NTK

Technical Information

Steel

Work Material	Process		Cutting speed (m/min)	Feed rate (mm/rev)	Depth of Cut (mm)	Grade	
						1	2
Carbon Steel Alloy Steel	Turning	Rough	150 - 300	- 0.5	- 3.0	**QM3**	ZM3
			300 -	- 0.2	- 1.0	**WA1**	
		Finish	150 - 300	- 0.2	- 0.5	**T15**	T3N
			300 -	- 0.2	- 0.5	**HC1**	WA1
	Milling		100 - 150	- 0.15 (mm/t)	- 2.0	**TA3**	QM3
			200 -	- 0.1 (mm/t)	- 2.0	**C7X**	
	Grooving		100 - 150	- 0.2		**QM3**	ZM3
			200 -	- 0.2		**N40**	C7X
Stainless Steel 3 series			100 - 150	- 0.2	- 2.0	**ZM3**	QM3
			150 - 300	- 0.2	- 2.0	**T15**	C7X
Stainless Steel 4 series			100 - 150	- 0.2	- 2.0	**ZM3**	QM3
			150 - 300	- 0.3	- 2.0	**T15**	C7X
Bearing Steel			100 - 300	- 0.3	- 3.0	**C7X**	N40
Tool Steel			100 - 180	- 0.2	- 3.0	**T15**	T3N
Sintered Alloy			50 - 200	- 0.2	- 3.0	**QM1**	C7X
Hardened Steel	Continuous		100 - 150	- 0.25	- 0.5	**HC7**	HC4
	Interrupted		- 180	- 0.25	- 0.5	**B36**	
Inconel 718	Rough		50 - 150	- 0.5	- 3.0	**SX9**	
			50 - 250	- 0.4	- 3.0	**WA1**	
	Finish		30 - 100	- 0.2	- 1.0	**TA3**	QM3
Waspaloy	Rough		80 - 200	- 0.5	- 3.0	**WA1**	
			100 - 400	- 0.4	- 3.0	**SX9**	
	Finish		50 - 100	- 0.2	- 1.0	**TA3**	QM3
Inconel 713 Rene 88	Rough		50 - 100	- 0.5	- 3.0	**SX9**	
			50 - 150	- 0.4	- 3.0	**WA1**	
	Finish		30 - 80	- 0.2	- 1.0	**TA3**	QM3
Inconel 6 series	Rough		80 - 200	- 0.5	- 3.0	**SX9**	
			100 - 400	- 0.4	- 3.0	**WA1**	
	Finish		50 - 100	- 0.2	- 1.0	**TA3**	QM3
Hasteloy	Rough		80 - 250	- 0.5	- 3.0	**SX9**	
			100 - 500	- 0.4	- 3.0	**WA1**	
	Finish		50 - 100	- 0.2	- 1.0	**TA3**	QM3
Stellite	Rough		50 - 250	- 0.5	- 2.0	**WA1**	
	Finish		50 - 150	- 0.3	- 1.0	**HC7**	

Cast Iron

Work Material	Process		Cutting speed (m/min)	Feed rate (mm/rev)	Depth of Cut (mm)	Grade	
						1	2
Gray Cast Iron	Turning	Rough	100 - 500	- 0.5	- 5.0	**SX1**	SX9
			500 - 1000	- 0.7	- 5.0	**SX1**	SX9
		Finish	100 - 500	- 0.3	- 1.0	**HW2**	HC2
			500 - 1000	- 0.3	- 1.0	**B20**	B16
	Milling	Rough	100 - 200	- 0.3 (mm/t)	- 5.0	**QM1**	QM3
			200 - 500	- 0.3 (mm/t)	- 5.0	**SX1**	SX8
		Finish	100 - 150	- 0.15 (mm/t)	- 2.0	**QM1**	
			200 - 500	- 0.1 (mm/t)	- 2.0	**SX1**	SX8
	Grooving		100 - 150	- 0.2		**QM3**	
			200 -	- 0.2		**HW2**	HC2
Ductile Cast Iron	Rough		150 - 300	- 0.5	- 2.0	**SX9**	SP2
	Finish	Continuous	100 - 450	- 0.25	- 1.0	**HC6**	
		Interrupted	100 - 350	- 0.25	- 1.0	**SX8**	Q15
	Grooving		-200	- 0.2		**Q15**	HC6
Alloy Cast Iron (Cylinder Liner)			300 - 600	- 0.4	- 2.0	**HW2**	HC2
			600	- 0.4	- 2.0	**B16**	
Chilled Cast Iron			100 - 200	- 0.4	- 2.0	**HC2**	SX9

Others

Aluminum	Low Si content	100 - 500	- 0.4	- 2.0	**UC2**	UC1
	Hi Si content	500 -	- 0.4	- 2.0	**UC2**	UC1
Non Ferrous (Copper , Brass)		300 - 700	- 0.3	- 4.0	**KM1**	T3N

Ceramic Series

	NTK Grade	Components	Applications	Physical characteristics					
				Density	Hardness	Bending strength	Young's modulus	Thermal expansion coefficient	Heat conductivity
				g/cm³	HRA	MPa	GPa	X10⁻⁶/K	W/m-K
Silicon-nitride-based	SX1	Si_3N_4	・Highly efficient cutting of gray cast iron	3.2	93.5	1200	320	3.0	29
	SX2	Si_3N_4	・Milling of gray cast iron	3.2	93.5	1100	320	3.0	29
	SX8	Si_3N_4	・Strong interrupted cutting of gray cast iron	3.2	93.0	1200	320	3.2	33
	SX9	Si_3N_4	・Ni-based Heat Resistant Alloys	3.3	93.5	1200	330	3.0	15
	SP2	TiN-coating + Si_3N_4	・Rough turning of gray cast iron	3.2	93.5	1100	320	3.0	29
Alumina-based	HC1	Al_2O_3	・Semi-finishing and finishing of cast iron ・Tube scarfing	4.0	94.0	700	400	7.8	17
	HW2	Al_2O_3	・Semi-finishing and finishing of cast iron ・Liner machining	4.1	94.0	750	390	7.8	19
	HC2	Al_2O_3 +TiC	・Semi-finishing and finishing of cast iron ・Machining of hardened materials	4.3	94.5	800	420	7.8	21
	HC4	Al_2O_3 +TiC	・Machining of hardened materials	4.6	95.5	1000	420	7.9	25
	ZC4	TiN-coating Al_2O_3 + TiC	・Machining of hardened materials	4.6	95.5	1000	420	7.8	25
	HC6	TiC + Al_2O_3	・Semi-finishing and finishing of ductile materials ・Using Coolant semi-finishing and finishing of cast iron	4.7	94.0	800	450	7.6	29
	HC7	Al_2O_3 +TiC	・Machining of hardened materials Turning of roll materials ・Semi-finishing and finishing of cast iron	4.6	95.5	1000	420	7.9	25
	ZC7	TiN-coating Al_2O_3 + TiC	・Machining of hardened materials Turning of roll materials ・Semi-finishing and finishing of cast iron	4.6	95.5	1000	420	7.9	25
Whisker-based	WA1	Al_2O_3 + SiC	・Rough turning of heat-resistant alloys ・Highly efficient machining of cast iron ・Roughing of hardened rolls	3.7	94.5	1200	400	7.6	-

CBN Series

	NTK Grade	Binder	CBN content	Applications
Ultrahigh-pressure sintered compacts	B16	TiN-coated special ceramics	82%	High-speed rough finishing of gray cast iron and rolled materials
	B20	Special ceramics	60%	High-speed finish turning of gray cast iron
	B22	TiN-based	80%	Turning of hardened rolls
	B24/B26	TiN-based	65%	Continuous and interrupt cutting of sintered steel at middle speed ranges
	B36	Special ceramics	65%	Interrupt cutting of sintered steel at middle speed ranges

＊Note : Data of coated products relates to the respective base materials.

