/63
*40	0.45/119	0.40/55

	Toolox® 33		***Toolox® 44***	
cutting speed: v [m/min]	65–90		40–65	
diameter [mm]	feed [mm/U]			
	min.–max.	start value	min.–max.	start value
3.0–5.0	0.08–0.15	0.10	0.06–0.11	0.07
5.01–10.0	0.09–0.16	0.12	0.08–0.13	0.10
10.01–15.0	0.16–0.22	0.18	0.12–0.18	0.15
15.01–20.0	0.22–0.28	0.25	0.16–0.20	0.18

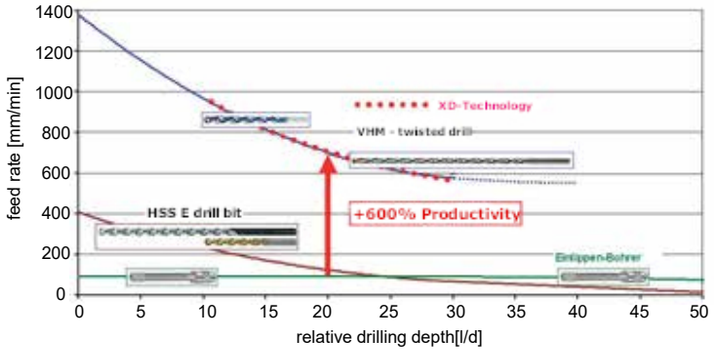
Solid carbide exchangeable inserts or brazed tips are used for medium diameters. Refer to the table for cutting parameters.

	Toolox® 33		Toolox® 44	
cutting speed: v [m/min]	50–80		40–60	
diameter [mm]	feed [mm/U]			
	min.–max.	start value	min.–max.	start value
7.5–12.0	0.10–0.16	0.13	0.08–0.14	0.11
12.01–20.0	0.15–0.23	0.20	0.12–0.20	0.15
20.01–25.0	0.18–0.27	0.22	0.14–0.22	0.17
25.01–30.0	0.20–0.30	0.24	0.16–0.25	0.19

Überlange Bohrungen bis zu über 50 x D können auch auf Bearbeitungszentren mit IKZ sehr produktiv hergestellt werden, wenn man VHM-Bohrer mit spezieller Geometrie verwendet. Typische Schnittwerte zeigt die nachstehende Tabelle.

material	hardness	diameter	depht	rel. depht	cutting parameters			cooling
		d [mm]	l [mm]	l/d	vc [m/min]	f [mm]	vf [mm/min]	emulsion
Toolox® 33	300 HB	5	10	20	50	0.15	477	IK, p=20bar
Toolox® 44	45 HRc	5	100	20	36	0.15	344	IK, p=20bar

Factory specifications Titex



TOOLOX® 33 / TOOLOX® 44

TOOLOX®
ENGINEERING & TOOL STEEL

Deep drilling in Toolox® presents a special challenge that the renowned manufacturer Botek successfully addresses and economically solves with a unique cutting geometry. The single-lip full drill tools, Type 110, with special geometry for diameters up to 12.0mm, as well as the single-lip deep drilling tools, Type 01, with interchangeable cutting inserts and guide bars in a special configuration starting from a diameter of 12.0mm, have proven to be excellent solutions.

For further information, please contact Botek (www.botek.de) and feel free to refer to us.

Toolox® 33	drill-Ø	3	4	5	6	7–8	9–10	11–12	>12
	cutting speed [m/min]	50	50	50	50	40–50	40–50	40–50	40–50
	feed [mm/U]	0.005	0.01	0.015	0.0175	0.02	0.03	0.04	0.1
	coolant pressure [bar]	100	100	100	90	80	70	60	40
	pilot drilling distance [mm]	40	40	50	60	60	70	70	70
	pilot drilling feed [mm/U]	0.0025	0.005	0.0075	0.009	0.01	0.015	0.02	0.05

factory specs. Botek

Attainable tool life with oil: approximately 10 – 12 meters under optimal process conditions.

