D-1 Technical Information

Turning Tools

Recommend Collocation of General Turning Grades and Chip Breakers

	ISO P Steel	ISO M Stainless Steel	ISO K Cast Iron	ISO S Cast Iron
Finishing	OPF – OC2115 OTF – OC2115	OMF – OP1215 – OP1315 OTF – OP1215 – OP1315 MSF – OP1215 – OP1315	OKM – OC3210 – OC3215	SMM – OP1105 – OP6215
Semi Finishing	OPM – OC2125 – OC2325 – OC2325S OTM – OC2125 – OC2325 – OC2325S	MF – OP1215 – OP1315 OMM – OC4315 – OP1215 – OP1315 OTM – OP1215 – OP1315	General chip breaker – OC3210 – OC3215 OKR – OC3215 – OC3220	OSM – OP1105 – OP6215
Roughing	OPR – OC2125 – OC2325S OTR – OC2125 – OC2325 – OC2325S		Flat (None chip breaker) – OC3215 – OC3220	

A
B
C
D
E/I

Recommended Cutting Parameters on Different Grades

ISO	P类 IOS P		
Materials	Carbon steel	Alloy steel	Hardened and tempered steel
Hardness	HB120–180	HB180–240	HB240–350

ISO	IOS M	
Materials	Austenite	Martensite
Hardness	HB120–200	HB330

ISO	IOS K	
Materials	Grey cast Iron	Nodular cast Iron
Hardness	HB150–220	HB140–220

ISO	IOS N
Materials	Aluminium alloy
Hardness	HB60

Recommended Cutting Parameters on Different Grades

Materials \ Grade		OC2015	OC2025	OC2115	OC2125
Carbon steel	Vc(m/min)	450–200	430–180	480–260	460–240
Alloy steel		320–140	300–130	340–150	330–150
Hardened and tempered steel		200–80	190–70	220–80	210–70

Materials \ Grade		OC4015	OC4025	OC4225	OP1205
Austenite	Vc(m/min)	200–100	190–90	210–110	220–100
Martensite		200–140	210–130	220–140	260–170

Materials \ Grade		OC3015	OC3115D	OC3215	
Grey cast Iron	Vc(m/min)	280–160	400–190	380–200	
Nodular cast Iron		280–140	300–150	220–110	

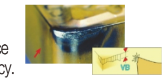
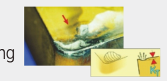
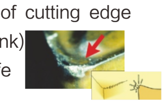
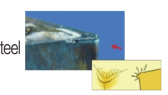
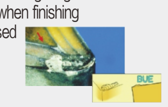
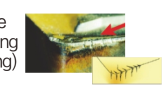
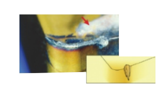
Grade	OK434			
Vc(m/min)	900–400			

A
B
C
D
E/I

Common Problems and Solutions for Turning

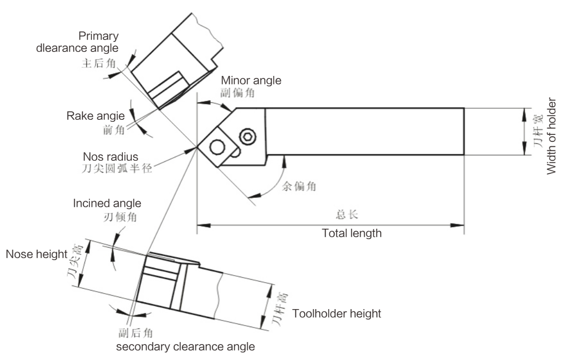
FAQ		Reason / Solutions	Insert Grade: Harder Grade	Insert Grade: Tougher Grade	Cutting Conditions: Vc	Cutting Conditions: Fn	Cutting Conditions: Ap	Cutting Conditions: Coolant	Tool Shape: Chip Breaker Review	Tool Shape: Rake Angle	Tool Shape: Corner Radius	Tool Shape: Setting Angle	Tool Shape: Edge Strength	Tool Shape: Change to Higher Tolerance	Tool Shape: Toolholder Rigidity	Setting/Machine: Workpiece/Tool Installation	Setting/Machine: Overhang Length	Setting/Machine: Power,Rigidity
Too Much Wear On Nose	Accuracy Out Tolerance	Wear Increase at Flank Wear	◎								↑							
		Unsuitable Cutting Conditions			↓	↑												
Surface Accuracy Deterioration	Poor Roughness Of Surface	Tool wearness Increasing, Cutting Edge not Sharp	◎		↓			◎		↑	↑		↓	◎				
		Cutting Edge Chipping		◎		↓	↓		◎		↑		↑			◎	◎	◎
		Unsuitable Geometry							◎		↑		↓	◎				
		Unsuitable Cutting Conditions			↑	↓	↓	◎										
		Vibration,Chattering		◎	↑↓	↓	↓	◎	◎	↑	↓	↑	↓		◎	◎	◎	◎
		Built-up Edge			↑	↑		◎	◎	↑			↓	◎				
Heat	Cutting Heat Factors	Unsuitable Cutting Conditions			↓	↓	↓											
		Unsuitable Geometry	◎						◎	↑			↓					
Deterioration of Accuracy	Variation of Dimension	Unsuitable Insert Accuracy												◎				
		Position Offset of Workpiece and Tool							◎	↑	↓	↑			◎	◎	◎	◎
Edge Damage	Wear Increase at Relief Face	Flank Wear	◎		↓				◎	↑	↑		↓					
		Rake Face Wear	◎		↓	↓	↓		◎	↑		↓						
	Chipping	Vibration,Shock		◎		↓	↓		◎			↓	↑		◎	◎	◎	◎
	Built-up Egde	Unsuitable Workpiece Hardness and Cutting Conditions			↑	↑		◎	◎	↑			↓	◎				
	Comp Cracks	Unsuited Tool's Material and Cutting Condition to Workpiece Material			↓	↓	↓	◎	◎	↑			↓					
	Edge Nose Deformation	Interrupted Cutting	◎		↑	↓	↓	◎	◎	↑	↑	↓	↓					
	Tool Life	Unsuited Material and Cutting Condition		◎		↓	↓		◎		↑	↓	↑		◎	◎	◎	◎
Chip Control	Long, Tangling Chips	Unsuitable Cutting Conditions			↓	↑	↑											
		Unsuitable Material and Cutting Conditions							◎		↓	↑						
	Chips Scattering	Unsuitable Cutting Conditions				↓	↓	◎										
		Unsuitable Geometry on cutting edge							◎		↑	↓						
Burrs Turned-down Edge	Steel, Aluminum-Burr	Unsuitable Cutting Conditions			↑	↓		◎										
		Insert Wear, Unsuitable Geometry	◎						◎	↑	↓	↑	↓					
	Iron Cast, Turned-down Edge	Unsuitable Cutting Conditions			↓	↑		◎										
		Insert Wear, Unsuitable Geometry	◎						◎	◎	↓	↓	↓					
	Soft Steel, Turned-down Edge	Unsuitable Cutting Conditions				↓	↓											
		Insert Wear, Unsuitable Geometry	◎						◎	↑	↑		↑		◎	◎	◎	◎

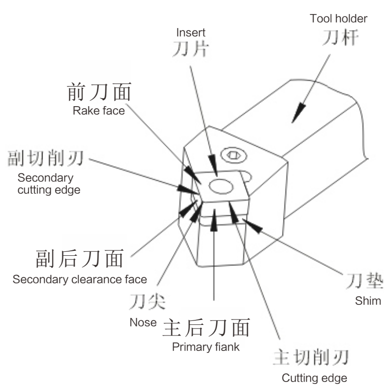
Tool Wear and Solution

Tool Wear Types	Situation	Reason	Solutions
Flank Wear	Higher cutting resistance Notch wear on flank Poor roughness of surface or deterioration of accuracy. 	Soft grades Excessive cutting speed Small flank angle Low feed	Select a higher wear-resistant grade Reduce cutting speed Increase flank angle Increase feed
Crater Wear	Uncontrolled chip Poor surface quality when finishing High speed processing carbon steel 	Soft grades Excessive cutting speed Excessive feed The strength of chip breaker Insufficient	Change to a higher wear-resistant grade Reduce cutting speed Reduce feed Select a higher strength chip breaker
Chipping	Sudden fracture of cutting edge (rake face and flank) Instability insert life 	Toughness insufficient Excessive feed rate Strength of cutting edge insufficient Instability of the tool	Select a tougher grade Decrease feed rate Increase honing of cutting edge (chamfering to rounding) Increase the stability and setting angle
Insert Fracture	Cutting resistance increased Poor surface roughness 	Toughness insufficient Excessive feed rate Strength of cutting edge insufficient Instability of the tool	Select a tougher grade Decrease feed rate Increase honing of cutting edge (chamfering to rounding) Increase the stability and setting angle
Plastic Deformation	Variation of dimension Nose wear,cutting edge drape or passivating. when processing alloy steel Poor surface roughness 	Soft grade Excessive cutting speed Excessive cutting depth and feed rate Overheat on cutting edge	Select a higher red hardness cutting material Decrease cutting speed Decrease cutting depth and feed rate Select a higher thermal conductivity cutting material(CVD+sufficient coolant)
Build-Up-Edge	Workpiece dissolve with Cutting edge Poor surface roughness when finishing Cutting resistance increased Cutting soft materials 	Cutting speed too low Cutting edge obtuse Unsuitable tool material	Increase cutting speed Increase rake angle Select small sticking force
Themal Crack	Crack by heat cycle (often happen in milling and interrupted cutting) 	Toughness of tool grade insufficient Swell and shrink by cutting heat(cold-thermocyling)	Cutting without coolant/Sufficient coolant Select a tougher and more thermal shock resistance grade
Flaking	Often in instability cutting and cutting high-hardness materials 	Build-up edge Uncontrolled chip	Increase rake angle Increase chip breaker
Notch Wear	Notch partial failure Partial chipping Partial cratering 	Processing hardened material, oxide-scale,superalloy	Select a higher wear-resistance CVD grade Adopt taper cutting (variable cutting depth) Decrease setting angle

The Names of Each Part of Turning Tool

Names of Turning Holder Parts





Effects of Rake Angle

Larger rake angle makes cutting edge sharper. reduces resistant forces of chip flow. diminishes friction and prevent deformation. leading to smaller. less abrasion and higher surface quality. However,too large rake angle would reduce the rigidity and strength of tool.Heat can’t be diffused easily,Serious breakage and abrasion on tool would occur,reducing too life.Please choose rake angle according to machining conditions.

Value selection	Situations
Small rake angle	When machining brittle and hard materials; When roughing and interrupted cutting
Big rake angle	When machining Plastic or soft materials; When finishing;

The Names of Each Part of Turning Tool

Effects of Clearance Angle

The main function of clearance angle to reduce the friction between the clearance face of tool and the surface of workpiece. When the rake angle is fixed,larger clearance angle can increase and the achieve higher surface quality.However,if clearance angle is too large,the strength of cutting edge would decrease.Also,heat can’t be diffused easily and serious abrious would occur,reducing tool life.

The principle of choosing clearance angle:Choose small cleara–nce angle if friction is not serious

Value selection	Situations
Small clearance angle	In order to increase nose strength when roughing When machining brittle and hard materials
Large clearance angle	In order to reduce friction when finishing When machining materials easy to be hardened;

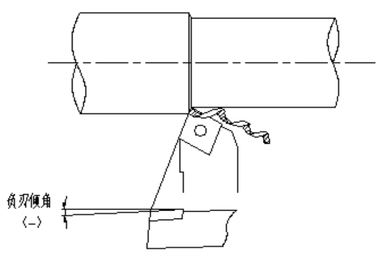
The Names of Each Part of Turning Tool

Effects of Inclined Angle

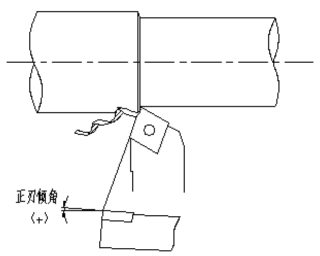
Positive or negative inclined angle determines the direction of chip flow, and also affects the strength and impact resistance of insert nose.

As diagram(1) shows, when the inclined angle is negative, namely nose is in the lowest point as apposed to eht bottom of tool, chips flow to the machined surface of workpiece.