Cermet Series

	NTK Grade	Components	Applications	Physical characteristics					
				Density g/cm3	Hardness HRA	Bending strength MPa	Young's modulus GPa	Thermal expansion coefficient X10^{-6}/K	Heat conductivity W/m-K
Cermets	T3N	TiC + TiN	·High-speed finishing of steel ·Machining of sintered alloys	6.0	92.7	1400	450	8.3	13
	T15	TiC + TiN	·Semi-finishing and finishing of steel	6.3	92.5	1700	450	8.4	21
	N20	TiN-based	·Boring and grooving of steel ·Pipe scarfing	5.6	91.5	1600	460	9.0	42
	N40	TiN-based	·General turning of steel ·Grooving of steel	5.9	91.5	1900	450	8.9	42
	C7X	TiCN	·Semi-finishing and finishing of steel ·Grooving of steel	7.0	91.5	1800	440	8.2	31
PVD coated cermets	Z15	TiN-coating	·Semi-finishing and finishing of steel ·Finishing of ductile cast iron	6.3	92.5	1700	450	8.4	21
	Q15	TiCN-coating	·High-speed finishing of ductile cast iron	6.3	92.5	1700	450	8.4	21
	C7Z	TiN-coating	·Boring and grooving of steel	7.0	91.5	1800	440	8.2	31

Micrograin Carbide Series

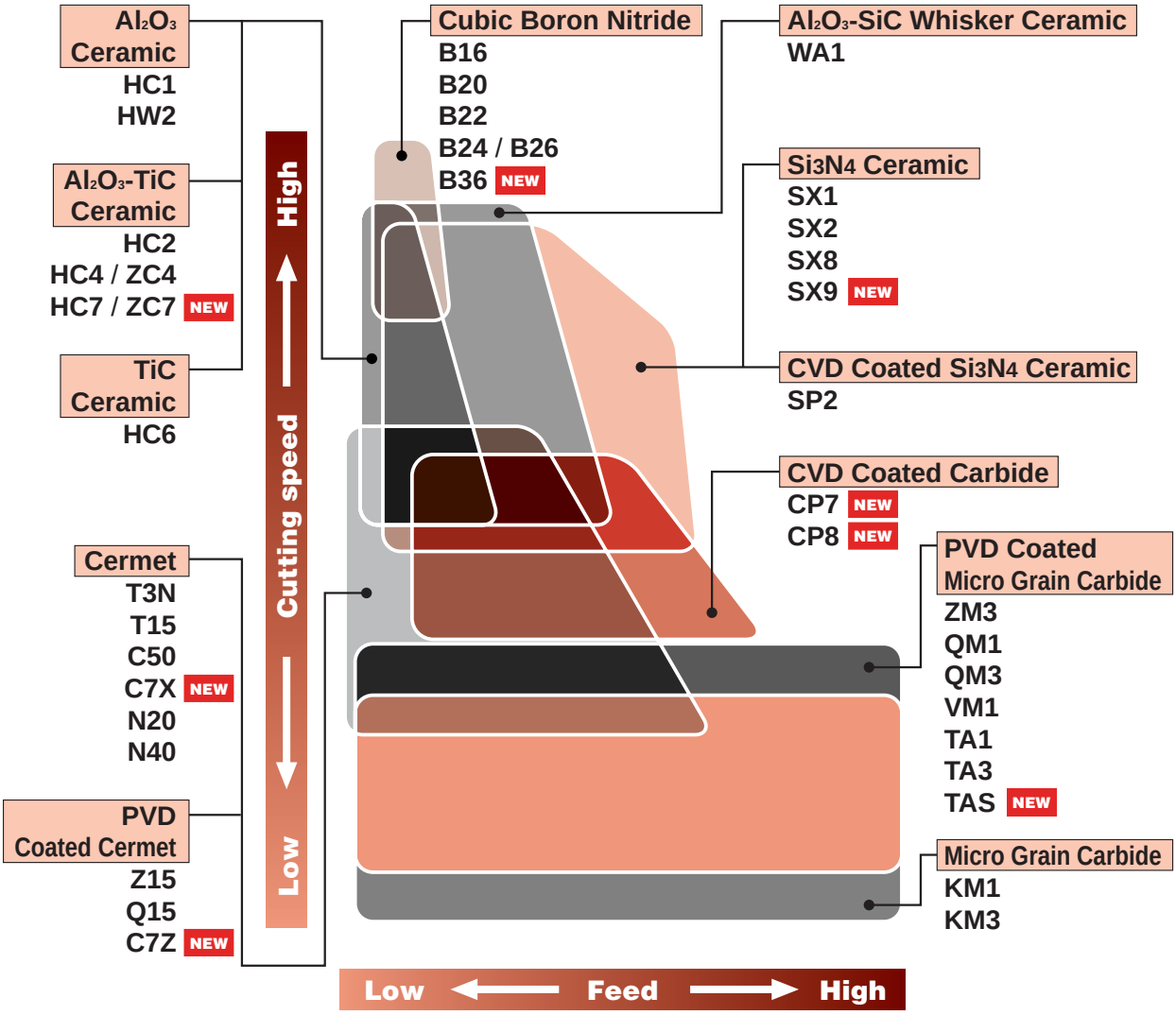
	NTK Grade	Components	Applications	Physical characteristics					
				Density g/cm^3	Hardness HRA	Bending strength MPa	Young's modulus GPa	Thermal expansion coefficient X10^{-6}/K	Heat conductivity W/m-K
Micrograin carbide	KM1	Micrograin carbide	·Turning for aluminum	14.4	91.0	3000	580	5.8	63
PVD coated Micrograin carbides	ZM3	TiN-coating	·Turning of stainless steel and titanium	14.4	91.0	3000	580	5.8	63
	QM1	TiCN-coating	·Turning of sintered alloys and heat resistant alloys	14.8	92.0	2500	640	5.7	84
	QM3	TiCN-coating	·Continuous/interrupt cutting and milling of steel	14.4	91.0	3000	580	5.8	63
	VM1	TiCN-coating	·Turning of free-cutting steel	14.8	92.0	2500	640	5.7	84
	TA1	TiAlN-coating	·Turning and milling of steel and ductile cast iron	14.8	92.0	2500	640	5.7	84
	TA3	TiAlN-coating	·Turning and milling of steel and ductile cast iron	14.4	91.0	3000	580	5.8	63
	TAS	TiAlN-coating	·Turning for stainless steel	14.8	92.0	2500	640	5.7	84

CVD-Coated Carbide Series

	NTK Grade	Components	Applications	Physical characteristics					
				Density g/cm^3	Hardness HRA	Bending strength MPa	Young's modulus GPa	Thermal expansion coefficient X10^{-6}/K	Heat conductivity W/m-K
CVD-coated carbides	CP7	Al_2O_3 - TiCN + carbide	·Rough and semi-finish turning of cast iron	13.8	90.1	2200	580	-	-
	CP8	Al_2O_3 - TiC + carbide	·Rough and semi-finish turning of cast iron	15.0	92.2	2000	600	4.5	79

∗Note : Data of coated products relates to the respective base materials.

Application Range of NTK Insert Grade



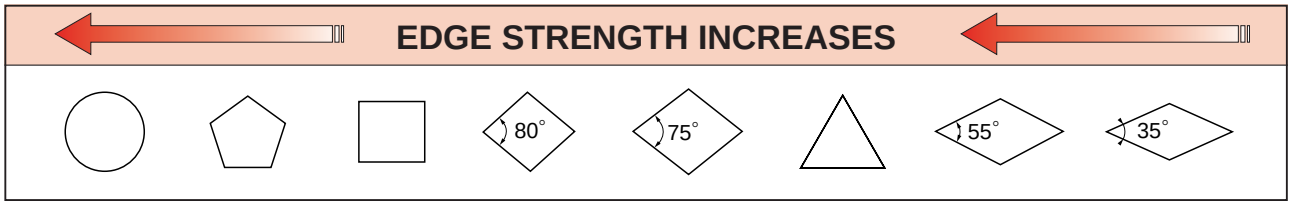
Use a Rigid Set-Up.
NTK ceramics work best when both the machine and work piece are secure - eliminate overhang.

Use Sturdy Tooling.
For best results, use toolholders designed for ceramics whenever possible. A top clamp with a pin lock is recommended when using an insert with a hole. Use a mechanical chip breaker if possible. Also, make sure that the insert pocket is clean and burr free.

Use the Largest Insert Size Possible
The strength of Ceramics has increased dramatically over the years, but the fact remains - larger is stronger.

Use Suggested Speeds and Feeds
Avoid dwelling in cuts. Consult charts.

Use a Negative Insert with the Largest Corner Angle.



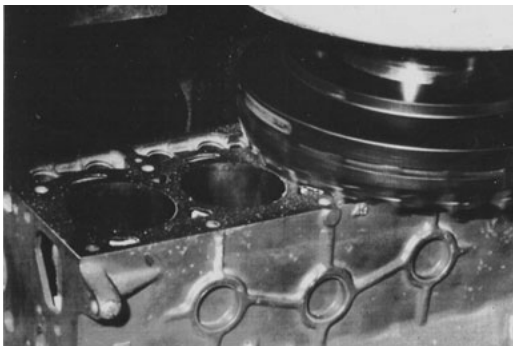
Use the Largest Nose Radius Possible
Without Causing Chatter.
Usually the stronger the nose radius the longer the tool life. Avoid using 0.4 corner radius inserts.

Use Proper Edge Preparation.
Success with ceramic greatly depends upon the cutting edge. Consult the edge preparation sections for proper specifications.

Use No Coolant with Ceramics Except
Silicon Nitride.
If this is not possible then a flooded coolant condition must be used.

Use Ceramics Safely.
Make sure machine operators have adequate training in the use of high speed ceramics. Follow machining parameters with safety in mind at all times.

Use the Largest Lead Angle Possible.
Distributing the workload over a greater area of the cutting edge will prolong tool life.



GUIDELINES FOR SUCCESSFUL MACHINING OF CAST IRONS

No Coolant.
Do not use coolant on heavy interruptions - especially at high speeds.

Roughing
When roughing cast iron the nose of the insert must be below the surface scale.