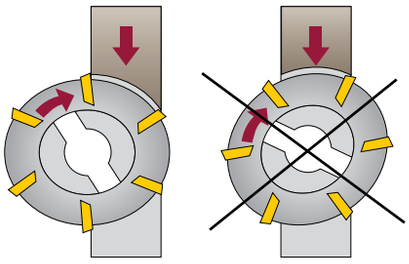
Toolox® 44	drill-Ø	3	4	5	6	7	8	9–10	11–12	>12
	cutting speed [m/min]	50	50	50	50	40–50	40–50	40–50	40–50	40–50
	feed [mm/U]	0.005	0.01	0.012	0.015	0.015	0.0175	0.02	0.03	0.07
	coolant pressure[bar]	100	100	100	90	90	80	70	60	40
	pilot drilling distance [mm]	40	40	50	50	60	60	70	70	70
	pilot drilling feed[mm/U]	0.0025	0.005	0.006	0.0075	0.0075	0.009	0.01	0.015	0.035

factory specs. Botek

Attainable tool life with oil: approximately 2 – 3 meters under optimal process conditions.

Milling

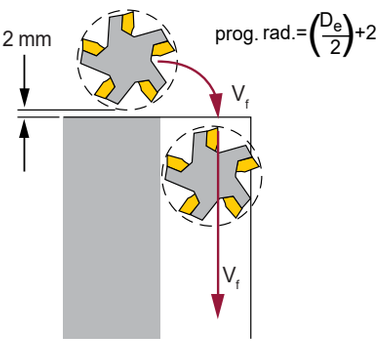
Toolox® is exceptionally resistant to deformation due to extremely low residual stresses when machined with optimal parameters and when unnecessary heat is not introduced into the workpiece. Prolonged tool life is achieved through smart milling strategies, stable workpiece fixation, and maintaining adequate chip thickness. Toolox® possesses a unique microstructure that facilitates machining despite its high hardness. Carbides are very hard and wear-resistant structural components. Their microscopically fine, spherical shape in the Toolox® microstructure prevents the typical edge damage found in other tool steels. Maintaining a sufficient tooth feed ensures the removal of carbides along with the chips, while insufficient feed would lead to excessive abrasive wear on the cutting edge. Sharp cutting edges with a positive geometry are ideal for Toolox®. Choose tools designed for processing high-alloyed steels. Tools for hard machining (up to 60 HRC) are unsuitable, as their cutting edges often have negative rake angles.



The introduction to the cutting process using the "roll-in" method.

Entry via the "roll-in" method Wear after 800 machining passes.

Straight entry into the workpiece Wear after 390 machining passes.



TOOLOX® 33 / TOOLOX® 44

TOOLOX® ENGINEERING & TOOL STEEL

Face Milling

Interrupted cuts are milled more effectively using round inserts. Particularly high productivity is achieved with HPC (High-Performance Cutting) tools. Corner radius cutters are also suitable for Toolox®.

Recommendation for 45° milling cutters

	Toolox® 33		*Toolox® 44*	
cutting speed: v [m/min]	180–220		120–160	
feed: f_z [mm/Zahn]	min.–max.	start value	min.–max.	start value
Insert grade P30	0.15–0.35	0.25	0.15–0.35	0.25

Recommendation for face milling cutters with round inserts.

	Toolox® 33		*Toolox® 44*	
cutting speed: v [m/min]	180–220		140–180	
feed: f_z [mm/Zahn]	min.–max.	start value	min.–max.	start value
Insert grade P30	0.10–0.25	0.15	0.10–0.25	0.15

Recommendation for end mills / corner radius cutters.

	Toolox® 33		*Toolox® 44*	
cutting speed: v [m/min]	180–220		120–160	
feed: f_z [mm/Zahn]	min.–max.	start value	min.–max.	start value
Insert grade P30	0.12–0.25	0.17	0.12–0.25	0.17

Cutting values for HPC (High-Performance Cutting) copy and face milling cutters.

material group	material designation	Festigkeit N/mm2	*copy milling*								*Plunge/circular milling.*							
			dry machining				*wet machining*				*dry machining*				*wet machining*			
			cutting material 1st choice	Vc [m/min]			cutting material 1st choice	Vc [m/min]			cutting material 1st choice	Vc [m/min]			cutting material 1st choice	Vc [m/min]		
				min	**start**	max		min	**start**	max		min	**start**	max		min	**start**	max
8.2	Toolox® 33 Werkzeugstähle	900–1100	F25M	**120**	**140**	160	F25M	110	**130**	150	F25M	**80**	**90**	100	F25M	**70**	**85**	100
10.0	Toolox® 44 gehärtete Stähle	41–47HRC	F15M	**120**	**160**	200	–	–	**–**	–	F15M	**80**	**105**	130	–	–	–	–

Werksangaben Hoffmann

End Milling

In slot milling, a depth of cut (ap) of 0.5 x D (where D is the diameter of the end mill) has proven to be effective, and sufficient chip space should be available. End milling, including trochoidal milling, is very productive with an ap equal to the full cutting length and an ae of approximately 0.1 x D. Dry milling with compressed air cooling for chip removal helps avoid thermal shock and overloading due to chip recutting.