As diagram(2) shows, when inclined angle is positive.namely the nose is in the highest point as apposed to the bottom of the tool,chips flow to the areas of workpiece surface that haven't been machined.



Negative inclined angle



Positive inclined angle

The change of inclined angle also affects insert nose strength and impact resistance.When the inclined angle is negative.the nose is in the lowest point of cutting edge.When the cutting edge enters the workpiece,the contacting point is on the cutting edge or rake face,proteting the nose from impact and increase the strength of the nose.Normally,negative inclined angle should be chosen for tools with big rake angle.This can not only increase nose strength.But also prevent the impact of entry.

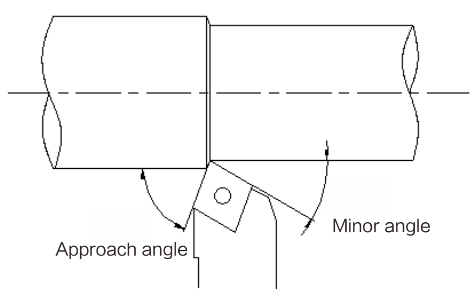
The Names of Each Part of Turning Tool

Effects of Approach Angle

Reduces approaching angle increases the strength of tools and enable heat to diffuse easily,improving surface quality.This is becauce when the approach angle is small,cutting edge width is large,and then the unit width of cutting edge bears less cutting force.Meanwhile, tool life can be improved.

Normally, select 90° approach angle for turning of slender and step shaft; select 45° approach angle for external turning. End surface machining and chamfering.When approach angle is larger,radial force is reduced,cutting is stable ,cutting thickness is increased,and chip breaking is excellent.

Value selection	Situations
Small approach	For those materials with high intensity,high hardness and hardened layer on the surface
Big approach angle	When rigidity of the machine is not enough



The Names of Each Part of Turning Tool

Effects of Minor Angle

Minor angle is the main angle that can affect surface quality,and it can also affect tool strength.If the approach angle is too small, the friction between the secondary flank and machined surface of workpiece will increase,causing vibration.

The principle of selecting minor angle:Select small minor angle when roughing or when the friction is unaffected and is on vibration.Select large minor angle when finishing.

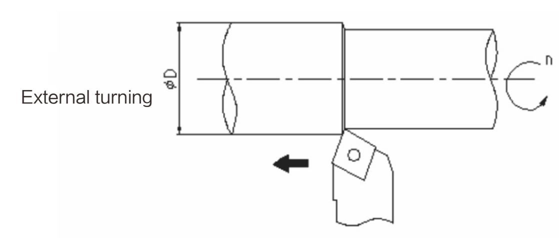
Nose Radius

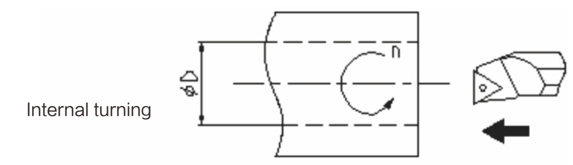
Nose radius significantly affects nose strength and surface quality. Large nose radius means higher cutting edge strength,and the abrasion on the rake face and clearance face can be reduced to some extent. However,if the nose radius is too large,radial force will increase,and vibration is easy to occur,affecting machining precision and surface quality.

Value selection	Situations
Small nose radius	Finishing at small cutting depth Machining parts such as slender shaft When the rigidity of the machine is not enough
Large nose radius	When roughing/When machining hard materials(intermittent cutting) When the rigidity of the machine is not enough

Tool Wear and Solution

Calculation of Cutting Speed





$$Vc = \frac{\pi \times D \times n}{1000}(m/\min)$$

In the formula：Vc：Cutting speed(m/min)

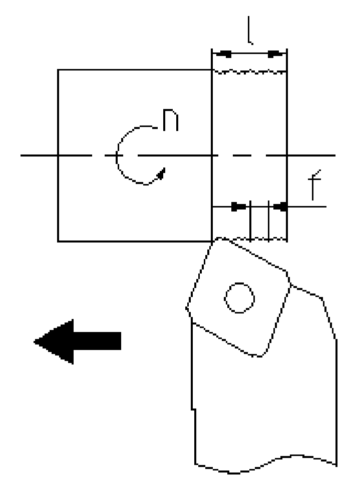
n：Rotating speed of main axle (rev/min)

D：Diameter of workpiece(mm)

For example：When the rotating speed is 280rev/min and the diameter of workpiece is 150mm,the cutting speed should be：

$$Vc = \frac{\pi \times D \times n}{1000} = \frac{3.14 \times 150 \times 280}{1000} = 132(m/min)$$

Calculation of Feed Rate



$$f = \frac{l}{n}(mm/rev)$$

In the formula：f：Feed rate per rotation(mm/rev)

L：Cutting length per minute(mm/min)

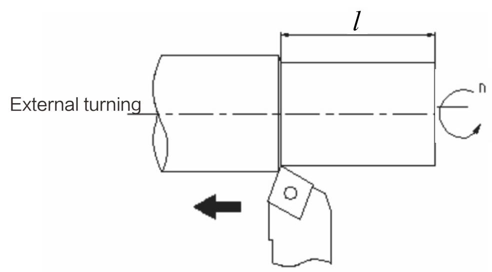
N：Rotating speed of main axle(rev/min)

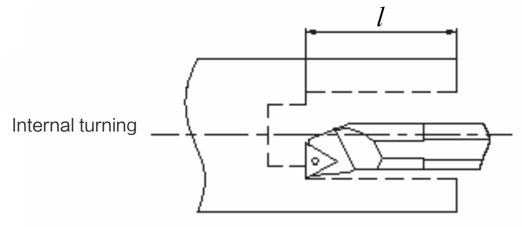
For example：When the rotating speed of main axle is 500rev/min, and the cutting length per minute is 100mm/min,the feed rate per rotating should be：

$$f = \frac{l}{n} = \frac{100}{500} = 0.2(mm/rev)$$

Tool Wear and Solution

Cutting Time Calculation of External and Internal Turning



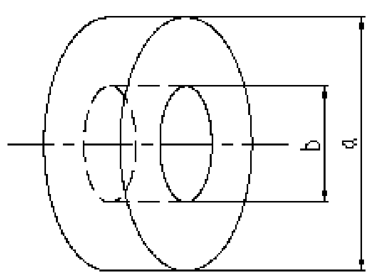


$$T = \frac{l}{f \times n}(\min)$$

In the formula：T：Cutting time(min)
L：length of machined areas(mm)
F：Feed rate(mm/rev)
N：Rotating speed of main axle(rev/min)
For example：When the rotating speed of main axle is 250rev/min, and the feed rate is 2.0mm/rev.the time needed for a cutting length of 150mm should be：

$$T = \frac{l}{f \times n} = \frac{150}{0.2 \times 250} = 3(\min)$$

Time Calculation End Surface Turning (Constant Linear Speed)

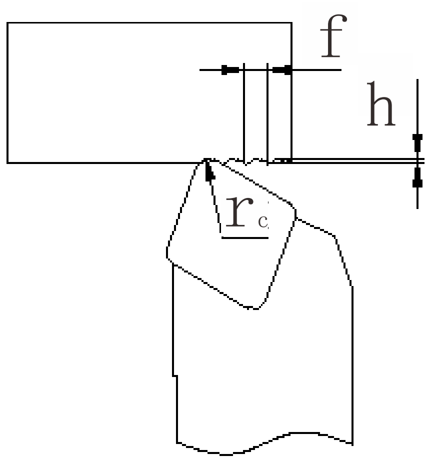


$$T = \frac{\pi \times (a^2 - b^2)}{4000 \times Vc \times f}(\min)$$

In the formula：T：Cutting time(min)
Vc：length of machined areas(mm)
F:Cutting spead
For end surface without hole，b=0，the formula is still Valid.

Tool Wear and Solution

The Oretical Value Calculation of Machined Surface Roughness



$$R = \frac{f^2}{8r_c} \times 1000(\mu m)$$

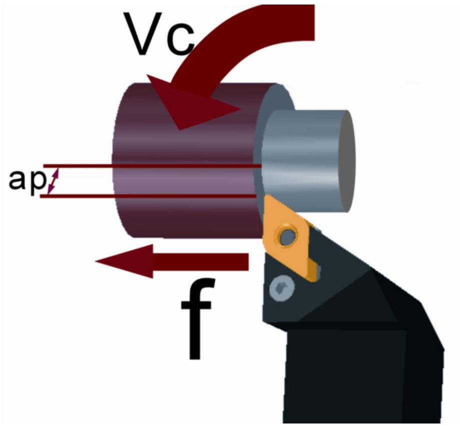
In the formula：R：Theoretical roughness value of machined surface
F：Feed rate(mm/rev)
Rc：Nose radius(mm)
For example：When the feed rate is 0.2mm/rev,and the nose radius is 0.4mm. the theoretical roughness value of machined surface should be：

$$R = \frac{f^2}{8r_c} \times 1000 = \frac{0.2^2}{8 \times 0.4} \times 1000 = 12.5(\mu m)$$

Tool Wear and Solution

Effects of Three Main Parameters

Normally,short machining time,long tool life and high machining precision are expected in machining,so the material quality,hardness,and shape of the workpiece,and properties of machine should be fully considered and then we can select suitable tools and adopt high-efficiency cutting parameters,namely three parameters.



Cutting Speed (Vc)

When the workpiece is rotating on the machine,the number of is rotation per minute is defined as Rotating speed of main axle(n).Because of its rotation,the cutting speed measured on the contacting point of diameter is defined as linear speed.m/min.Normally,linear,linear speed is considered to measure the effect of cutting speed on machining

Effect of Cutting Speed

Cutting speed has significant effect in tool life.When the cutting speed is increased,cutting temperature will increase and tool life will be shortened.Cutting speed varies according to the different types and hardness of work-piece.The below congclusions are reached after many cutting experiments:

(1)Normally tool life would be reduced to half when the cutting speed is increased by 20%. Tool life would be 20% of the original life if the cutting speed is raised by 50%。

(2)Low speed (20-40m/min) cutting could easily cause vibration and shorten tool life.

Tool Wear and Solution

Feed Rate(fn)

Feed rate is defined as the moving distance of tool after workpiece rotates for one circle,measured by mm/rotation.

Feed Rate(fn)

Feed rate is a key factor that determines surface quality. Meanwhtile it also affect the range of chip forming and the thickness of chips during machining.

In term of the effect on tool life,small feed rate leads to serious abrasion on clearance face,reducing tool life.

Cutting Depth(ap)

Cutting depth is defined as the difference between machined surface and unmachined surface.Measured by mm.it is half the difference value between the original diameter and machined diameter.

Effect of Cutting Depth

Cutting depth should be determined by the machining alllowance and shape of workpiece,power and rigidity of machice, and tool rigidity.

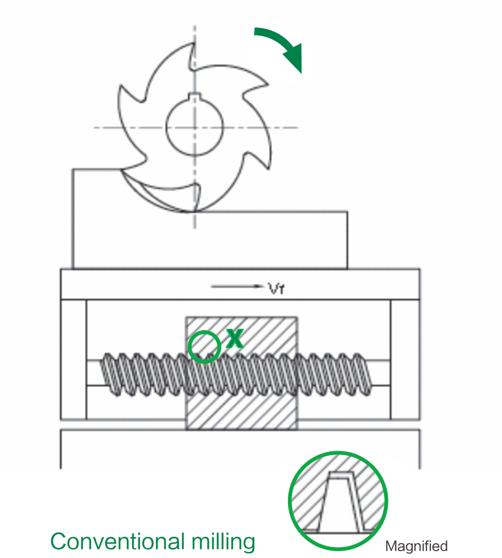
The change of cutting depth has little effect on tool life.If the cutting depth is too low. The cutting nose only scrapes the hardened layer on the workpiece surface.reducing tool life.When there is hardened oxide layer on workpiece surface,higher cutting depth should be adopted within the possible range of machine’s power to avoid cutting nosr just cutting the hardened layer of workpiece.