Out of Roundness
Out of round cutting conditions cause excessive tool wear. Make sure the insert nose is cutting at all times.

Sand in Castings.
When the scale contains sand, insert failure from depth of cut notching increases.
Reduce the lead angle to minimize this problem.

Burrs
When a breakout problem occurs, use a larger nose radius, larger lead angle or decrease the feed rate exiting the workpiece.

Dwelling
Avoid dwelling in cuts. This will cause premature insert wear.

Turning Gray Cast Iron (HB 180 - 230)

Cutting Condition	Coolant	NTK Grade Selection Per Speed Range	
Roughing-interrupted (as cast)	×	SX8 silicon nitride	(200 - 600m/min)
Roughing-continuous (as cast)	○	SX1, SP2 silicon nitride	(300 - 1000m/min)
	×	HW2 ceramic	(500 - 800m/min)
Finish-interrupted	○	SP2, SX1 silicon nitride	(200 - 600m/min)
	○	HC6 ceramic	(200 - 600m/min)
Finish-continuous	×	HW2,HCI ceramic	(500 - 800m/min)
	×	HC2 ceramic	(300 - 600m/min)
	○	HC2 ceramic	(400 - 600m/min)
	○	HC6 ceramic	(200 - 600m/min)

Turning Ductile (Nodular) Cast Iron (HB 180 - 250)

Cutting Condition	Coolant	NTK Grade Selection Per Speed Range	
Roughing-interrupted (as cast)	○	SX8 silicon nitride	(200 - 400m/min)
Roughing-continuous (as cast)	○	SX9, SX1, SP2 silicon nitride	(300 - 600m/min)
Finish-interrupted	×	HC6 ceramic	(200 - 600m/min)
Finish-continuous	○	HC6 ceramic	(300 - 600m/min)
	○	HC2 ceramic	(300 - 600m/min)

Milling Cast Irons

Cutting Condition	Coolant	NTK Grade Selection Per Speed Range	
Rough-gray-ductile	×	SX9, SX1 silicon nitride	(200 - 600m/min)
	×	SX8 silicon nitride	(200 - 400m/min)
Finish-gray or ductile	○	SX9, SP2 silicon nitride	(200 - 600m/min)
	×	HC6 ceramic	(100 - 200m/min)

GUIDELINES FOR SUCCESSFUL USING CERMETS

Tuning Steels.

Using cermets to machine steels provide the user with extended tool life, superior surface finishes and higher productivity through the use of speed. When using cermets to machine steels, feed rates and depth of cuts have to be selected more conservatively than with carbides because of the difference in strength.

Milling Steels.

The criteria for success when using cermets for milling are two fold - improved surface finishes and extended tool life. Most successful applications of cermets for milling are with cutters under 250 in diameter

Consult the "Guidelines for Cermet Success" section for additional information.

GRADE DISCUSSION		
T3N	-	Use this grade when turning (35-50Rc) steels. Do not use on iterrupted cuts, only for finish applications. Can be used to mill (40 HRC) die steels. Do not run with coolant, if possible.
T15	-	Use these general purpose grades to finish and semi-finish steels and stainless steels.
N40	-	Use N40 for the toughest steel applications. Maximum depth of cut -3.5mm. Can be run with or without coolant. Good choice on older machines. (90m/min and up)
C7X	-	Use C7X for general purpose milling of steels. Both exhibit excellent shock and wear resistance.

Carbon and Alloy Steels

Hardness (HB)	Cutting Condition	Speed Range	NTK Grade Selection
130 - 220	Rough Turning	90 - 200	N40 / C7X
	Finish Turning	240 - 360	T3N / T15 / C7X
	Milling	150 - 240	C7X
260 - 300	Rough Turning	100 - 175	N40 / C7X
	Finish Turning	150 - 240	T3N / T15 / C7X
	Milling	120 - 165	C7X
300 - 400	Rough Turning	80 - 125	T15
	Finish Turning	100 - 180	T3N
	Finish-Milling	75 - 120	C7X / T3N

Tool Steels

- 45 HRC	Finish Turning	100 - 135	T3N
	Finish-Milling	75 - 150	C7X

NOTE - Speeds based upon using a CNGA-120408 insert.
- Ceramics can be used in machining steels. Consult speed and feed chart.
- Mechanical chipbreakers should be used with ceramics.

Use a Rigid Set-Up.
NTK cermets work best when both the machine and work piece are secure - eliminate overhang.

Use Sturdy Tooling.
Use rigid tooling which reduces the chance of chatter. Make sure the insert pocket is clean and burr free. Use a top clamp.

Use Largest insert Size Possible.Use Largest Nose Radius Possible Use Largest Lead Angle Possible.
Use Cermets to Machine the Following.

Carbon Steels	Stainless Steels	Aluminum (with low Si)
Alloy Steels	Powdered Metal	Non-Ferrous Materials
Tools Steels	Inco 600-700 Series	Non-Metallic Materials

Use Cermets to Machine (HRC 35-50) Materials.
Cermets resist edge deformation and are very wear resistant when machining harder materials.

Use Suggested Speed Range.
Consult the speed chart for proper speeds cermet speeds increase productivity.

Use Correct Chipbreaker Design.
Do not curl the chips too tight.Avoid chips from striking the insert or piling up at cutting edge.

Use Light Feeds.
Do not exceed 0.38mm/rev feed rate. Cermets are more feed sensitive than carbides.

IMPORTANT POINTS TO REMEMBER

Thermal Toughness.
Cermets are more thermal sensitive to coolant than carbides. As a result, rough turning, boring and milling should not be performed using coolant. Conversely, coolant can be used when finish turning or boring.
If a cermet insert breaks after machining several parts and coolant is being used, turn off the coolant,replace the cutting edge and start over. Usually, this type of cermet failure is thermal related. The toughness level of cermet materials increases when no coolant is used. Cermets resist cutting edge build-up, so they cut much freer and surface finishes are excellent without the use of coolant. If coolant has to be used, it must be a flooded condition.

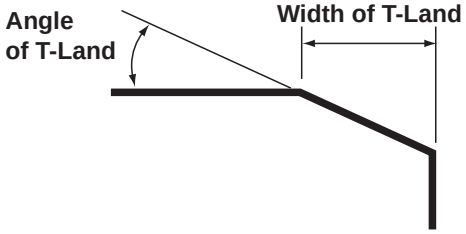
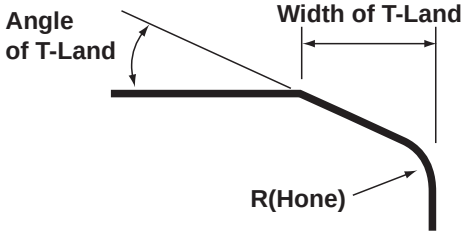
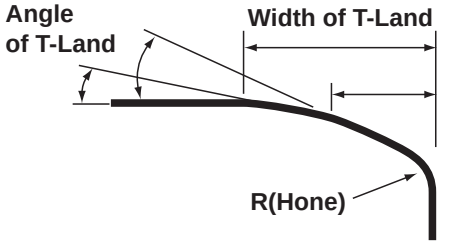
Fracture Toughness.
Cermets are best used in semi-finishing and finishing applications. Cermets do not bend - carbides do. Roughing through scaled surfaces are usually best performed by carbides. Cermets can machine parts with interruptions but care must be taken in the form of larger lead angles, stronger insert geometries and larger nose radius. Do not rough any material using a 55˚ or 35˚ rhomboid cermet insert.

- Much of the success of ceramics are the result of using the correct edge preparations.
  Since ceramic is such a hard material, it needs some edge work in order to withstand cutting forces to optimize the cutting tool performance. The correct edge preparation must correspond to the ceramic grade being used, the kind of material being machined and the machining operation being performed.

- The majority of ceramic applications can be handled with NTK's standard edge preparations.
  These edges are described on the next page. Whenever possible use a stocked standard edge preparation. As special conditions arise, then the edge preparation will have to be modified to meet these conditions. The following chart offers an explanation of edge preparations.

Explanation of Ceramic Cutting Edges

EDGE STRENGTH INCREASES

	Up sharp edges are not recommended for ceramics. Only cermets in some special cutting tool applications.
	Hones help protect the edge of ceramics from chipping or fracturing. Feed rates must be greater than the hone size to prevent a rubbing rather than a cutting action. Excessive honing reduces tool life
	This geometry is typically the most common ceramic edge preparation. The cutting forces are distributed over a concentrated area of the ceramic edge. Aword of caution - the larger the T-land or hone the greater the cutting pressure, temperature and wear.
	A hone added to a T-land provides a stronger edge to prevent chipping. Usually this thype of geometry works best on interrupted cuts or turning hardened steels.
	Double T-lands and hones are generally used in heavy roughing cuts of hardened materials. This edge is extremely shock resistant but also generates large cutting forces.