Threads

Both Toolox® materials can be machined with **machine tap drills**. Experienced machinists drill the core hole slightly larger. Cutting paste, cutting oil, or a richer emulsion have proven to be particularly effective.

Thread milling is a productive process that offers high manufacturing reliability, even for very small diameters and especially in cases where thread cutting is challenging.

Counterboring and countersinking with indexable insert tools are easily achievable on machining centers. For less stable machines, countersinks with integral guide pins have proven to be effective.

	Toolox® 33	*Toolox® 44*
cutting speed: v [m/min]	7–10	3–5
thread size	Rotational speed [1/min]	
M5	445–635	190–320
M6	370–530	160–265
M8	270–400	120–200
M10	220–320	95–160
M12	185–265	80–130
M16	140–200	60–100
M20	110–160	45–80

	Toolox® 33	*Toolox® 44*
cutting speed: v [m/min]	80–110	50–70
feed: f_z [mm/tooth]	0.03–0.06	0.02–0.05

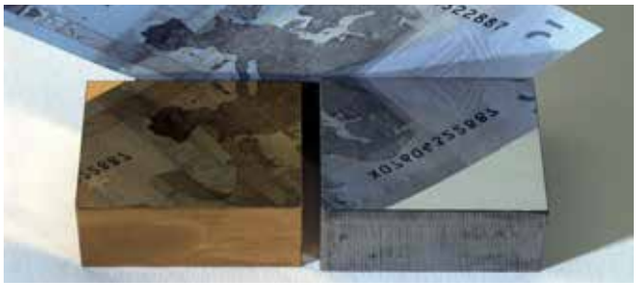
	Toolox® 33	*Toolox® 44*
cutting speed: v [m/min]	0.10–0.20	0.10–0.20
diameter [mm]	Rotational speed [1/min]	
19	670–1340	335–840
24	530–1060	265–665
34	375–750	185–470
42	300–600	150–380
57	225–440	110–280

TOOLOX® 33 / TOOLOX® 44

TOOLOX® ENGINEERING & TOOL STEEL

Toolox 33
Toolox 44

Polieren von Toolox®



1. Fine grinding using a coarse abrasive (e.g., grit size 120). All traces of processing or erosion are completely removed in this step. It is advisable to use the flat side of the abrasive. Vary the grinding direction in a crisscross pattern to achieve an absolutely flat surface, make your work more efficient, and save time.

2. Fine grinding as in step 1, but with a finer grit size, such as 320. All remaining traces from the previous grinding are completely eliminated.

3. Coarse polishing with diamond paste on a piece of brass. Grit size 45µm. This coarse polishing is performed until all remaining traces and scratches from the previous step (step 2) are completely eliminated.

4. Proceed as in step 3, but use 15µm diamond paste until all traces remaining from step 3 are gone.

5. In this step, follow the same procedure as in step 4, but now use 7µm diamond paste. Continue until all remaining traces from step 4 are removed.

6. Polish with 7µm diamond paste on a fiber or plastic element. Continue until the last remaining imperfections from step 5 are eliminated.

7. Follow the same process as in step 6, but use 3µm diamond paste instead of 7µm paste. Continue until the last nuances of imperfections from step 6 are removed. (We use the word "nuance" here because, by this point, the surface is already so smooth and fine that there are essentially no visible scratches to the naked eye.)

8. Polish with 3µm diamond paste on a piece of felt until all remaining nuances from the previous step are gone.

9. As a final step, polish with 3µm diamond paste and cotton. This is done by hand and achieves the ultimate shine. Continue until the entire surface has a uniform luster.

Welding of Toolox®

Toolox® welds well when the following guidelines are observed. The carbon equivalent for Toolox® is as follows:

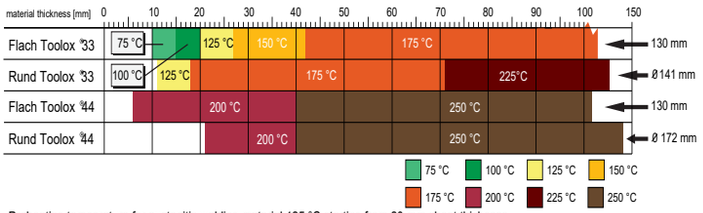
For Toolox® 33: CEIIW 0.62–0.71 / CET 0.4–0.44

For Toolox® 44: CEIIW 0.92–0.96 / CET 0.55–0.57

Austenitic welding fillers such as AWS 307 or AWS 309 are suitable for welding without preheating. This results in a strength of approximately Rp0.2 = 500 MPa in the weld. Non-alloyed or low-alloy welding fillers yield strengths up to Rp0.2 = 930 MPa and good toughness. For the selection of welding fillers, also refer to page 84.