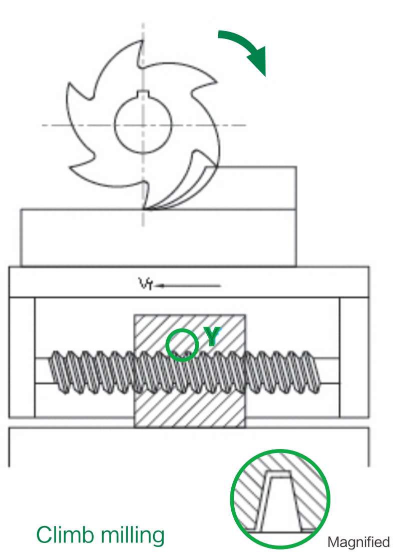
E-2 Technical Information

Milling Tools

Technical Information About Indexable Miling Tools

Difference and Selection Between Down Miling and Up Miling





Conventional milling(also called up milling):the feed direction of workpiece is opposite to that of the milling rotation at the connecting position

Climb milling(also called down milling):the feed direction of workpiece is the same as that of the milling rotation at the connecting position

In down milling,the major force of cutting edge is compressive stress,white in up milling the tensite stress.The compressive strength ofcemented carbide material is much larger than its tensile strength.In down milling,as chips become thin from thick gradually,cutting edge and workpiece press against each other.The friction between edge and workpiece is small,thus reducing the abrasion of edge,the hardening of workpiece surface and the surface roughness(Ra).in up milling ,chips become thick from thin gradually.When the insert is cutting into the workpiece,it produces strong friction and more heat than in down milling,and make workpiece surface hardened.

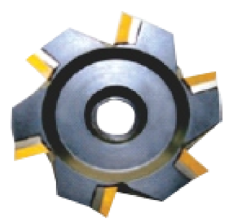
In up milling,because horizontal direction of cutting force milling cutter conducting on workpiece is opposite to the feed direction of workpiece,the lead screw of worktable joints closely with oneside of the screw nut.In down milling,the direction of cutting force is the same as the feed direction.When edge's radial force on workpiece is large enough,the worktable will bounce left and right,thus make the gap fall behind.The gap will return to the front side with the continuing rotation of lead screw.At this moment the worktable stops motion,however,it will bounce left and right again when the radial cutting force is large enough again.The periodical bounce of worktable will cause poor surface quality of workpiece and tool breakage.

When using end mills for down milling,the edges always starts cutting at the workpiece surface,therefore end mills are not suitable for machining workpiece with hardened surface.

Up milling is recommended for milling thin-wall components or square milling with high requirenment for precision.

Pitch Selection

Pitch is the distance between one point on one cutting edge and the same point on the next edge.Milling cutters are mainly classified into coarse.Close and extra close pitches

Optimized stability		
L	M	H
Coarse pitch unequal pitch design 	Close pitch 	Extra close pitch 
When the milling width is equal to diamete of cutter,the machining system is stable and main power of machine is sufficient,the use of coarse pitch can achieve high productive efficiency.	Used in general milling and multiple mixed productions.	When the milling width is less than diameter of cutter, cutting by maximum edges can achieve high productive effciency.

Selection of Approach Angle

The approach angle is formed by insert and tool body. Lt affects chip thickness.Cutting forces and tool−life.Decreasing the approach angle reduces chip thickness and expands the cutting area between cutting edge and workpiece at a given feed rate.

A Smaller approach angle also ensures stable entry into or exiting workpiece,protecting the cutting edge and extending tool life.However,this will increase axial cutting forces on the workpiece,thus is not suitable for machining thin workpiece Such as thin plate.

Approach angle	Feed rate per tooth	Maximum chip stickiness
90°	fz	$hex = fz \times sinkr$
75°	fz	$hex = 0.96 \times fz$
60°	fz	$hex = 0.86 \times fz$
45°	fz	$hex = 0.707 \times fz$
圆刀片	fz	$hex = \frac{\sqrt{ic^2 \times (ic-2a_p)^2}}{ic} \times f_z$

The Names of Each Part of Milling Tools

Vc : cutting speed(m/min)

fz : feed rate per tooth(mm/z)

Zn : number of teeth

fz : feed rate per revolution(mm/rev)

Vf: feed rate of worktable(feed speed)(mm/min)

n: spindle speed

Tc: machining time(min)

L: Actual working distance(mm)

Dc: nominal diameter of milling tool(mm)

π: circumference ratio≈3.14

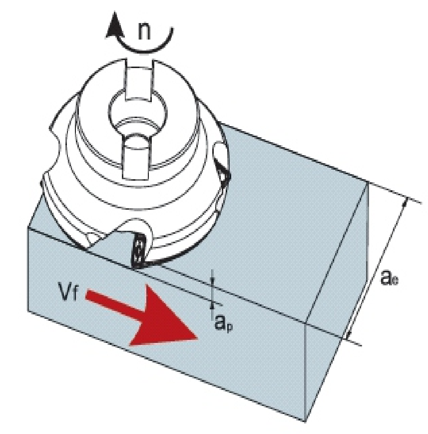
Q: metal removal rate(cm³/min)

Cutting speed

$$Vc = \frac{\pi \times Dc \times n}{1000} \ (m/min)$$

Spindle speed

$$n = \frac{1000 \times Vc}{\pi \times Dc} \ (rev/min)$$

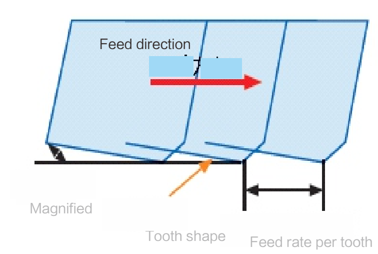


Feed rate of worktable(feed speed)

$$Vf = fz \times n \times zn \ (mm/min)$$

Feed rate per tooth

$$fz = \frac{Vf}{n \times Zn} \ (mm/z)$$

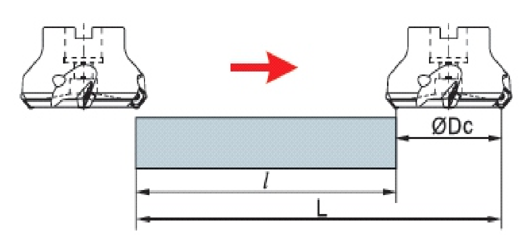


Feed rate per revolution

$$fn = \frac{Vf}{n} \ (mm/rev)$$

Machining time

$$Tc = \frac{L}{Vf} \ (min)$$

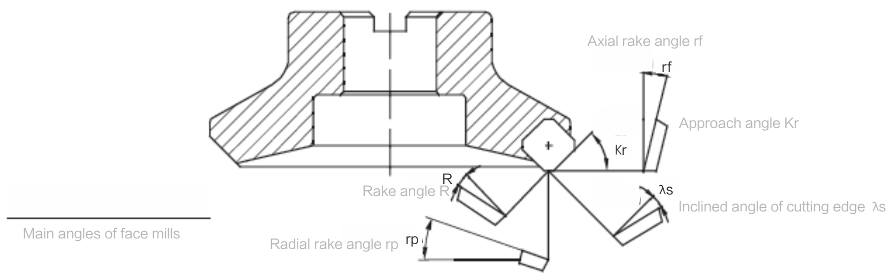


Metal removal rate

$$Q = \frac{ap \times ae \times Vf}{1000} \ (cm^3/min)$$

A B C D E/2

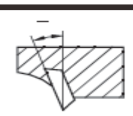
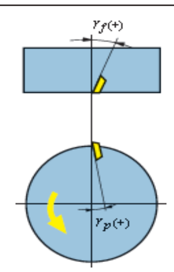
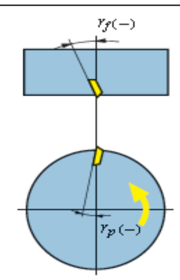
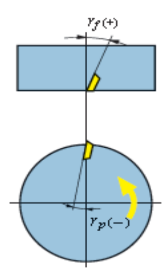
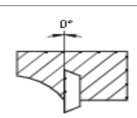
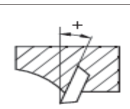
Function of Each Part in Face Milling



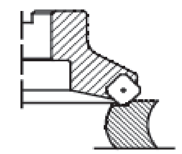
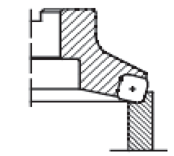
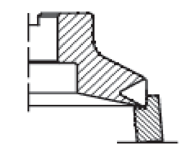
Main Angles of Face Mill

Designation	Function	Effect		
Axial rake angle r_f	Determining the chip direction	Negative, excellent capability of chip removal		
Radial rake angle r_p	Determining whether the cutting is easy and fast or not	Positive angle: good cutting performance		
Approach angle K_r	Determining the chip thickness	Kr↑, chip thickness↑; Kr↓ chip thickness↓		
Rake angle R	Determining whether easy and fast the cutting is or not	Poor cutting performance, High-strength cutting edge	(−)←0→+	Good cutting performance, Low-strength cutting edge
Inclined angle of cutting edge λs	Determining the chip flow direction	Poor capability of chip removal, High-strength cutting edge	−←0→+	Good performance of chip removal, Low-strength cutting edge

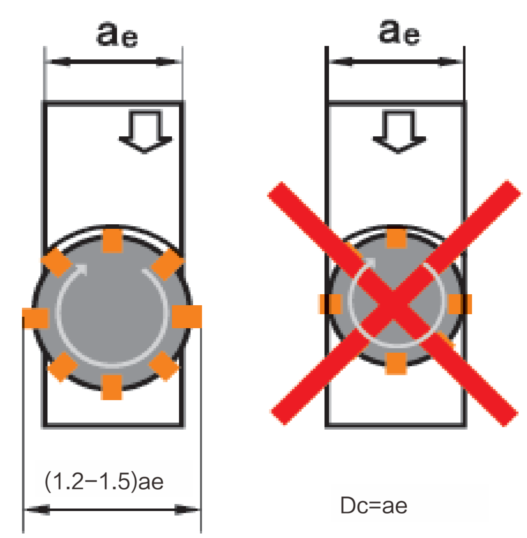
不同前角的组合特征 Characteristics of Different Rake Angles Combined

		Double posotove rake angle	Double negative Rake angle	Positive and negative negative rake angle
Negative rake angle				
0° rake angle				
Positive rake angle				
rf Axial rake angle rf		+	−	+
rp Radial rake angle rp		+	−	−
Applicable material machined	P	√		√
	M	√		√
	K		√	√
	N	√		
	S	√		√

Selection Method of Cutting Tools

主偏角 approach angle	45°	75°	90°
Schematic diagram			
Instruction	Axial force is the largest,it will bend when machining thin−wall workpiece,reducing the precision of workpiece.It can help avoid fringe brekage of workpiece when machining cast iron	The main force is radial cutting force. in is often used in general face milling	he axial is zero in theory,suitable for milling thin plate workpiece

Selection of Cutting Width and Tool Cutting Diameter in Face Milling



Tool cutting diameter
Cutting width

Generally speaking,the relation between cutting width and tool cutting diameter is Dc=(1.2−1.5)ae
in practical machining,same center line of tool center and work piece center should be avoided.