Standard Edge Preparation for NTK Ceramics

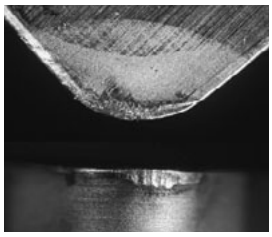
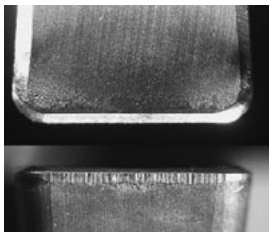
Grade	Shape	Thickness	I.C. Size	NTK Std. Edge Prep.
HC1	Negative Rake	4.76 or less 6.35 or over	all sizes	0.1 T-land 0.2 T-land
HC2				
HC6				
HW2	Positive Rake	all sizes	7.94 or less 9.525 or over	0.05 T-land
HC4 / ZC4				
HC7 / ZC7				
SX1 SX8 SP2	Negative Rake	all sizes	7.94 or less	0.1 T-land
			12.7 or over	0.2 T-land
	Positive Rake	all sizes	7.94 or less	0.1 T-land
			9.525 or over	
SX5	Negative Rake	all sizes	all sizes	0.05 T-land
SX9	Positive Rake			

Recommended Edge Preparation for HC1, HC2, HC6, HW2, ZC4, ZC7, SX1, SX8, SP2, SX9

Material	Application	Shape & Edge Preparation
Cast iron	Rough	① Negative rake 0.2 T-land (standard)
	Fine Finish	① Positive rake 0.05 T-land (standard)
		② Negative rake 0.1 T-land (standard)
Mild Steel	Rough	① Negative rake 0.2 T-land (standard) 7.94 thick
		② Negative rake 0.4 T-land (standard) 7.94 thick with Hone
	Finish-Semi-Finish	① Negative rake 0.1 T-land (standard)
		② Negative rake 0.2 T-land (standard)
	Finish with interruption	① Negative rake 0.2 T-land (standard)
		② Negative rake 0.2 T-land (special) with Hone
Hardened Steel	Finish-Semi-Finish	① Negative rake 0.2 T-land (special)
	Fine Finish	① Negative rake 0.1 T-land (standard)
		② Positive rake 0.05 T-land (standard)
Chilled Iron	Finish-Semi-Finish	② Positive rake 0.2 T-land with Hone (special)
	Mill Roll Turning	① CDH or RCGX Double T-land (standard) insert
Hi-Ni Alloy INCONEL 718 WASPALOY etc.	Rough	① Positive rake 0.05 T-land
	Finish	① Positive rake Heavy hone (special)
		② Positive rake 0.05 T-land

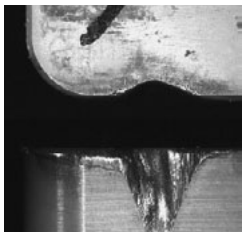
Damage and Solution

Normal Wear (Flank wear [VB])

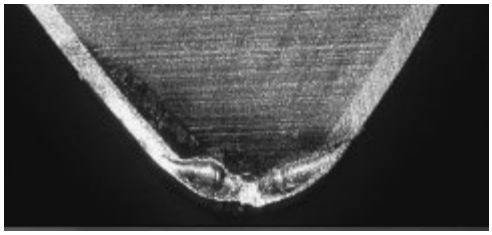
Solution
Reduce the cutting speed.
Increase the feed rate.
Increase nose-R size.
Change the tool grade with better wear resistance.

Notch wear [VC]



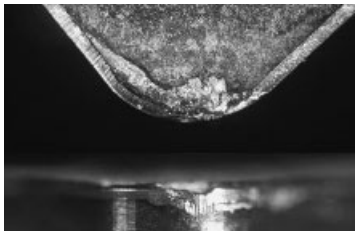
Solution
Change the tool grade with better wear resistance.
Decrease the approch angle or change insert shape.
Increase the feed rate.

Crater wear [KT]



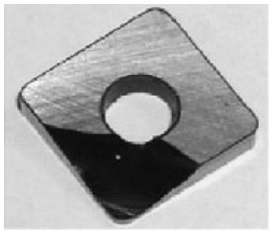
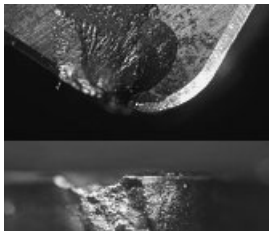
Solution
Reduce the cutting speed.
Change dry cutting to wet cutting.
Change the tool grade with better wear resistance.

Chipping



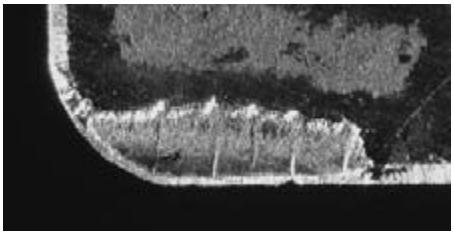
Solution
Increase the amount of cutting-edge honing.
Reduce the rake angle.
Change the tool grade with better notch resistance.

Fracture and breakage

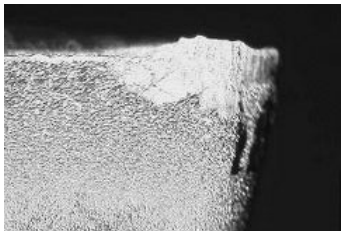
Solution
Review the cutting conditions (reduce "f × d").
Increase the amount of cutting-edge honing.
Change the tool grade with better notch resistance.

Thermal shock crack



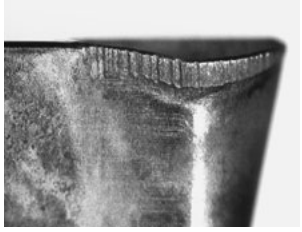
Solution
Reduce the cutting speed and the feed rate.
Change wet cutting to dry cutting.
Change the tool grade with better thermal shock resistance.

Built-up edge

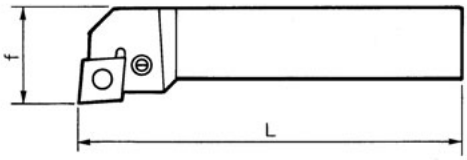


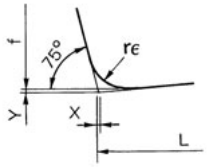
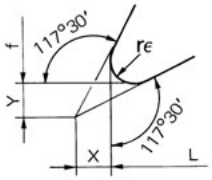
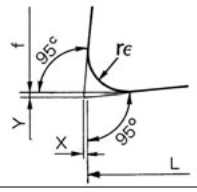
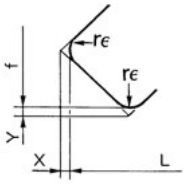
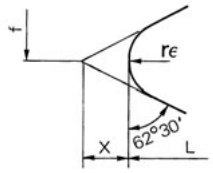
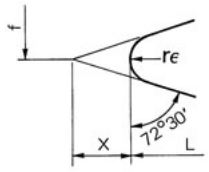
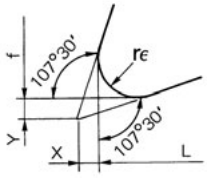
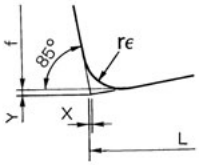
Solution
Increase the cutting speed and the feed rate.
Increase the rake angle.
Use oil coolant.

Plastic Deformation



Solution
Reduce the cutting speed and feed rate.
Reduce the cutting depth.
Change the tool grade with better heat resistance.

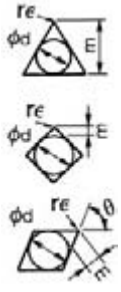


Edge code	Shape of the edge	Dimensions (mm)			Edge code	Shape of the edge	Dimensions (mm)		
		rε	X	Y			rε	X	Y
K	80-deg rhombic insert. 	0.4	0.007	0.028	Q	35-deg rhombic insert 	0.4	0.537	0.537
		0.8	0.015	0.055			0.8	1.073	1.073
		1.2	0.022	0.083			1.2	1.61	1.610
		1.6	0.029	0.110			1.6	2.146	2.146
		2.4	0.044	0.165			2.4	3.218	3.218
L	80-deg rhombic insert Type 31) 	0.4	0.040	0.040	S	Square insert (Type 12). 	0.4	0.164	0.164
		0.8	0.079	0.079			0.8	0.329	0.329
		1.2	0.119	0.119			1.2	0.493	0.493
		1.6	0.159	0.159			1.6	0.658	0.658
		2.4	0.238	0.238			2.4	0.986	0.986
P	55-deg rhombic insert 	0.4	0.463	–	V	35-deg rhombic insert 	0.4	0.923	–
		0.8	0.925	–			0.8	1.846	–
		1.2	1.389	–			1.2	2.769	–
		1.6	1.851	–			1.6	3.692	–
		2.4	2.776	–			2.4	5.538	–
Q	55-deg rhombic insert 	0.4	0.211	0.211	Y	Square insert (Type 17) 	0.4	0.003	0.033
		0.8	0.422	0.422			0.8	0.006	0.066
		1.2	0.633	0.633			1.2	0.009	0.099
		1.6	0.844	0.844			1.6	0.012	0.132
		2.4	1.265	1.265			2.4	0.017	0.132

Note: The values of X and Y in this table are based on a rake angle of 0 degrees. Therefore, these values slightly differ from actual ones.
" (Type XX)" denotes the type number of a standard C-shaped holder.