1 Preheat both sides of the weld joint to approximately 100–150mm on each side. The preheat temperature should be reached in the middle of the plate. Maintain the preheat temperature throughout the entire welding process, especially during tack welding.

Minimum preheating temperature for non-alloyed and low-alloy welding additives



Preheating temperature for austenitic welding material 125 °C starting from 20 mm sheet thickness.

2 Use soft or stainless electrodes if possible. The electrodes must be dry. The maximum allowable hydrogen content is 5ml/100g of weld metal. To achieve optimal grain structure quality, welding should be carried out using the TIG process with a filler wire having the same chemical composition as the base material. The simplest method is to cut a rod from a leftover part of the base material.

3 Weld with a heat input resulting in a t8/5 value between 10 and 20 seconds.

4 When welding, an interpass temperature should not exceed:
170°C for Toolox® 33
225°C for Toolox® 44
before proceeding to the next pass.

5 Perform a post-weld heat treatment in the area approximately 100-150mm on each side of the weld joint. The soaking time should be 5 minutes per millimeter of plate thickness or at least 60 minutes. Typically, a soaking time of 2 hours is sufficient. The start of the soaking time is the moment when the temperature is achieved throughout the entire annealing volume.

* Post-weld heat treatment should be performed at a temperature of 150–200°C if only low requirements regarding dimensional stability are needed.

* **The post-weld heat treatment should be carried out at a temperature of 560–580°C if high requirements for dimensional stability are necessary, and the influence of the weld on the texture formation result needs to be minimized.**

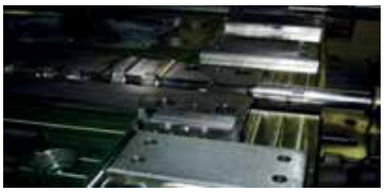
Examples of Applications

Toolox was originally developed as a plastic mold steel, but it soon proved to be highly suitable for a wide range of other applications.

Plastic molds made from Toolox are wear-resistant, and Toolox's fine microstructure makes it easy to polish and photo-etch. Additionally, Toolox is highly machinable due to its microstructure with spherical carbides. It doesn't require the addition of sulfur, which could otherwise compromise toughness and polishability.

Stamping, bending, and forming tools benefit from the high base hardness of Toolox® 44. With a hardness of approximately 45 HRC, Toolox® 44 is particularly resistant to pressure and wear, making it a valuable material for bending tools. Its high toughness allows for load-bearing without fracturing, even in unfavorable constructions. In addition, Toolox® 44 is used in printing plates and slide guides. **Machine blades** made from Toolox® 44 cut high-strength sheets in steel mills.

Hydroforming tools require high strength, toughness, and workability. This is where Toolox® 44 fully leverages its advantages.



The high tempering temperature allows for various hot applications. Slide and molding components in **aluminum die-casting tools** are manufactured from Toolox® 44. Even in the harshest conditions when removing furnace slag in steel mills or aluminum smelting, Toolox® withstands longer than conventional wear-resistant steels. Its excellent weldability is of particular importance in this regard.

TOOLOX® 33 / TOOLOX® 44

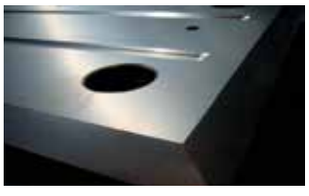
TOOLOX® ENGINEERING & TOOL STEEL

High-strength and wear-resistant machine parts of all kinds are made from Toolox® when precision is of the utmost importance.

The extremely low internal stresses of the material are ensured by the high tempering temperature of at least 590° C, which acts like stress-relief annealing. Additionally, Toolox® is exclusively processed using cold methods in our facilities, eliminating heat-induced stresses and hardness loss from cutting processes such as flame or plasma cutting. The hassle-free maintenance of shape tolerances is why many manufacturers rely on Toolox®.

The high hardness already provides excellent wear resistance without the need for additional heat treatment.This is beneficial for **fixtures** that can be manufactured directly from the raw material and put to immediate use without heat treatment.

Achieving the highest demands for long-term precision is possible by **nitriding the surface**. Toolox® retains its core hardness during the nitriding process while gaining increased resistance to abrasion and corrosion.



Toolox 33

Toolox 44