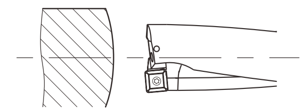
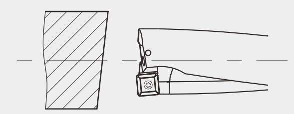
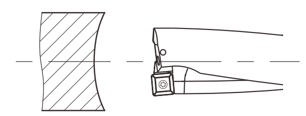
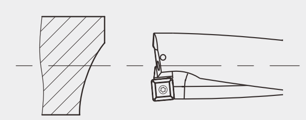
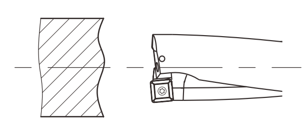
E-3 Technical Information

Drilling Tools

Drilling Application

initial Drill Peneration

Initial drill peneration is an important factor for suceessful drilling. one way of ensuring good hole quality is to make sure the peneration surface of the workpiece is vertical to the drill centre axis.
In addtion, an indexable drill can carry our inital peneration of convex, concave, inclined and irregular surfaces by adjusting rates.

workpiece surface	countermeasures
	For a convex surface, the conditions are relatively good and the centre of the drill ideally makes contact with the workpiece first, thus normal feed can be adopted.
	When penerating an inclined surface, the cutting edges will be unevenlly loaded, which may result in the premature drill abrasion. if the angle of the inclined surface is larger than 2° , the feed should be reduced to 1/3 of the value recommended for the drill.
	When drilling into non-sysmmetric curved surface, the drill tends to deviate from the centre because it is penetrating an inclined surface. the feed should be reduced to lower than the value recommended for the initial peneration of concave surface.
	When drilling into irregular surface, the insert faces the risk of chipping, which may also occur when drilling through the workpiece.therefore, the feed rate should be reduced.reduced to lower than the value recommended for the initial peneration of concave surface.
	When drilling into irregular surface, the insert faces the risk of chipping, which may also occur when drilling through the workpiece. therefore, the feed rate should be reduced

Calculations for Shallow Drilling

Cutting Speed

$Vc = \dfrac{Dc \times \pi \times n}{1000}$	Vc(m/min):cutting speed Dc(mm):drill diameter n(rev/min):rotating speed

实例：

Spindle speed is 1600rev/min, drill diameter is 20mm, thus cutting speed is:

$$Vc = \frac{Dc \times \pi \times n}{1000} = \frac{20 \times 3.14 \times 1600}{1000} = 100\ (m/min)$$

Machining Time

$Vc = \dfrac{Dc \times \pi \times n}{1000}$	Tc(min):machining time fr(mm/rev)feed rate per revolution i:umber of holes Id(mm):drilling depth n(rev/min):spindle speed

实例：

Drilling a hole with a diameter of 20mm and a depth of 40mm,cutting speed is 100m/min and feed rate per revolution is 0.1mm/rev.Calculate the drilling time.

$$n = \frac{Vc \times 1000}{Dc \times \pi} = \frac{100 \times 1000}{20 \times 3.14} = 1600\ (rev/min)$$

$$Tc = \frac{Id \times i}{n \times fr} = \frac{40 \times 1}{1600 \times 0.1} = 0.25\ (min)$$

Feed Speed

$V_f = fr \times n (mm/min)$	Vf(mm/min):feed speed fr(mm/rev):feed rate per revolution n(rev/min):spindle speed

实例：

Example:spindle speed is 1500 rev/min, feed rate per revolution is 0.1 mm/rev, thus feed speed is:

$$V_f = fr \times n = 0.1 \times 1500 = 150\ (mm/min)$$

Metal Removal Rate

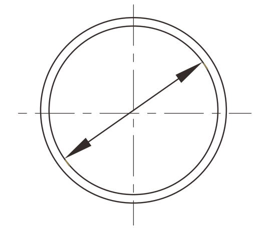
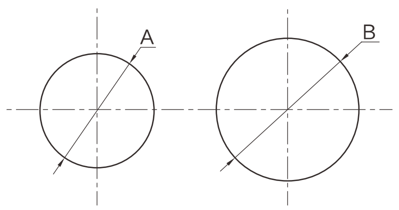
$Q = \dfrac{V_f \times \pi \times Dc^2}{4 \times 1000}$	Q(cm³/min):metal removal rate Dc(mm):drill diameter Vf(mm/min):feed speed

实例：

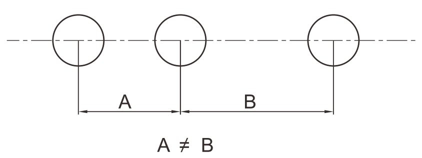
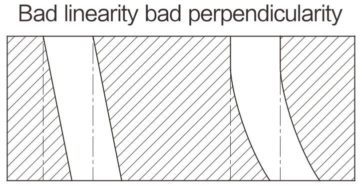
Example:drill diameter is 20mm, feed speed is 160mm/rev, thus metal removal rate is:

$$Q = \frac{V_f \times \pi \times Dc^2}{4 \times 1000} = \frac{160 \times 3.14 \times 20^2}{4 \times 1000} = 50.24\ (cm^3/min)$$

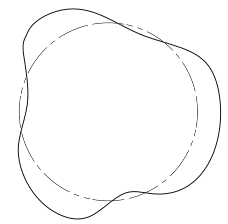
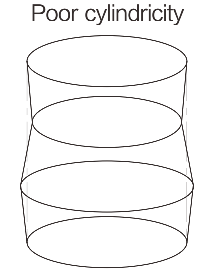
Common Problems and Solutions for Drilling

Problem	Cause	Solution
Oversize holes 	Poor clamping Large run−out around spindle	Select the holder and chuch with high Precisioncalibrating spindle Check and adjust after clamping drill
	Non−symmetric point angle Large run−out Chisel edge is off center	Regrind drill Check the precision after clamping drill
Irregular hole size 	Non−symmetric point angle Large run−out Chisel edge is off center Excessive margin abrasion	Select the holder and chuch with high Precision Calibrating spindle Check and adjust after clamping drill
	Poor clamping Large run−out around spindle Workpiece is not firmly held	Select the holder and chuch with high Precision Calibrating spindle Check and adjust after clamping drill
	Feed rate is too high	Reduce the feed speed
	Coolant provide is not enough	Change the coolant supply method, Or increase coolant volume

Common Problems and Solutions for Drilling

Problem	Cause	Solution
Low position accuracy 	Poor re-positioning of spindle Poor clamping Large run-out around spindle	Improve the re-positioning precision of Machineselect the holder and chuch With high precision Calibrating spindle Check and adjust after clamping drill
	The feed direction is not Vertical to the workpiece Surface	Adjust the feed direction vertical to The workpiece
	Top center not align with the Spindle center	Check and adjust alignment carefully Before drilling
Bad linearity bad perpendicularity  bad linearity bad perpendicularity	Excessive margin abrasion	Regrind
	Poor center hole accuracy	Increase the position accuracy of hole
	Non-symmetric point angle Large run-out Chisel edge is off center	Regrind drill Chech the precision after regrinding
	Insufficient drill rigidity	Increase drill rigidity
	Uneven workpiece rigidity Top center not align with the Spindle center (lathe)	The workpiece must be horizontal or Premachined to horizontal before drilling Pre-drill a center hole

Common Problems and Solutions for Drilling

Problem	Cause	Solution
Poor roundness 	Non-symmetric point angle Large run-out Chisel edge is off center	Regrind drill Chech the precision after regrinding
	Poor clamping Large run-out around spindle Workpiece is not firmly held	Select the holder and chuch with high Precisioncalibrating spindle check run Out and adjust after clamping drill
	Clearance angle is too large	Regrind drill
	Insufficient drill rigidity	Increase drill rigidity
Poor workpiece surface quality	Incorrect regriding	Regrind calibration
	Insufficient coolant or Unsuitable coolant type	Change the coolant supply method, Or increase coolant volume
	Poor clamping Large run-out around spindle	Select the holder and chuch with high Precisioncalibrating spindle
	Feed rate is too high	Decrease the feed rate
	Excessive abrasion on Cuttingedge Excessive build-up on margin	Regrind drill Select a coated drill
	Chip jamming	Select a suitable drill(considering flute Geometry, helical angle etc)change the Cutting method (adjust feed rate, use Step feed etc.)
Poor cylindricity 	Non-symmetric point angle Large run-out Chisel edge is off center Excessive margin abrasion	Regrind drill Chech the precision after regrinding
	Feed rate is too low	Increase the feed speed

Shallow Drilling Recommend Cutting Parameter Chat

ISO	Material	HB	mm	mm/r	m/min
P	Carbon steel	80–200	16.0–23.0 24.0–30.0 31.0–38.0 39.0–46.0 47.0–58.0	0.05–0.09 0.05–0.09 0.06–0.10 0.07–0.11 0.08–0.12	200(170–240)
	Low alloy steel	150–260	16.0–23.0 24.0–30.0 31.0–38.0 39.0–46.0 47.0–58.0	0.05–0.09 0.05–0.12 0.06–0.14 0.08–0.16 0.10–0.20	170(140–220)
	High alloy steel	150–320	16.0–23.0 24.0–30.0 31.0–38.0 39.0–46.0 47.0–58.0	0.05–0.09 0.05–0.12 0.06–0.16 0.08–0.18 0.10–0.22	150(120–180)
	Cast steel	180–250	16.0–23.0 24.0–30.0 31.0–38.0 39.0–46.0 47.0–58.0	0.05–0.08 0.05–0.08 0.06–0.10 0.07–0.11 0.07–0.12	140(120–170)
M	Stainless steel Ferritic stainless steel Martensitic stainless steel	150–270	16.0–23.0 24.0–30.0 31.0–38.0 39.0–46.0 47.0–58.0	0.05–0.09 0.05–0.12 0.06–0.16 0.08–0.18 0.10–0.22	160(110–230)
	Austenitic stainless steel	150–275	16.0–23.0 24.0–30.0 31.0–38.0 39.0–46.0 47.0–58.0	0.05–0.09 0.05–0.11 0.06–0.13 0.08–0.14 0.10–0.16	140(110–220)
K	Malleable cast iron	150–230	16.0–23.0 24.0–30.0 31.0–38.0 39.0–46.0 47.0–58.0	0.05–0.10 0.05–0.14 0.08–0.16 0.10–0.20 0.12–0.24	160(120–220)
	Grey cast iron	150–220	16.0–23.0 24.0–30.0 31.0–38.0 39.0–46.0 47.0–58.0	0.05–0.10 0.05–0.14 0.08–0.16 0.10–0.20 0.12–0.24	200(170–240)
	Nodular cast iron	160–250	16.0–23.0 24.0–30.0 31.0–38.0 39.0–46.0 47.0–58.0	0.05–0.09 0.05–0.12 0.06–0.14 0.08–0.16 0.10–0.20	160(130–200)
N	Aluminium alloy	60–110	16.0–23.0 24.0–30.0 31.0–38.0 39.0–46.0 47.0–58.0	0.05–0.10 0.05–0.14 0.08–0.16 0.10–0.20 0.12–0.24	300(250–350)

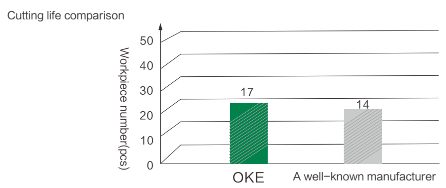
E-4 Technical Information

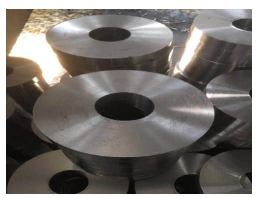
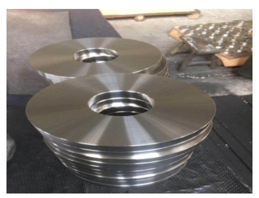
Application Cases

Stainless Steel Cutting Application Cases


Stainless steel flange

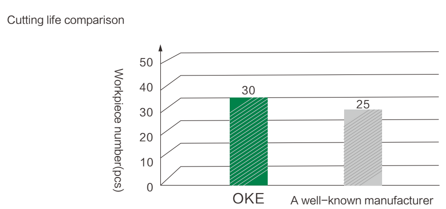
Customer: XX Company
Workpiece: Stainless steel flange(no hole)
Workpiece material: 304L
Lathe type: CSK50A
OKE insert: CNMG120412-MF/OP1215
Compare insert: A well-known manufacturer
Cooling type: Fluid cooling
Processing content: End face rough turning
Cutting parameter: Vc= 180 m/min，Fn= 0.28 mm/r，Ap= 2.2 mm



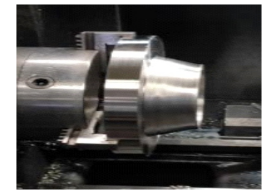



Stainless steel flange

Customer: XX Company
Workpiece: Flange
Workpiece material: SUS304
Lathe type: HTC1635i
OKE insert: WNMG060412-MSF/OP1315
Compare insert: A well-known manufacturer
Cooling type: Fluid cooling
Processing content: End face fine finishing
Cutting parameter: Vc= 200 m/min，Fn= 0.28 mm/r，Ap= 0.6 mm