Determining the Position of the Insert Nose

Method of calculating the position of the nose(mm)



Shape	Calculation expression
Trian-gular	$m=\frac{3}{2}d-\gamma\varepsilon$
Square	$m=(\sqrt{2}-1)\times\frac{d}{2}-\gamma\varepsilon$
Rhombic	$m=\left(\frac{1}{\sin\frac{\theta}{2}}-1\right)\times\left(\frac{d}{2}-\gamma\varepsilon\right)$

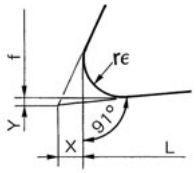
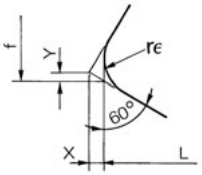
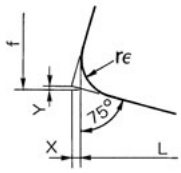
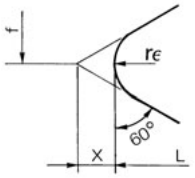
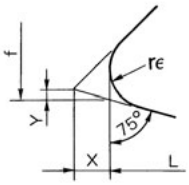
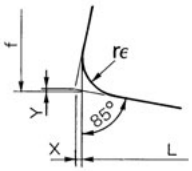
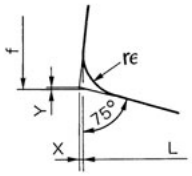
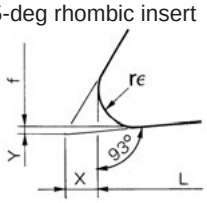
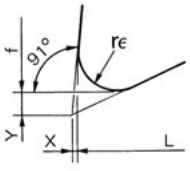
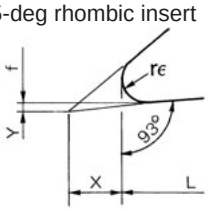
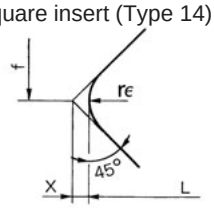
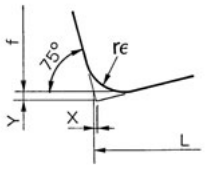
Values of "φd" and "γε" used to calculate "m" (mm)

Inscribed circle code		Calculation value(φd)
–	5	3.971
–	6	4.761
–	7	5.561
2	8	6.351
–	0	7.941
3	–	9.525
4	–	12.701
5	–	15.875
6	–	19.051
8	–	25.401

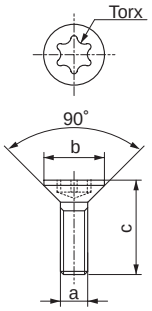
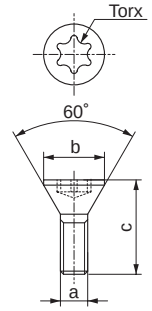
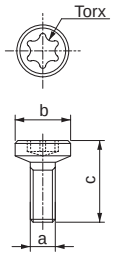
Nose code	Nominal value	Calculation value(γε)
Y	0.2	0.2032
1	0.4	0.3969
2	0.8	0.7938
3	1.2	1.1906
4	1.6	1.5875
6	2.4	2.3812

Cutting Edge Positional Dimension List for Each Nose R

● Nose-R and Cutting Edge Positional Dimensions

Edge code	Shape of the edge	Dimensions (mm)			Edge code	Shape of the edge	Dimensions (mm)		
		r ε	X	Y			r ε	X	Y
A (G)	Triangular insert (Type 21, 22) 	0.4	0.283	0.012	E (T)	Square insert (Type 13) 	0.4	0.145	0.043
		0.8	0.567	0.024			0.8	0.291	0.084
		1.2	0.850	0.036			1.2	0.436	0.168
		1.6	1.134	0.048			1.6	0.581	0.252
		2.4	1.701	0.072			2.4	0.872	0.503
B (R)	Square insert (Type 11, 16) 	0.4	0.089	0.024		Triangular insert (Type 24) 	0.4	0.397	–
		0.8	0.178	0.048			0.8	0.794	–
		1.2	0.268	0.072			1.2	1.191	–
		1.6	0.357	0.096			1.6	1.587	–
		2.4	0.535	0.143			2.4	2.281	–
	Triangular insert (Type 23) 	0.4	0.370	0.099	H	Square insert 	0.4	0.033	0.003
		0.8	0.740	0.198			0.8	0.066	0.006
		1.2	1.110	0.297			1.2	0.099	0.009
		1.6	1.480	0.397			1.6	0.132	0.012
		2.4	2.219	0.595			2.4	0.089	0.017
	80-deg rhombic insert (Type 21, 22) 	0.4	0.028	0.007	J	55-deg rhombic insert 	0.4	0.344	0.039
		0.8	0.055	0.015			0.8	0.687	0.079
		1.2	0.083	0.022			1.2	1.031	0.118
		1.6	0.110	0.029			1.6	1.375	0.157
		2.4	0.165	0.044			2.4	2.062	0.236
C (F)	Triangular insert (Type 25) 	0.4	0.012	0.283		35-deg rhombic insert 	0.4	0.839	0.065
		0.8	0.024	0.567			0.8	1.679	0.131
		1.2	0.036	0.850			1.2	2.518	0.196
		1.6	0.048	1.134			1.6	3.357	0.261
		2.4	0.072	1.701			2.4	5.036	0.392
D	Square insert (Type 14) 	0.4	0.164	–	K	Square insert (Type 15) 	0.4	0.024	0.089
		0.8	0.329	–			0.8	0.048	0.178
		1.2	0.493	–			1.2	0.072	0.268
		1.6	0.658	–			1.6	0.096	0.357
		2.4	0.986	–			2.4	0.143	0.535

Screw and Wrench List for Holders

Shape	Screw No.	Dimensions (mm)				Wrench Item-No.
		a	b	c	Torx	
	**LR-S-2×3.7**	M2×0.4	3.2	3.7	T6	RLR-13S
	LR-S-2×4.4	M2×0.4	3.2	4.4	T6	RLR-13S
	LR-S-2×5.5	M2×0.4	3.2	5.5	T6	RLR-13S
	LR-S-2.5×4.8	M2.5×0.45	3.6	4.8	T7	RLR-15S
	LR-S-2.5×6	M2.5×0.45	3.6	6.0	T7	RLR-15S
	LR-S-2.5×6.8	M2.5×0.45	3.6	6.8	T7	RLR-15S
	LR-S-3×6.2	M3×0.5	5.2	6.2	T10	RLR-20S
	LR-S-3×7.8	M3×0.5	4.2	7.8	T10	RLR-20S
	LR-S-4×5.8	M4×0.7	5.8	5.8	T10	RLR-20S
	LR-S-4×9	M4×0.7	5.8	9.0	T10	RLR-20S
	**LRIS-2.2×6**	M2.2×0.45	3.2	6.0	T6	RLR-13S
	LRIS-2.5×7	M2.5×0.45	3.6	7.0	T7	RLR-15S
	LRIS-3×6	M3×0.5	4.0	6.0	T10	RLR-20S
	1230 - C	M3×0.5	4.4	9.0	T8	
	LRIS-4×6	M4×0.7	5.8	6.0	T15	LLR-25S
	LRIS-4×8	M4×0.7	5.8	8.0	T15	LLR-25S
	LRIS-4×10	M4×0.7	5.8	10.0	T15	LLR-25S
ISO standard	**LRIS-5×10**	M5×0.8	7.0	10.0	T20	LLR-28S
	**1150 - C**	M5×0.8	6.4	13.5	T10	RLR-20S
	1160 - C	M6×1	8.0	13.5	T20	LLR-28S
	1161 - C	M6×1	8.0	10.5	T20	LLR-28S
	1180 - C	M8×1	11.0	13.5	T20	LLR-28S

Competitors' Grade Comparison Tables

Ceramic

	NTK	CeramTec	Kennametal	Sandvik	Greenleaf	Toshiba	Ssang Yong
Al_2O_3-based (White ceramics)	HC1 HW2	SN60 SN80	K060 KW80 K090	CC620	GEM9/GEM19	LXA AZ5000	SZ200
Al_2O_3-TiC-based (Black ceramics)	HC2 HC4(ZC4) HC7(ZC7)	SH1/SH2 SH20F	KY1615 HT46D	CC650	GEM7 GEM2	LX11 LX21	ST100 ST300
Si_3N_4-based (Silicon-nitride)	SX1 SX2(SP2) SX9	SL500 SL100/SL250C SL800	KY3500 KY3400 KY1540	CC690 (GC1690)		FX105 FX90 CX710	SN500 SN300 SN700
Al_2O_3-SiCw-based (Whisker)	WA1		KY4300	CC670	WG300		
TiC-based	HC6						SD200

( ) : Coating

CBN

NTK	CBN content (%)	Sumitomo	Mitsubishi	Toshiba
B16	82		BN500	BX930
B20	60	BN250	MB730	BX350
B22	80	BN100	MB710	BX360
B24, B26	60	BNX20	MB820 MB825	BX850
B36	65	BN300	MB835	BX380

Cermet

	NTK	Sumitomo	Toshiba	Mitsubishi	Kyocera	Iscar
P01	T3N	T05A	N302 X407	NX22	TN30 (PV30)	IC20N
			X407	NX33	(PV30)	
P10	T15 (Z15)(Q15) N20	T12A (T12Z) T1200A	NS520 (GT530)	NX1010 (GP20N)	TN60	IC520N
P15	C7X(C7Z)		N308	NX55 (UP35N)	TC40N	IC530N
P20	C7X (C7Z) N40	T250A T130A (T130Z)	N350 NS530	NX335 NX99 NX530	TN60	IC75T
P25		CS8000	NS540	NX2525	TN90 (PV90) TC60M	IC30N

( ) : Coating

Coated Carbide

	NTK	Sumitomo	Toshiba	Mitsubishi	Sandvik	Iscar
P01		AC1000	T7005.T715X	UE6005	GC4015	TX100
P10		AC1000 AC2000	T715X	UE6005 UE6010	GC4015	TP100 TP1000/CP200
P20	QM1, VM1, TA1	AC2000 AC3000	T7020	UC6010.UC6025 F620.UP20M	GC4025.GC4030 GC1120.GC1020	TP200/TX150 CP250/CP300
P30	ZM3 QM3, TA3	AC3000.AC304 AC230.AC325	T725.T325 GH330.AH330	UC6025.UE6035 AP15TF	GC4035.GC235 GC1025.GC4030	TP400 CP500
P40	TA3, ZM3 QM3	AC3000 AC304		UE6035		TP400 P500
M10	CP8	AC1000 AC2000	T715X	UC7020	GC215 GC2015	TP100 CP200
M20	CP8	AC2000.AC3000 AC325.AC304	T715X GH330.AH330	UC7020.F620 UP20M	GC1025.GC2025 GC4035.GC1120	TP200/TP300 CP300/CP500
M30		AC3000 AC325	T335S T325.AH740	US735.F620 AP15TF	GC2035 GC235	TP300/TP400 TP40/CP500
M40			GH340		GC235	TP400
K01		AC105G	T5010.AH110	UC5005.UE6005	GC4015	TX100
K10	CP8	AC500G.AC211 EH10Z	T5020.AH1020 GH110	UC6010 F5010	GC3015 GC4015	TP100 TX100/TX150
K20	TA1, QM1	AC500G EH20Z	T5020.AH120 J740.AH750	UC6010 AP15TF	GC4025 GC1120.GC1020	TX150 CP200/CP250
K30	QM1, TA3	ACZ310		AP15TF	GC4035	CP500

The above data is based on estimations from the respective competitors' catalogs and other documents.
Therefore, the listed data is not always the latest data or was approved by those competitors.

Material Cross Reference List

Carbon Steel

DIN	ISO	JIS
C10E / C10R	C10	S10C
C15E / C15R	C15E4 / C15M2	S15C
C22 / C22E / C22R	–	S20C
C25 / C25E / C25R	C25 / C25E4 / C25M2	S25C
C30 / C30E / C30R	C30 / C30E4 / C30M2	S30C
C35 / C35E / C35R	C35 / C35E4 / C35M2	S35C
C40 / C40E / C40R	C40 / C40E4 / C40M2	S40C
C45 / C45E / C45R	C45 / C45E4 / C45M2	S45C
C50 / C50E / C50R	C50 / C50E4 / C50M2	S50C
C55 / C55E / C55R	C55 / C55E4 / C55M2	S55C
C60 / C60E / C60R	C60 / C60E4 / C60M2	S58C

Cast Iron

EN-GJL-100	100	FC100
EN-GJL-150	150	FC150
EN-GJL-200	200	FC200
EN-GJL-250	250	FC250
EN-GJL-300	300	FC300
EN-GJL-350	350	FC350
EN-GJL-400	400	FC400

Ductile Cast Iron

EN-GJS-350	350-22	FCD350
EN-GJS-400	400-15	FCD400
EN-GJS-450	450-10	FCD450
EN-GJS-500	500-7	FCD500
EN-GJS-600	600-3	FCD600
EN-GJS-700	700-2	FCD700

Heat Resistant Alloy

X53CrMnNi21-9		SUH36
CrNi2520		SUH310
CrAl1205		SUH21
X6CrTi12	X6CrTi12	SUH409
	X2CrTi12	SUH409L
X45CrSi9-3		SUH1

High Alloy Steel

DIN	ISO	JIS
	C70U	SK70
	HS18-0-1	SKH2
	HS6-5-3-8	SKH40
	HS1-8-1	SKH50
S6-5-2	HS6-5-2	SKH51
-	HS6-6-2	SKH52
S6-5-3	HS6-5-3	SKH53
-	HS6-5-4	SKH54
S5-5-2-5	HS6-5-2-5	SKH55
S10-4-3-10	HS10-4-3-10	SKH57
	HS2-9-2	SKH58
	HS2-9-1-8	SKH59
	105V	SKS3
105WCr6	105WCr1	SKS31
X210Cr12	210Cr12	SKD1
	100CrMoV5	SKD12
X30WCrV9	X30WCrV9-3	SKD5
	X37CrMoV5-1	SKD6
X40CrMoV5	X40CrMoV5-1	SKD61
	X35CrWMoV5	SKD62
	32CrMoV12-28	SKD7
	55NiCrMOV7	SKT4

Low Alloy Steel

DIN	ISO	JIS
17Cr3	–	SCr415
17CrS3	–	SCr415
–	20Cr4(H)	SCr420(H)
–	20CrS4	SCr420
34Cr4	34Cr4	SCr430
34CrS4	34CrS4	SCr430
37Cr4	37Cr4	SCr435
37CrS4	37CrS4	SCr435
41Cr4	41Cr4	SCr440
41CrS4	41CrS4	SCr440
18CrMo4	18CrMo4	SCM418
18CrMoS4	18CrMoS4	SCM418
34CrMo4	34CrMo4	SCM435
34CrMoS4	34CrMoS4	SCM435
42CrMo4	42CrMo4	SCM440
42CrMoS4	42CrMoS4	SCM440
–	22Mn6	SMn420
–	36mN6	SMn438
–	42Mn6	SMn443
	41CrAlMo74	SACM645

Stainless Steels (Austenitic)

X12CrNi17-7	X10CrNi18-8	SUS301
X2CrNiN18-7	X2CrNiN18-7	SUS301L
X10CrNiS18-9	X10CrNiS18-9	SUS303
X5CRNi18-10	X5CrNi18-9	SUS304
X2CrNi19-11	X2CrNi19-11	SUS304L
X2CrNiN18-10	X2CrNiN18-9	SUS304LN
X5CrNi18-12	X6CrNi18-12	SUS305
	x6CrNi25-20	SUS310S
X5CrNiMo17-12-2	X5CrNiMo17-12-2	SUS316
X2CrNiMo17-13-2	X2CrNiMo17-12-2	SUS316L
X2CrNiMoN17-12-2	X2CrNiMoN17-11-2	SUS316LN
X6CrNiMoTi17-12-2	X6CrNiMoTi17-12-2	SUS316Ti
X2CrNiMo18-16-4	X2CrNiMo19-14-4	SUS317L
	X2CrNiMoN18-12-4	SUS317LN
	X1CrNiMoCu25-20-5	SUS890L
X6CrNiTi18-10	X6CrNiTi18-10	SUS321
X6CrNiNb18-10	X6CrNiNb18-10	SUS347
	X3NiCr18-16	SUS384
	X3CrNiCu18-9-4	SUSXM7

Stainless Steels (ferritic / tensitic)

X6CrA113	X6CrA113	SUS405
X6Cr17	X6Cr17	SUS430
X7CrS18	X7CrS17	SUS430F
X6CrTi17	X3CrTi17	SUS430LX
X6CrNb17	X2CrTi17	SUS430J1L
X6CrMo17-1	X6CrMo17-1	SUS434
	X1CrMoTi16-1	SUS436L
	X2CrMoTi18-2	SUS444
X10Cr13	X12Cr13	SUS410
X6Cr13	X6Cr13	SUS410S
	X12CrS13	SUS416
X20Cr13	X20Cr13	SUS420J1
X30Cr13	X30Cr13	SUS420J2
	X29CrS13	SUS420F
X20CrNi17-2	X19CrNi16-2	SUS431
	X70CrMo15	SUS440A
	X105CrMo17	SUS440C