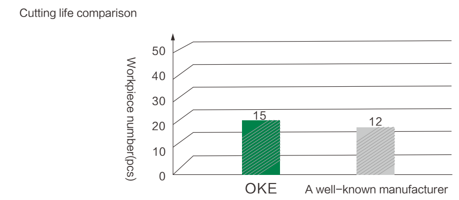


Stainless Steel Cutting Application Cases



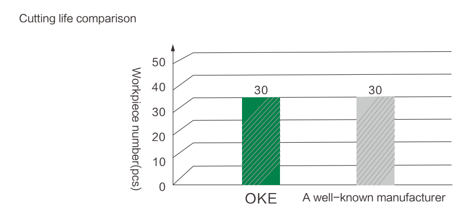

Stainless steel flange

Customer: XX Company
Workpiece: Hubbed flange
Workpiece material: SUS304L
Lathe type: HTC1635i
OKE insert: WNMG060412-OMM/OP1215
Compare insert: A well-known manufacturer
Cooling type: Fluid cooling
Processing content: Taper、end face(semi-finishing)
Cutting parameter: Vc= 160 m/min，Fn= 0.18 mm/r，Ap= 1.5 mm

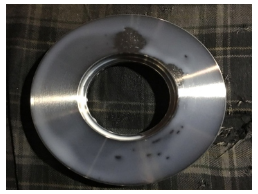


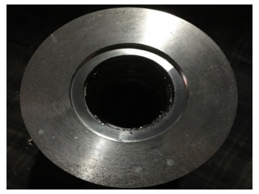

Stainless steel flange

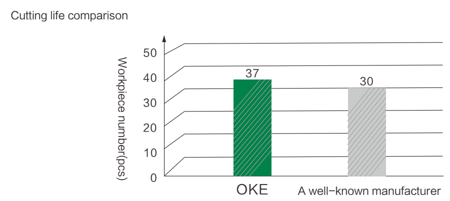
Customer: XX Company
Workpiece: Flange
Workpiece material: 45#Forge piece
Lathe type: CNC lathe
OKE insert: WNMG080412-OMM/OP1215
Compare insert: A well-known manufacturer
Cooling type: No
Processing content: End face turning
Cutting parameter: Vc= 258 m/min， Fn= 0.2 mm/r，Ap= 1.25 mm



Stainless Steel Cutting Application Cases



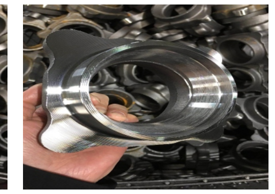


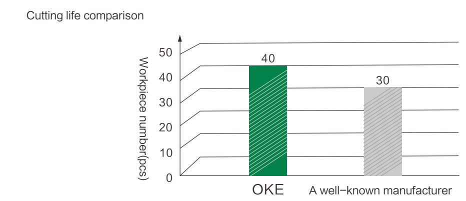


Stainless steel flange

Customer:	XX Company
Workpiece:	Flange
Workpiece material:	SUS316
Lathe type:	CNC lathe
OKE insert:	WNMG060412-MF/OC4315
Compare insert:	A well-known manufacturer
Cooling type:	Cooling liquid
Processing content:	End face rough turning, remove black skin
Cutting parameter:	Vc= 200 m/min，Fn= 0.28-0.33 mm/r，Ap= 0.2-0.8 mm

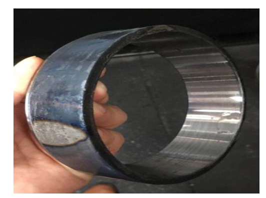
Steel Cutting Application Cases

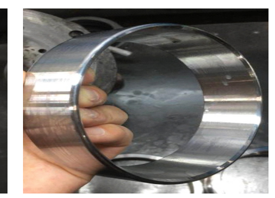


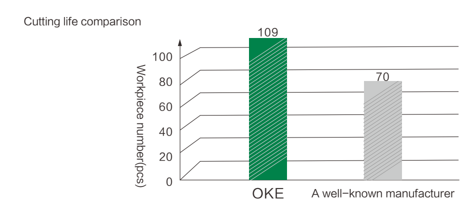


Steel

Customer:	XX Company
Workpiece:	Hub Bearing Unit(outer ring)
Workpiece material:	55# forge steel
Lathe type:	CY-K800H
OKE insert:	WNMG080412-OPM/OC2125
Compare insert:	A well-known manufacturer
Cooling type:	No
Processing content:	End face and external rough turning
Cutting parameter:	Vc=260 m/min， Fn= 0.28 mm/r，Ap= 1.3 mm



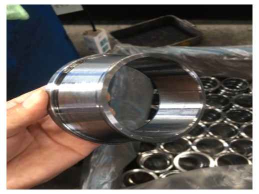




Steel

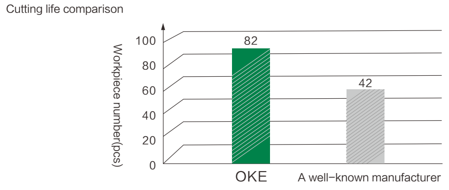
Customer:	XX Company
Workpiece:	Bearing outer ring
Workpiece material:	Gcr15
Lathe type:	SK50P
OKE insert:	WNMG080412-Z/OC2325
Compare insert:	A well-known manufacturer
Cooling type:	Fluid cooling
Processing content:	External semi-finishing turning
Cutting parameter:	Vc= 393 m/min， Fn= 0.176 mm/r，Ap= 1.0 mm

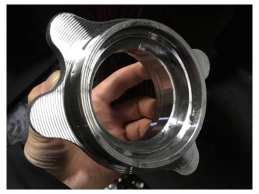
Steel Cutting Application Cases

Steel

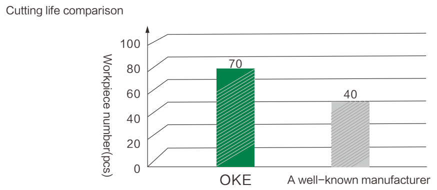
Customer: XX Company
Workpiece: Bearing outer ring
Workpiece material: Gcr15
Lathe type: SK50P
OKE insert: WNMG080408-Z/OC2325
Compare insert: A well-known manufacturer
Cooling type: Fluid cooling
Processing content: External finishing turning
Cutting parameter: Vc= 340 m/min, Fn= 0.18 mm/r, Ap= 0.5 mm



Steel

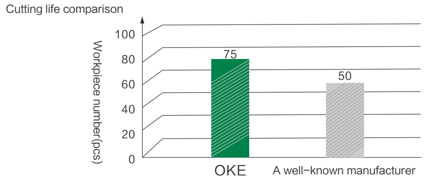
Customer: XX Company
Workpiece: Outer bearing
Workpiece material: 65# forge steel
Lathe type: Horizontal CNC lathe
OKE insert: WNMG080412-OPM/OC2125
Compare insert: A well-known manufacturer
Cooling type: No
Processing content: End face、and external
Cutting parameter: Vc= 160-220 m/min, Fn= 0.2-0.28 mm/r, Ap= 1.0 mm

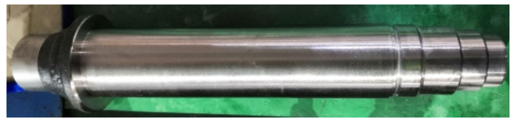
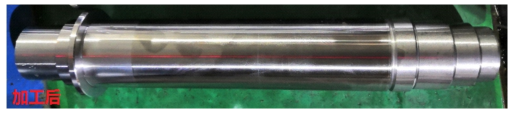


Steel Cutting Application Cases

Steel

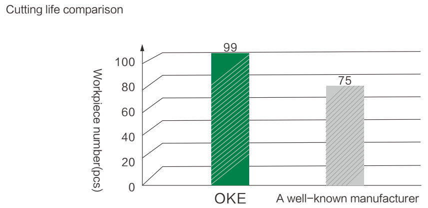
Customer: XX Company
Workpiece: Cross bearing
Workpiece material: 55# forge steel
Lathe type: Horizontal CNC lathe
OKE insert: WNMG080408-OPM/OC2125
Compare insert: A well-known manufacturer
Cooling type: Emulsion fluid cooling
Processing content: End face、external
Cutting parameter: Vc= 79 m/min, Fn= 0.4 mm/r, Ap= 1.25 mm



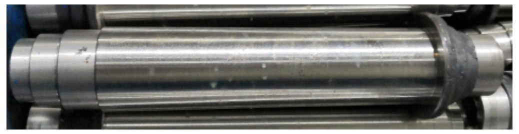
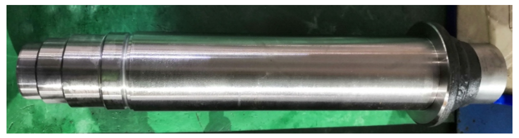



Steel

Customer: XX Company
Workpiece: Spindle
Workpiece material: 20CrMoH
Lathe type: Horizontal CNC lathe
OKE insert: TNMG160408-OPR/OC2115
Compare insert: A well-known manufacturer
Cooling type: No
Processing content: External roughing turning
Cutting parameter: Vc= 138-218 m/min, Fn= 0.24-0.36 mm/r, Ap= 1 mm

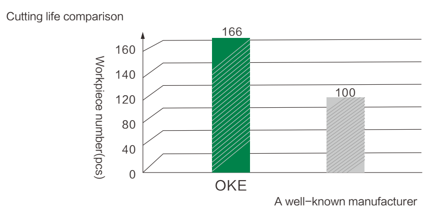


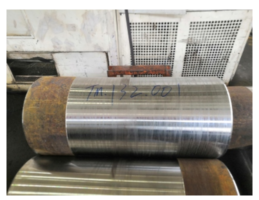
Steel Cutting Application Cases

Steel

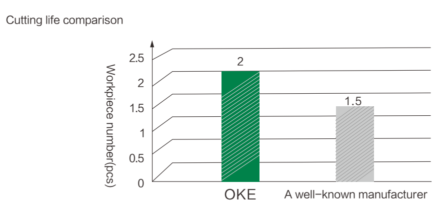
Customer: XX Company
Workpiece: Spindle
Workpiece material: 20CrMoH
Lathe type: Horizontal CNC lathe
OKE insert: VNMG160404-OPF/OC2115
Compare insert: A well-known manufacturer
Cooling type: No
Processing content: External roughing turning
Cutting parameter: Vc= 132-181 m/min, Fn= 0.12-0.24 mm/r, Ap= 0.5 mm



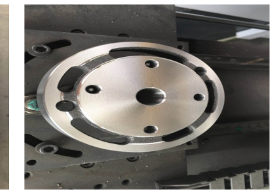



Steel

Customer: XX Company
Workpiece: The outer cylinder
Workpiece material: 30CrMnSi
Lathe type: Horizontal CNC lathe
OKE insert: CNMG160608-OPM/OC2125
Compare insert: A well-known manufacturer
Cooling type: No
Processing content: External roughing turning
Cutting parameter: Vc= 138 m/min, Fn= 0.4 mm/r, Ap= 3 mm

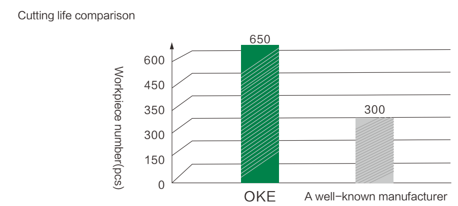


Cast iron Cutting Application Cases

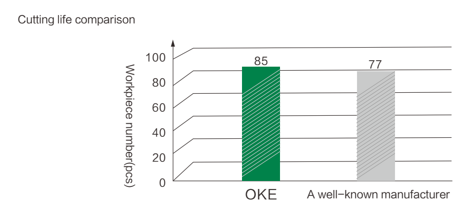
Cast iron

Customer: XX Company
Workpiece: Air Compressor Flange
Workpiece material: HT250
Lathe type: SK50P
OKE insert: WNMG080412/OC3215
Compare insert: A well-known manufacturer
Cooling type: No
Processing content: External and end face roughing turning
Cutting parameter: Vc= 550 m/min, Fn= 0.35 mm/r, Ap= 1.2 mm

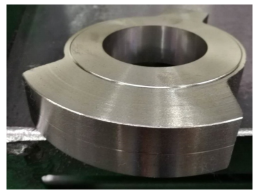


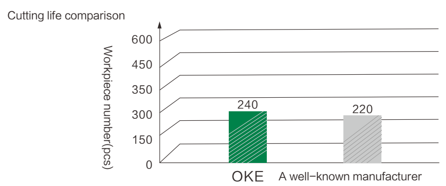

Cast iron

Customer: XX Company
Workpiece: Brake disc
Workpiece material: G3000
Lathe type: i5T3
OKE insert: TNMG220416-GH/OC3215
Compare insert: A well-known manufacturer
Cooling type: No
Processing content: End face semi-finishing turning
Cutting parameter: Vc= 706 m/min, Fn= 0.32 mm/r, Ap= 1.0 mm