Titanium Alloys

TiAl5Sn2.5		
TiAl6V4		
TiAl6V4ELI		
TiAl4Mo4Sn4Si0.5		

Conversions on Brinell Hardness of Steel

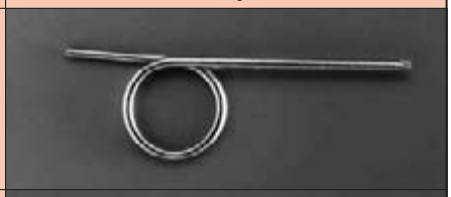
Brinell recess diameter mm	Brinell hardness 10mm balls, 3000kgf load			Vickers hardness	Rockwell hardness				Special Rockwell hardness Special brale indenter			Shore hardness	Tensile strength kgf/mm2 [N/mm2] Approximate value (1)
	Standard ball	Hultgren ball	Tungsten carbide ball		Scale A Load: 60 kgf brale indenter	Scale B Load: 100 kgf Diameter: 1/16"" indenter	Scale C Load: 150 kgf brale indenter	Scale D Load: 100 kgf brale indenter	15-N scale Load: 15 kgf	30-N scale Load: 30 kgf	45-N scale Load: 45 kgf"		
–	–	–	–	940	85.6	–	68.0	76.9	93.2	84.4	75.4	97	–
–	–	–	–	920	85.3	–	67.5	76.5	93.0	84.0	74.8	96	–
–	–	–	–	900	85.0	–	67.0	76.1	92.9	83.6	74.2	95	–
–	–	–	767	880	84.7	–	66.4	75.7	92.7	83.1	73.6	93	–
–	–	–	757	860	84.4	–	65.9	75.3	92.5	82.7	73.1	92	–
2.25	–	–	745	840	84.1	–	65.3	74.8	92.3	82.2	72.2	91	–
–	–	–	733	820	83.8	–	64.7	74.3	92.1	81.7	71.8	90	–
–	–	–	722	800	83.4	–	64.0	73.8	91.8	81.1	71.0	88	–
2.30	–	–	712		–	–	–	–	–	–	–	–	–
–	–	–	710	780	83.0	–	63.3	73.3	91.5	80.4	70.2	87	–
–	–	–	698	760	82.6	–	62.5	72.6	91.2	79.7	69.4	86	–
–	–	–	684	740	82.2	–	61.8	72.1	91.0	79.1	68.6	-	–
2.35	–	–	682	737	82.2	–	61.7	72.0	91.0	79.0	68.5	84	–
–	–	–	670	720	81.8	–	61.0	71.5	90.7	78.4	67.7	83	–
–	–	–	656	700	81.3	–	60.1	70.8	90.3	77.6	66.7	-	–
2.40	–	–	653	697	81.2	–	60.0	70.7	90.2	77.5	66.5	81	–
–	–	–	674	690	81.1	–	59.7	70.5	90.1	77.2	66.2	–	–
–	–	–	638	680	80.8	–	59.2	70.1	89.8	76.8	65.7	80	–
–	–	–	630	670	80.6	–	58.8	69.8	89.7	76.4	65.3	–	–
2.45	–	–	627	667	80.5	–	58.7	69.7	89.6	76.3	65.1	79	–
2.50	–	601	–	677	80.7	–	59.1	70.0	89.8	76.8	65.7	–	–
	–	–	601	640	79.8	–	57.3	68.7	89.0	75.1	63.5	77	–
2.55	–	578	–	640	79.8	–	57.3	68.7	89.0	75.1	63.5	–	–
	–	–	578	615	79.1	–	56.0	67.7	88.4	73.9	62.1	75	–
2.60	–	555	–	607	78.8	–	55.6	67.4	88.1	73.5	61.6	–	–
	–	–	555	591	78.4	–	54.7	66.7	87.8	72.7	60.6	73	210 {2095}
2.65	–	534	–	579	78.0	–	54.0	66.1	87.5	72.0	59.8	–	205 {2010}
	–	–	534	569	77.8	–	53.5	65.8	87.2	71.6	59.2	71	202 {1981}
2.70	–	514	–	553	77.1	–	52.5	65.0	86.7	70.7	58.0	–	195 {1912}
	–	–	514	547	76.9	–	52.1	64.7	86.5	70.3	57.6	70	193 {1893}
	495	–	–	539	76.7	–	51.6	64.3	86.3	69.9	56.9	–	189 {1854}
2.75	–	495	–	530	76.4	–	51.1	63.9	86.0	69.5	56.2	–	186 {1824}
	–	–	495	528	76.3	–	51.0	63.8	85.9	69.4	56.1	68	186 {1824}
	477	–	–	516	75.9	–	50.3	63.2	85.6	68.7	55.2	–	181 {1775}
2.80	–	477	–	508	75.6	–	49.6	62.7	85.3	68.2	54.5	–	177 {1736}
	–	–	477	508	75.6	–	49.6	62.7	85.3	68.2	54.5	66	177 {1736}
	461	–	–	495	75.1	–	48.8	61.9	84.9	67.4	53.5	–	172 {1687}
2.85	–	461	–	491	74.9	–	48.5	61.7	84.7	67.2	53.2	–	170 {1667}
	–	–	461	491	74.9	–	48.5	61.7	84.7	67.2	53.2	65	170 {1667}
	444	–	–	474	74.3	–	47.2	61.0	84.1	66.0	51.7	–	162 {1589}
2.90	–	444	–	472	74.2	–	47.1	60.8	84.0	66.8	51.5	–	162 {1589}
	–	–	444	472	74.2	–	47.1	60.8	84.0	65.8	51.5	63	162 {1589}
2.95	429	429	429	455	73.4	–	45.7	59.7	83.4	64.6	49.9	61	154 {1510}
3.00	415	415	415	440	72.8	–	44.5	58.8	82.8	63.5	48.4	59	149 {1461}
3.05	401	401	401	425	72.0	–	43.1	57.8	82.0	62.3	46.9	58	142 {1392}
3.10	388	388	388	410	71.4	–	41.8	56.8	81.4	61.1	45.3	56	136 {1334}
3.15	375	375	375	396	70.6	–	40.4	55.7	80.6	59.9	43.6	54	129 {1265}
3.20	363	363	363	383	70.0	–	39.1	54.6	80.0	58.7	42.0	52	124 {1216}
3.25	352	352	352	372	69.3	(110.0)	37.9	53.8	79.3	57.6	40.5	51	120 {1177}
3.30	341	341	341	360	68.7	(109.0)	36.6	52.8	78.6	56.4	39.1	50	115 {1128}
3.35	331	331	331	350	68.1	(108.5)	35.5	51.9	78.0	55.4	37.8	48	112 {1098}
3.40	321	321	321	339	67.5	(108.0)	34.3	51.0	77.3	54.3	36.4	47	108 {1059}
3.45	311	311	311	328	66.9	(107.5)	33.1	50.0	76.7	53.3	34.4	46	105 {1030}
3.50	302	302	302	319	66.3	(107.0)	32.1	49.3	76.1	52.2	33.8	45	103 {1010}
3.55	293	293	293	309	65.7	(106.0)	30.9	48.3	75.5	51.2	32.4	43	99 {971}
3.60	285	285	285	301	65.3	(105.5)	29.9	47.6	75.0	50.3	31.2		97 {951}
3.65	277	277	277	292	64.6	(104.5)	28.8	46.7	74.4	49.3	29.9	41	94 {922}
3.70	269	269	269	284	64.1	(104.0)	27.6	45.9	73.7	48.3	28.5	40	91 {892}
3.75	262	262	262	276	63.6	(103.0)	26.6	45.0	73.1	47.3	27.3	39	89 {873}
3.80	255	255	255	269	63.0	(102.0)	25.4	44.2	72.5	46.2	26.0	38	86 {843}
3.85	248	248	248	261	62.5	(101.0)	24.2	43.2	71.7	45.1	24.5	37	84 {824}
3.90	241	241	241	253	61.8	100.0	22.8	42.0	70.9	43.9	22.8	36	82 {804}
3.95	235	235	235	247	61.4	99.0	21.7	41.4	70.3	42.9	21.5	35	80 {785}
4.00	229	229	229	241	60.8	98.2	20.5	40.5	69.7	41.9	20.1	34	78 {765}
4.05	223	223	223	234	–	97.3	(18.8)	–	–	–	–	-	–
4.10	217	217	217	228	–	96.4	(17.5)	–	–	–	–	33	74 {726}
4.15	212	212	212	222	–	95.5	(16.0)	–	–	–	–	-	72 {706}
4.20	207	207	207	218	–	94.6	(15.2)	–	–	–	–	32	70 {686}
4.25	201	201	201	212	–	93.8	(13.8)	–	–	–	–	31	69 {677}
4.30	197	197	197	207	–	92.8	(12.7)	–	–	–	–	30	67 {657}
4.35	192	192	192	202	–	91.9	(11.5)	–	–	–	–	29	65 {637}
4.40	187	187	187	196	–	90.7	(10.0)	–	–	–	–	–	63 {618}
4.45	183	183	183	192	–	90.0	(9.0)	–	–	–	–	28	63 {618}
4.50	179	179	179	188	–	89.0	(8.0)	–	–	–	–	27	61 {598}
4.55	174	174	174	182	–	87.8	(6.4)	–	–	–	–	-	60 {588}
4.60	170	170	170	178	–	86.8	(5.4)	–	–	–	–	26	58 {569}
4.65	167	167	167	175	–	86.0	(4.4)	–	–	–	–	–	57 {559}
4.70	163	163	163	171	–	85.0	(3.3)	–	–	–	–	25	56 {549}
4.80	156	156	156	163	–	82.9	(0.9)	–	–	–	–	-	53 {520}
4.90	149	149	149	156	–	80.8	–	–	–	–	–	23	51 {500}
5.00	143	143	143	150	–	78.7	–	–	–	–	–	22	50 {490}
5.10	137	137	137	143	–	76.4	–	–	–	–	–	21	47 {461}
5.20	131	131	131	137	–	74.0	–	–	–	–	–	–	46 {451}
5.30	126	126	126	132	–	72.0	–	–	–	–	–	20	44 {431}
5.40	121	121	121	127	–	69.8	–	–	–	–	–	19	42 {412}
5.50	116	116	116	122	–	67.6	–	–	–	–	–	18	41 {402}
5.60	111	111	111	117	–	65.7	–	–	–	–	–	15	39 {382}

Notes:
1. The numerals parenthesized in this table are usually not used.
2. The units and values enclosed in braces ({ }) in this table are based on SI units and are shown for reference only. (1 N/mm^2 = 1 MPa)
3. This table is an excerpt from the JIS Iron and Steel Handbook.