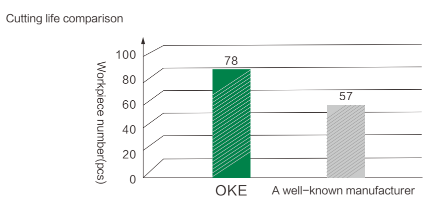
Cast iron Cutting Application Cases



Cast iron

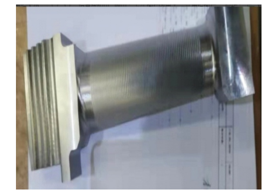
Customer:	XX Company
Workpiece:	Air compressor flange
Workpiece material:	HT250
Lathe type:	Horizontal CNC lathe
OKE insert:	WNMG080412/OC3215
Compare insert:	A well-known manufacturer
Cooling type:	No
Processing content:	External and end face turning
Cutting parameter:	Vc= 356 m/min， Fn= 0.28 mm/r，Ap= 1 mm

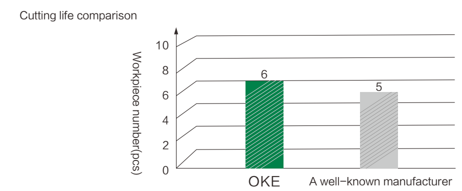



Cast iron

Customer:	XX Company
Workpiece:	Brake drum
Workpiece material:	HT250
Lathe type:	Horizontal CNC lathe
OKE insert:	WNMG080408/OC3215
Compare insert:	A well-known manufacturer
Cooling type:	No
Processing content:	Endface and external rough turning
Cutting parameter:	Vc= 230–290 m/min， Fn= 0.3–0.45 mm/r，Ap= 2–3 mm

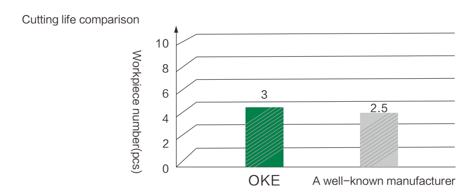
Milling Application Cases



Milling

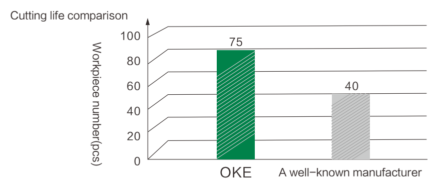
Customer:	XX Company
Workpiece:	Trubine blade
Workpiece material:	22Cr12NiWMoV–5
Lathe type:	HSTM–500–HD
OKE insert:	APKT170516R–QG/OP1312
Compare insert:	A well-known manufacturer
Cooling type:	Fluid cooling
Processing content:	Profile Milling
Cutting parameter:	Vc= 241 m/min， Vf= 3500 mm/min， Ap= 1.2 mm，Ae= 16 mm

Milling

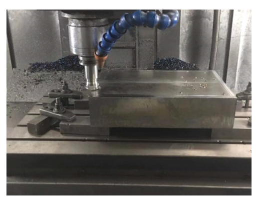
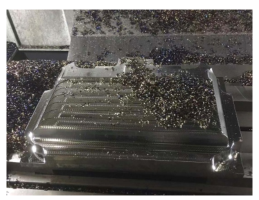
Customer:	XX Company
Workpiece:	Gimbal Joint
Workpiece material:	30CrMnSiNi2A
Lathe type:	VI850
OKE insert:	APMT1135PDER–M2/OP1130
Compare insert:	A well-known manufacturer
Cooling type:	Fluid cooling
Processing content:	Finishing face milling and profile milling
Cutting parameter:	Vc= 120 m/min， Vf= 3500 mm/min， Ap= 0.18 mm，Ae= 2 mm

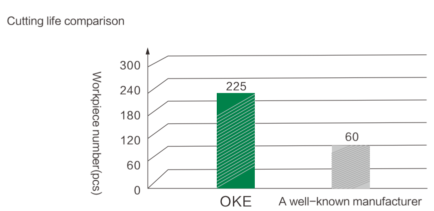
Milling Application Cases

Milling

Customer:	XX Company
Workpiece:	Side panel mold
Workpiece material:	45#
Lathe type:	CNC gantry milling
OKE insert:	APMT1604PDER-H2L/OP1215
Compare insert:	A well-known manufacturer
Cooling type:	Comressed air
Processing content:	U-groove, square groove machining, parting
Cutting parameter:	Vc= 94 m/min, Fn= 1.04 mm/r, Ap= 0.3-0.35 mm

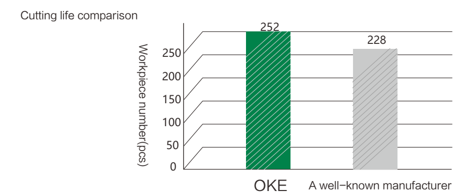





Milling

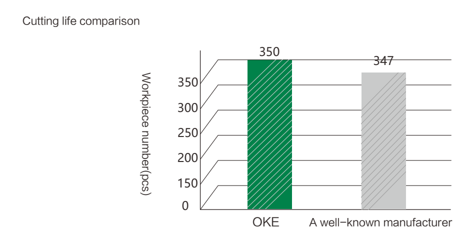
Customer:	XX Company
Workpiece:	Side panel mold
Workpiece material:	45#
Lathe type:	CNC gantry milling
OKE insert:	RPMT1204MO-JSL/OP1315
Compare insert:	A well-known manufacturer
Cooling type:	Comressed air
Processing content:	U-groove, square groove machining, parting
Cutting parameter:	Vc= 138 m/min, Fn= 0.96 mm/r, Ap= 0.45 mm

Threading Application Cases

Thread

Customer:	XX Company
Workpiece:	Joint
Processing industry:	Valve
Workpiece material:	SUS201
Lathe type:	Wenzhou Eastsea CNC
OKE insert:	RT1601L-11WA/OP1205
Compare insert:	A well-known manufacturer
Processing content:	Internal threading turning
criterion of changing tool:	Insert wear
Cutting fluid:	Yes
Cutting parameter:	Vc=75-83m/min Fn=2.309mm/r

Thread

Customer:	XX Company
Workpiece:	Elbow
Machining Industry:	Valve
Workpiece material:	304
Lathe type:	KND
OKE insert:	RT1601L-14WA/OP1205
Compare insert:	A well-known manufacturer
Processing content:	Internal threading turning
criterion of changing tool:	Insert wear
Cutting fluid:	Yes
Cutting parameter:	Vc=58~65m/min Fn=1.814mm/r

E-5 Technical Information

General Technical Reference

Selection Method of Cutting Tool

Selection Method of General Turning Tools:

1.Understand the processed material condition,Machine Model and condition.
2.Select the suitable insert shape,setting angle and clamoin designation.
3.According to above conditions select details of tools as L/R.demension,etc.
4.Select the type,chip break and grade of insert according to all conditions.

Selection Method of Parting and Grooving tools:

1.Understand the processed material condition,Machine Model and condition.
2.Select the insert type according to processing methods(external,internal,face grooving)
3.According to above conditions select details of tools as L/R，demensions,etc.
4.Select the type,clamping designation,chip break and grade of insert according to all conditions

Selection Method of Threading Tools:

1.Understand the processed material condition,Machine Model and condition.
2.Select the tool type according to thread's type,processing methods,etc.
3.According to above conditions select details of cutting tools as L/R,demension,etc.
4.Select the type,chip break and grade of Insert according to all condition

Selection Method of Cutting Tool

Selection Method of Milling Tool Specifications:

1. The first step is to understand the material condition, machine type and state you need to process.
2. Determine the basic type of milling tool according to the processing method(plane milling, Square shoulder milling, imitation milling, milling slot, corner milling, etc.).
3. According to the machining precision and the shape and size of the machining surface and other factors to determine the use of the overall milling cutter or transposable milling cutter.
4. According to the above factors and your machine model to determine the interface, dimensions and other details of the tool.
5. Finally determine the blade specification, groove type, and brand number corresponding to the above factors.

Selection Method for Hole Processing Tool Specifications:

1. Understand the material condition, machine type and state you need to process.
2. Determine the basic types of hole cutting tools(drilling, boring, hinge, thread processing, etc.) according to the processing process.
3. According to the machining accuracy and the dimension of the machining hole, it is determined that the whole tool or the fork-turning tool is used.
4. According to the above factors and your machine model to determine the interface, dimensions and other details of the tool.
5. Finally determine the insert specification, groove type, and brand number corresponding to the above factors.

The Correction Coefficient Table Of Hardness and Cutting Speed

Material		Theoretical Hardness	The Correction Coefficient Table Of Hardness and Cutting Speed								
			Hardness Decrease ← Hardness Difference(Measured Difference − Theoretical Difference) → Hardness Increase								
			−60	−40	−20	0	20	40	60	80	100
P		HB180	1.42	1.24	1.11	1.00	0.91	0.84	0.77	0.72	0.67
M		HB180	1.44	1.25	1.11	1.00	0.91	0.84	0.78	0.73	0.68
K	Grey Cast Iron	HB220	1.21	1.13	1.06	1.00	0.95	0.9	0.86	0.82	0.79
K	Nodular Cast Iron	HB250	1.33	1.21	1.09	1.00	0.91	0.84	0.75	0.7	0.65
N		HB75			1.05	1.00	0.95				
S		HB350			1.12	1.00	0.89				
HRC				−6	−3	0.00	3	6	9		
H		HRC60		1.10	1.02	1.00	0.96	0.93	0.9		

Actual Processing Speed=Recommended Processing Speed*Correction Factor Of Cutting Speed

Recommended Cutting Parameters See Packaging

i.e. Cutting general alloy steel, hardness HB180, CNMG120404-OPF/OC2015, the recommended cutting speed is V=250m/min. When measured hardness is HB220, the hardness difference is 40(220-180). Find The corresponding speed correction coefficient is 0.84 on above table, and then the actual processing speed Vc=250*0.84=210mm/min

The Correction Coefficient Table Of Insert Life and Cutting Speed

Insert Life / Insert Material	The Correction Coefficient Table Of Insert Life and Cutting Speed					
	10	15	30	45	60	90
OC2015	1.12	1.00	0.82	0.73	0.67	0.6
OC2025	1.11	1.00	0.84	0.76	0.71	0.64
OC2035	1.11	1.00	0.84	0.76	0.70	0.63
OC2115	1.25	1.00	0.68	0.54	0.46	0.37
OC2125	1.55	1.00	0.47	0.30	0.22	0.14
OP1205	1.15	1.00	0.82	0.74	0.69	0.64
OP1215	1.10	1.00	0.85	0.72	0.65	0.62
OP1030	1.10	1.00	0.85	0.72	0.65	0.62
OC4025	1.19	1.00	0.75	0.63	0.56	0.47
OC4315	1.22	1.00	0.73	0.61	0.54	0.45
OC3105	1.11	1.00	0.70	0.60	0.50	0.40
OC3215	1.22	1.00	0.80	0.65	0.60	0.55
OC3115D	1.25	1.00	0.72	0.63	0.52	0.41
OP2202	1.20	1.00	0.84	0.70	0.63	0.59
Actual Processing Speed=Recommended Processing Speed*Correction Factor Of Cutting Speed						

i.e. Cutting general alloy steel, CNMG120404−OPF/OC2015, the recommended cutting speed is V=250m/min (the standard life is 15 min). If the insert life of 60 mins is expected, find the speed correction coefficient is 0.67 on above table, and then the actual processing speed is Vc=250*0.67=167.5m/min.

Comparison Table for Turning Insert Chipbreaker

Negative Inserts

ISO	Processing Category	OKE	TaeguTec	KENNAMETAL	HITACHI	ZCCCT	SANDVIK	TUNGALOY	KYOCERA	KORLOY	SUMITOMO	MITSUBISHI
P	Superfinishing	R/L−F	FA	FF	FE		QF,LC	01、F	DP,GP,PP, VF,XP, XP−T,XF	VL	FA,FB, FL	PK,FH,FP, FY ,FS
P	Finishing	OPF 53 Z	FG,FA	FN	BE，B, CE，BH	DF	XF,PF,	TS,TSF,ZF, 11,NS,AS, TQ,NM,CS	DP,GP,PP	VF,VB	SU，LU, FE	LP,C, SA, SH
P	Finishing(Soft Steel)	OPF	FC	FN		SF		17,TS,NS,CB 11，27，ZF	XQ,XS	VL	FL	SY
P	Finishing(Wiper)		WS	FW		WGF	WL,WF	AFW,FW, ASW,SW	WF,WP	HW	LUW,SEW	SW
P	Semifinishing	OPM KPM	MP,MC, PC,MT	MN	CT,AB, AH,AY,AE	DM,PM	PM,QM, XM	TM,AM,DM, ZM,TA	PG,GS,PS	VM,MP	GU（UG）, UX, GE	MP,MA
P	Light Roughing	OPR	RT,通槽	RN,RP	RE，Y	DR LR	PR,HM XMR	TH,THS	PH	B25,HR, GR	MU，MX, UX	GH,RP, 通槽
P	Roughing	OPR OPH	RX,RH,HD, HT,HY,HZ	MR，RN, RP	TE,UE,HX, HE,H	DR HDR	QR,MR PR,HR	TI,TRS, TUS	PX	GH,VH, VT	HG,HP,HU, HW,HF	HZ，HL,HM, HX,HR,HV

Comparison Table for Turning Insert Chipbreaker

Negative Inserts

ISO	Processing Category	OKE	TaeguTec	KENNAMETAL	HITACHI	ZCCCT	SANDVIK	TUNGALOY	KYOCERA	KORLOY	SUMITOMO	MITSUBISHI
M	Finishing	OMF MSF	EA,SF	FP,FF	MP,AB,BH	EF	MF	SF,SA,SS	MQ,SQ	VP2,MP	SU,EF	SH,LM
	Semifinishing	OMM MF	ET,EM	MP,UP	PV,DE, SE,AH	EM	MM,QM, XM,K	SM,S,TA	MU,MS, TK,SX	HS,MM	EX,EG,GU	MS,GM, MM,MA,ES
	Roughing	OMR		MR,RP,P	AE	ER	MR	TH,SH,TU		GA,RM	HM,EM,MU	GH，HZ, RM,HL,HZ
K	Finishing	OKM	MT	FN	VA,AH	PM	KF	CF,TA		MP	UZ	LK,MA
	Semifinishing	TK,OKM Without chipbreaker	MG,RT	RP,UN	V,AE	PM	KM	CM	KQ,KG, C,	B25,MK	GZ(UX)	MK,GK,
	Roughing	OPR,平板	KT,RT	平板	RE	平板	KR,KRR	CH,平板	KH,GC,ZS	MA,RK		PK，平板
S	Finishing	OSF	EA,SF	FS			SF	HRF	MQ	VP2	EF	FJ
	Semifinishing	OSM	ML,MP, SU,MK	NG,UP,MS		VI	NGP,SM	HRM, HMM,SA	SQ,MS, MU,TK	VP3	EG,EX	MS
	Roughing	OSM		RP			SR,SMR		SG,SX	VP4	MU,EM	RS,GJ

Comparison Table for Turning Insert Chipbreaker

Positive Inserts

ISO	Processing Category	OKE	TaeguTec	KENNAMETAL	HITACHI	ZCCCT	SANDVIK	TUNGALOY	KYOCERA	KORLOY	SUMITOMO	MITSUBISHI
P	Finishing	OTF	FA,SA,FG	LF,FP	JQ	SF,HF	PF,UF,XF	01,PF FS,JS	PF,DP,GP, PP,VF	VL,VF	FC,FB, LU(FP,FK)	FP,FV, LP,SV
	Finishing(Wiper)		WS	FW			WF		WP		LUW,SDW	SW
	Semifinishing	OTM	PC,MT, PMR	MF,MP	JE	HM	XM,PM, UM,PR,XR	PM,PS,PF PSF,PSS 23,24	HQ,GK,	HMP,MP	MU	MV,MP, 全周
	Semifinishing(Wiper)	OTR	WT	MW			WM,PR, UR,KM					MW
M	Finishing	MSF,OTF		FP,FF	MP	EF	MF	SS&	CF,CK,GQ, GF,MQ,SK	VP1	FC	FM,LM
	Semifinishing	OTM		MP,UP		EM	MM	PM	HQ,GK	VL	MU	MM，通槽
K	Semifinishing	OTM		MW,平板		HR,HM，平板	KM,KR,KF	CM CM Without chipbreaker	平板	MP	MU	MK,通槽，平板
S	Finishing	OSM		GT-LF,R.GV, GT-HP		NF,NSF	SF,01		MQ	VP1	SI	FS,LS, FS-P, LS-P,FJ, LS,MS
	Semifinishing			MT-LF,R.GV-T, MT-FP			MM,QM, SMR			VL		
N	General cutting	NL,AK	FL	GT-HP,GT-LF, GW-F,GW-E		LH	AL	PP,AL	AH	AK,AR	AG,AW,AY	AZ

Material Comparison

Steel

	Nations And Standard										
ISO	China	Germany		USA	UK		Italy	Spain	Sweden	France	Japan
	GB（P类）	W-nr	DIN	AISI/SAE	BS	EN	UNI	UNE	SS	AFNOR	JIS
Carbon Steel	15	1.0401	C15	1015	080M15		C15C16	F.111	1350	CC12	
	20	1.0402	C22	1020	050A20	2C	C20C21	F.112	1450	CC20	
	35	1.0501	C35	1035	060A35		C35	F.113	1550	CC35	
	45	1.0503	C45	1045	080M40		C45	F.114	1650	CC45	
	55	1.0535	C55	1055	070M55		C55		1655		
	60	1.0601	C60	1060	080A62	43D	C60			CC55	
	Y15	1.7015	9SMN28	1213	230M07		CF9SMn28	11SMn28	1912	S250	SUM22
Manganese Steel	40Mn	1.1157	40Mn4	1039	150M36	15				35M5	
	25	1.1158	Ck25	1025							S25C
	35Mn2	1.1167	36Mn5	1335				36Mn5	2120	40Mn5	SMn438(H)
	30Mn	1.117	28Mn6	1330	150M28	14A	C28Mn			20M5	SCMn1
	35Mn	1.1183	Cf35	1035	060A35		C36		1572	XS38TS	S35C
		1.0718	9SMnPb28	12L13			CF9MnPb28	11SMnPb28	1914	S250Pb	SUM22L
		1.0722	10SPb20				CF10Pb20	10SPb		10PbF2	
		1.0726	35S20	1140	212M36	8M		F210G	1957	35MF4	
	Y13	1.0736	9SMn36	1215	240M07	1B	CF9SMn36	12SMn35		S300	
		1.0737	9SMnPb36	12L14			CF9SMnPb36	12SMnPb35	1926	S300Pb	
	55Si2Mn	1.0904	55Si9	9255	250A53	45	55Si8	56Si7	2085	55S7	
		1.0961	60SiCr7	9262			60SiCr8	60SiCr8		60SC7	
	15	1.1141	Ck15	1015	080M15	32C	C16	C15K	1370	XC12	S15C
	Ck45	1.1191	45	1045	080M46		C45	C45K	1672	XC42	S45C
	55	1.1203	Ck55	1055	070M55		C50	C55K		XC45	S55C
	50	1.1213	Cf53	1050	060A52		C53		1674	XC48TS	S50C
	60Mn	1.1221	Ck60	1060	080A62	43D	C60		1678	XC60	S68C
		1.1274	Ck101	1095	060A96				1870		SUP4
		1.3401	X120Mn12		Z120M12		XG120Mn12	X120Mn12		X120M12	SCMnH/1
	Gr15,45Gr	1.3505	100Cr6	52100	534A99	31	100Cr6	F.131	2258	100C6	SUJ2
		1.5415	15Mo3	ASTMA204Gr,A	1501-240		16Mo3KW	16Mo3	2912	15D3	
		1.5426	16Mo5	4520	1503-245-420		16Mo5	16Mo5			
		1.5622	14Ni6	ASTMA350LF5			14Ni6	15Ni6		16N6	
		1.5662	X8Ni9	ASTM A353	1501-509:510		X10Ni9	XBNi09			

A
B
C
D
E/5

Material Comparison

Steel

	国家和标准Nations And Standard										
ISO	China	Germany		USA	UK		Italy	Spain	Sweden	France	Japan
	GB（P类）	W-nr	DIN	AISI/SAE	BS	EN	UNI	UNE	SS	AFNOR	JIS
Nickel Chromiun Steel		1.5680	12Ni19	2515						Z18N5	
		1.5710	36NiCr6	3135	640A35	111A				35NC6	SNC236
		1.5732	14NiCr10	3415			16NiCr11	15NiCr11		14NC11	SNC415(H)
		1.5752	14NiCr14	3415，3310	655M13 655A12	36A				12NC15	SNC815(H)
Nickel Chromium Molybdenum Steel		1.6511	36CrNiMo4	9840	816M40	110	38CrNiMo4(KB)	35CrNiMo4		40NCD3	
		1.6523	21NiCrMo2	8620	850M20	362	20NiCrMo2	20NiCrMo2	2503	20NCD2	SNCCM220(H)
		1.6546	40NiCrMo2	8740	311-Type7		40NiCrMo2(KB)	40NiCrMo2			SNC240
	40CrNiMoA	1.6582	34CrNiMo6	4340	817M40	24	35CrNiMo6(KB)		2541	35NCD6	
		1.6587	17CrNiMo6		820A16			14CrNiMo13		18NCD6	
Chromium Steel	15Cr	1.7015	15Cr3	5015	523M15					12C3	SCr415(H)
	35Cr	1.7033	34Cr4	5132	530A32	18B	34Cr4(KB)	35Cr4		32C4	SCr430(H)
	40Cr	1.7035	41Cr4	5140	530M40	18	41Cr4	42Cr4		42C4	SCr440(H)
	40Cr	1.7045	42Cr4	5140				42Cr4	2245		SCr440
Manganese Chromium Steel	18CrMn	1.7131	16MnCr15	5115	527M20		16MnCr15	16MnCr15	2511	16MC5	
	20CrMn	1.7176	55Cr3	5155	527A60	48				55C3	SUP9(A)
	30CrMn	1.7218	25CrMo4	4130	1717CDS110		25CrMo4(KB)	55Cr3	2225	25CD4	SCM420；SCM430
	35CrMo	1.722	34CrMo4	4137，4135	708A37	19B	35CrMo4	34CrMo4	2234	35CD4	SCM432 SCRRM3
	40CrMoA	1.7223	41CrMo4	4140，4142	708M40	19A	41CrMo4	41CrMo4	2244	42CD4TS	SCM440
	42CrMo, 42CrMnMo	1.7225	42CrMo4	4140	708M40	19A	42CrMo4	42CrMo4	2244	42CD4	SCM440(H)
Chromium Molybdenum Steel		1.7262	15CrMo5					12CrMo4	2216	12CD4	SCM415(H)
		1.7335	13CrMo44	ASTM A182 F11 F12	1501-620Cr. 27		14CrMo44	14CrMo45		15CD3.5;15CD4.5	
		1.7361	32CrMo12		722M24	40B	32CrMo12	F.124.A	2240	30CD12	
		1.738	10CrMo910	ASTM A182 F22	1501-622Cr.31;45		12CrMo9,10	TU.H	2218	12CD9;10	
		1.7715	14MoV63		1503-660-440			13MoCrV6			
	50CrVA	1.8159	50CrV4	6150	735A50	47	50CrV4	51CrV4	2230	50CV4	SUP10
		1.8509	41CrAlMo7		905M39	41B	41CrAlMo7	41CrAlMo7	2940	40CAD6,12	
		1.8523	39CrMoV139		897M39	40C	36CrMoV12				