Information for wrench specifications

With a view aimed at improved machinability and environment - friendly parts , NTK has conducted partial reviews on the specifications of its conventional LLR-type wrenches.
PIease understand that when current products run out of stock , new specifications wiII be incorporated into new wrenches.

● Standard Parts

Number	Shape
RLR-13S Old wrench No. LLR-13S	
RLR-15S Old wrench No. LLR-15S	
RLR-20S Old wrench No. LLR-20S	
LLR-25S	
LLR-28S	

◆The following L-Type wrenches are available only as optional items:

● Optional

〈LLR type〉

Number	Shape
LLR-13S	
LLR-15S	
LLR-20S	

● Tightening Precautions

- Before using a wrench , make sure that the front end of the wrench and the wrench hole section of the screw to be tightened are free from plastic deformation.
- As shown in the views below , apply the wrench vertically to the screw.

- Be extra careful not to tighten the screw at a torque exceeding its guaranteed value. Overtorqueing could result in wrench breakage.

For safe use of the Extra Hard Tool Product safety.

1. To use extra hard tool product.

In accordance with the Product Liability Law (PL law) that has been in effect since July 1, 1995, we affix warning labels or caution labels to the packages of the products which are covered by the law. However, we donÅf t affix specific caution labels onto the tool itself. Therefore, please read this leaflet before using extra hard tool products and extra hard tool materials. In addition, we would like to ask you to inform your operators of the content of this leaflet as part of your safety training.

2. Basic features of extra hard tool materials

2-1. Meaning and usage of terms in this leaflet

Extra hard tool material: Generic name for tool materials such as extra hard alloys, cermet, ceramic, CBN sintering material and diamond sintering material.
Extra hard alloy : Tool material which is mainly made of WC (Carbonized tungsten)
Extra hard : Abbreviation for extra hard tool materials, or the abbreviation for extra hard alloy in the narrow sense.
Extra hard tool : Generic name of tools which are made of extra hard tool material.

2-2. Physical characteristics

Appearance: Each material is different. Example: Gray, black, gold color, etc. Odor: None
Hardness : Extra hard cermet: HV500 to 3000kg/mm^2, Ceramic : HV1000 to 4000kg/mm^2
Hardness : CBN sintering material : HV 2000 to 5000 kg/mm^2, Diamond sintering material: HV8000 to 12000kg/mm^2
Gravity: Extra hard: 9 to 16, cermet: 5 to 9, cerami : 2 to 7, CBN and diamond sintering material 3 to 5

2-3. Component

Carbide, nitride, carbonitride, oxide such as W, Ti, Al, Si, Ta, B, and materials that contain Co, Ni, Cr, Mo, etc. in addition to those compounds.

3. Cautions for handling extra hard tool materials

- Extra hard materials can sometimes be quite fragile, although they are normally very hard. The materials may be damaged by sharp impact or excessive tightening.
- Since extra hard materials have high specific gravity, care should be taken when handling large products or large amounts of the products which are made of those materials.
- Extra hard materials have different thermal expansion ratios from other metallic materials. Therefore, cracks may occur in the product after shrinkage fit or cold shrinkage fit because the temperature for use is significantly higher or lower than the specification temperature.
- If the extra hard material has corrosion due to liquid for grinding, lubricant or water, etc., the strength of the material will be deteriorated significantly. Be sure to store the material where it will not come in contact with liquids or water.

4. Cautions for machining extra hard tools

- Extra hard tools may lose strength significantly depending on the surface condition. Be sure to use diamonds for grinding.
- Extra hard tools may generate dust during grinding. If you inhale a great deal of the dust, it may affect your health. Please make sure to have equipment for disposal and wear protective devices such as a mask, etc. If the dust comes in contact with your bare skin gets into your eyes, wash thoroughly with water.
- When grinding the extra hard material or soldered material, heavy metal component will be included in the waste fluid. So, make sure to dispose of the waste fluid properly.
- When regrinding extra hard tools, do a post check to be sure that no cracks have occurred.
- If you use a laser or electric pen, etc. to mark the extra hard material or products, it may cause cracks. Do not make markings at places where stress will be applied.
- If electric discharge machining is conducted on the extra hard material, remnant cracks may occur on the surface which cause the material to weaken. Be sure to remove any cracks by grinding, if necessary.
- When soldering the extra hard materials, if the material temperature is much lower or higher than the melting temperature of the soldering material, it may cause defluxion or breakage of the product. Be careful about the temperature.

Cautions for using cutting tools

Objective product	Danger	Countermeasure
Cutting tools in general	◎This type of tool has very sharp blade. If you touch it directly, you may get injured.	＊Wear protective gear, such as protective gloves, etc., especially when taking out the product from the case or attaching the tool to a machine,
	◎If you use it improperly or if the conditions for use are inappropriate, it may cause breakage or shattering of the tool, which may result in injury.	＊Wear protective gear such as safety covers or protective glasses. ＊l Use within the recommended purpose of usage. Refer to the operation manual, catalogue, etc.
	◎Sudden increase of cutting resistance due to a mixture of impact and burden or excessive abrasion may cause breakage or shattering of the tool, which may result in injury.	＊Wear protective gear such as safety cover or protective glasses. ＊Stop the machine, wear the protective gloves and use tools such as nipper or clipper, etc. to remove cutting chips.
	◎Tools or workpieces will be very hot while cutting. Therefore, if you touch them immediately after the machining, you may get burn injury.	＊Wear protective gear such as protective gloves.
	◎Sparks, heat generated due to breakage while cutting, cutting chips may also cause a fire.	＊Do not use the tool where there is a possibility of fire or explosion. ＊If you use insoluble cutting lubricant, be sure to have antifire provisions.
	◎When using the tool at high speed rotation if the whole machine including the holder of the machine is not well balanced, the tool may get broken due to tremor or vibration, which may result in injury.	＊Wear protective gear such as safety cover or protective glasses. ＊Make sure to have a trial operation in advance in order to confirm that there is no vibration or abnormal sound.
	◎Touching burrs on the machined product directly may result in injury.	＊Do not touch with bare hands.
Throw-away type (blade change type) tools in general	◎If the chip or parts are not clamped securely, those may fall down or scatter while cutting, which may cause injury.	＊Clean the surface for attachment of an insert or the part for fixture of the insert completely before attaching the insert. ＊Make sure that the insert or the part is clamped securely using a spanner provided with the product before attachment. Also, do not use any inserts or parts other than the ones provided with the products.
	◎If the tool is tightened too tightly using a tool such as pipe, etc., the chip or tool may fall down or shatter while cutting. This is dangerous.	＊Do not use a tool such as a pipe. Use the spanner which is provided with the product.
	◎When using the tool at high speed rotation, a part or chip may be thrown out by centrifugal force, which is very dangerous. Be careful about handling the tool safely.	＊Use the tools only for the recommended purposes. Refer to the operation manual, catalog, or other source of information.
Cutters and other tools that are rotated for use	◎The sharp cutter blades may cause injury if you touch them directly with your hands.	＊Wear protective gear such as protective gloves, etc.
	◎The tool may be deflected due to eccentric rotation or bad balance that will cause vibration, breakage or scattering of the tool, which may result in injury.	＊Use the tool within the recommended rotation speed. ＊Check and adjust the accuracy of rotating section or balance periodically so that eccentric rotation or deflection does not occur due to abrasion of the bearings, etc.
Soldering tool	◎You may get injured due to defluxion or breakage of the chips, etc.	＊Confirm that the soldering is secure before use. ＊Do not use under conditions which may cause the tool to reach high temperatures.
Others	◎Repeating soldering many times may cause the chip to be broken easily. This is dangerous.	＊Do not use the chip which has been soldered many times because the strength will be lower.
	◎Using the tool for other than its intended purposes may cause breakage of the machine or tool. This is very dangerous.	＊Use the tools only as specified.

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