Material Comparison

Steel

ISO	Nations And Standard										
	GB（P类）	W-nr	DIN	AISI/SAE	BS	EN	UNI	UNE	SS	AFNOR	JIS
Steel	T10	1.1545	C105W1	W.110			C98KU C100KU	F.515 F.516	1880	Y1105	
	T12A	1.1663	C125W	W.112			C120KU	(C120)		Y2120	SK2
	CrV,9SiCr	1.2067	100Cr6	L3	BL3			100Cr6		Y100C6	
	Cr12	1.208	X210Cr12	D3	BD3		X210Cr13KU X250Cr12KU	X210Cr12		Z200Cr12	SKD1
	4Cr5MoVSi	1.2344	X40CrMoV51	H13	BH13			X40CrMoV5	2242	Z40CDV5	SKD61
	Cr6WV	1.2363	X100CrMoV51	A2	BA2		X35CrMoV05KU X40CrMoV51KU	X100CrMoV5	2260	Z100CDV5	SKD12
	CrWMo	1.2419	105WCr6				X100CrMoV51KU	105WCr5	2140	105WC13	SKS31 SKS2 SKS3
	Cr12W	1.2436	X210CrW12				10WCr6 107WCr5KU	X210CrW12	2312		SKD2
	5CrNiMo	1.2542	45WCrV7	S1	BS1		X215CrW121KU	45WCrSi8	2710		
	3Cr2W8V	1.2581	X30WCrV93 X30WCrV93KU	H21	BH21		45WCrV8KU	X30WCrV9		Z30WCV9	SKD5
	Cr12MoV	1.2601	X165CrMoV12				X28W09KU X30WCrV93KU	X160CrMoV12	2310		SKD11
	5CrNiMo	1.2731	55NiCrMoV6	L6			X165CrMoW12KU	F.250.S		55NCDV7	SKT4
	V	1.2833	100V1	W210	BW2					Y1105V	SKS43
	W6Mo5Cr4V2Co5	1.3243	S6-5-2-5					HS6-5-2-5	2723	Z85WDKCV	SKH55
	W18Cr4VCo5	1.3255	S18-1-2-5	T4	BT4		HS6-5-2-5	HS18-1-1-5		Z80WKCV 10-05-04-1	SKH3
	W6Mo5Cr4V2	1.3343	S6-5-2S	M2	BM2		X78WCo1805KU	HS6-5-2	2722	Z85WDCV 06-05-04-02	SKH9
		1.3348	S2-9-2	M7		Z	X82WMo0605KU	HS-2-9-2	2782	Z100WCWV 09-02-04-02	
	W18Cr4V	1.3355	S18-0-1	T1	BT1		HS2-9-2	HS18-0-1		Z80WCV 18-04-01	SKH2
	W6Mo5Cr4V3		S6-5-3	M3			X75W18KU				SKH52
				M42	BM42						SKH59

Material Comparison

Steel

ISO	国家和标准Nations And Standard					
	GB（P类）	W-nr	DIN	JIS	DAIDO	AISI/SAE
Die Steel						
					PX5N	P20mod
					NAK55	
					NAK80	
	3Cr13			SUS420J2mod	S-STAR	420mod
				SKS93	YK30	2
	9CrWMn			SKS3mod	GOA	01mod
	Cr12MoV		X165CrMoV12	SKD11	DC11	D2
				SKD11mod	DC53	D2mod
	4Cr5MoSiV1		X40CrMoV51	SKD61	DHA1	H13
					DH21	
					DH31-S	
					DH2F	

Material Comparison

Stainless Steel

ISO	国家和标准Nations And Standard										
	China	Germany		USA	UK		Italy	Spain	Sweden	France	Japan
	GB（P类）	W-nr	DIN	AISI/SAE	BS	EN	UNI	UNE	SS	AFNOR	JIS
Stainless Steel	0Cr13;1Cr12	1.4000	X6Cr13	403	403S17		X6Cr13	F.3110	2301	Z6C13	SUS403
		1.4001	X7Cr14					F.8401			
	1Cr13	1.4006	X10Cr13	410	410S21	56A	X12Cr13	F.3401	2302	Z10C14	SUS410
	1Cr17	1.4016	X6Cr17	430	430S15	60	X8Cr17	F.3113	220	Z8C17	SUS430
	2Cr13	1.4021	X20Cr13	410	S62	56B; 56C	X20C13	F.3401		Z20C13	SUS410
		1.4027	G-X20Cr14		420C29	56B				Z20C13M	SCS2
	4Cr13	1.4034	X46Cr13		420S45	56D	X40Cr14	F.3405	2304	Z40CM;Z38C13M	SUS420J2
	1Cr17Ni2	1.4057	X20CrNi172	431	431S29	57	X16CNi16	F.3427	2321	Z15CNi6.02	SUS431
	Y1Cr17	1.4104	X12CrMoS17	430F			X10CrS17	F.3117	2383	Z10CF17	SUS430F
	1Cr17Mo	1.4113	X6CrMo171	434	434S17		x8CrMo17		2325	Z8CD17.01	SUS434
		1.4313	X5CrNi134		425C11					Z4CND13.4M	SCS5
		1.4408	G-X6CrNiMo1810		316C16			F.8414			SCS14
	4Cr9Si2	1.4718	X45CrSi93	HW3	401S45	52	X45CrSi8	F.322		Z45CS9	SUH1
	0Cr13Al	1.4724	X10CrAl13	405	403S17		X10CrAl12	F.311		Z10C13	SUS405
	Cr17	1.4742	X10CrAl18	430	430S15	60	X8Cr17	F.3113		Z10CAS18	SUS430
	8Cr2OSi2Ni	1.4757	X80CrNiSi20	HNV6	443S65	59	X80CrSiNi20	F.320V		Z80CSN20.02	SUH4
	2Cr25N	1.4762	X10CrAl24	446			X16Cr26		2322	Z10CAS24	SUH446
Stainless Steel	0Cr18Ni9	1.4301	X5CrNi1810	304	304S15	58E	X5CrNi1810	F.3551 F.354 F.3504	2332	Z6CN18.09	SUS304
	1Cr18Ni9MoZr	1.4305	X10CrNiS189	303	303S21	58M	X10CrNiS18.09	F.3508	2346	Z10CNF18.09	SUS303
	0Cr19Ni10	1.4306	X2CrNi1911	304L	304S12		X2CrNi18.11	F.3503	2352	Z2CN18.10	SCS19
		1.4308	G-X6CrNi189		304C15					Z6CN18.10M	SCS13
	Cr17Ni7	1.4310	X12CrNi177	301			X12CrNi1707	F.3517	2331	Z12CN17.07	SUS301
		1.4311	X2CrNiN1810	304LN	304S62				2371	Z2CN18.10	SUS304LN
	0Cr19Ni9	1.4350	X5CrNi189	304	304S31	58E	X5CrNi1810			Z6CN18.09	SUS304
	0Cr17Ni11Mo2	1.4401	X5CrNiMo1712	316	316S16	Z6CND17.11	X5CrNiMo1712	F.3543	2347	1.4401	SUS316
	00Cr17Ni13Mo2	1.4429	X2CrNiMoN17133	316LN					2375	Z2CND17.13	SUS316LN
	0Cr27Ni12Mo3	1.4435	X2CrNiMo18143	316L	316S12		X2CrNiMo1713		2353	Z2CDN17.13	SCS16
	00Cr19Ni13Mo3	1.4438	X2CrNiMo17133	317L	317S12		X2CrNiMo18.16		2367	Z2CND19.15	SUS317L
		1.4460	X8CrNiMo275	329L					2324		SUS329L; SCH11 SCS11
	1Cr18Ni9Ti	1.4541	X6CrNiTi1810	321	2337	321S12	X6CrNiTi1811	F.3553	58B	Z6CNT18.10	SUS321
	1Cr18Ni11Nb	1.4550	X6CrNiNb1810	347	347S17	58F	X6CrNiTi1811	F.3552	2338	Z6CNNb18.1	SUS347
	Cr18Ni12Mo2Ti	1.4571	X6CrNiMoTi17122	316Ti	320S17	58J	X6CrNiMoTi17	F.3535	2350	Z6NDT17.12	
Stainless Steel		1.4581	G-X5CrNiMoNb1810		318C7		XG8CrNiMo18			Z4CNDNb1812M	SCS22
	Cr17Ni12Mo3Nb	1.4583	X10CrNiMoNb1812	318			X6CrNiMoTiNb17			Z6CNDNb1713B	
	1Cr23Ni13	1.4828	X15CrNiSi2012	309	309S24					Z15CNS20.1	SUH309
	0Cr25Ni20	1.4845	X12CrNi2521	310S	310S24		X6CrNi2520	F.331	2361	Z12CN2520	SUH310
	Cr15Ni36W3Ti	1.4864	X12NiCrSi3616	330						Z12CN35.1	SUH330
		1.4865	G-X40NiCrSi3818		330C11		XG50NiCr3919				SCH15
	5Cr2Mn9Ni4N	1.4871	X53CrMnNiN219	EV8	349S54;321S12	58B	X53CrMnNiN219			Z52CMN21.0	SUH35
	1Cr18Ni9Ti	1.4878	X12CrNiTi189	321	321S320	58C	X6CrNiTi1811	F.3523		Z6CNT18.12	Su321

Material Comparison

Cast Iron

ISO	国家和标准Nations And Standard										
	China	Germany		USA	UK		Italy	Spain	Sweden	France	Japan
	GB（P类）	W-nr	DIN	AISI/SAE	BS	EN	UNI	UNE	SS	AFNOR	JIS
Nodular Iron	QT400-18	GGG40		60-40-18	400/17		GS370-17	FGE38-17	0717-02	FGS370-17	FCD400
	QT450-10			65-45-12	420/12		GS400-13	FGE42-12		FGS400-12	FCD450
	QT500-7	GGG50		70-50-05	500/7		GS500-7	FGE50-7	0727-02	FGS500-7	FCD500
	QT600-3	GGG60		80-60-03	600/7		GS600-2	FGE60-2	0732-03	FGS600-2	FCD600
	QT700-2	GGG70		100-70-03	700/2		GS700-2	FGE70-2	0737-01	FGS700-2	FCD700
	QT800-2	GGG80		120-90-02	800/2		GS800-2	FGE80-2	0864-03	FGS800-2	FCD800
	QT900-2				900/2						
Grey Cast Iron		GG40		NO.60					0140	FGL400	FC350
	HT350	GG35		NO.50	350		G35	FG35	0135	FGL350	FC300
	HT300	GG30		NO.45	300		G30	FG30	0130	FGL300	FC250
	HT250	GG25		NO.35	250		G25	FG25	0125	FGL250	FC200
	HT200	GG20		NO.30	200		G20	FG20	0120	FGL200	FC150
	HT150	GG15		NO.20	150		G15	FG15	0115	FGL150	FC100
	Ht100				100		G10		0110		

Grade Comparison

	ISO Code	OKE	ZCCCT	MITSUBISHI	Korloy	TaeguTec	SUMITOMO	TUNGALOY	KYOCERA	HITACHI	SANDVIK	KENNAMETAL
CVD Turning	P01			UE6105		TT8105	AC8015P AC810P	T9205 T9105	CA510 CA5505	HG8010	GC4305 GC4315	KCP05B KCP05 KCPK05 KCK05B KCK05 KCK15B KCK15
	P10	OC2015 OC2115 OC2325	YBC151 YBC152	UE6105 MC6015 UE6110 MY5015	NC3215	TT8105 TT8115	AC8015P AC810P	T9205 T9105 T9215 T9115	CA510 CA515 CA5505 CA5515	HG8010	GC4305 GC4315 GC4325	KCP05B KCP05 KCPK05 KCP10B KCP10 KCK15B KCK15 KCK20B
	P20	OC2025 OC2125 OC2325	YBC251 YBC252	MC6015 UE6110 MC6025 UE6020 MY5015	NC3225 NC3120	TT5100 TT8125	AC8025P AC820P	T9215 T9115 T9225 T9125	CA025P CA525 CA5515 CA5525 CR9025	HG8025 IP2000 GM25	GC4315 GC4325 GC4225 GC1515	KCP10B KCP10 KCP25B KCP25 KCM15B KCM15
	P30	OC2035 OC2125 OC2135	YBC252 YBC351 YBC352	MC6025 UE6020 MC6035 UE6035 UH6400	NC3030	TT8125 T5100	AC8035P AC830P AC6030M AC630M	T9225 T9125 T9235 T9135 T6130	CA025P CA525 CA5525 CA530 CA5535 CR9025	IP3000 GM8035	GC4315 GC4325 GC4335 GC2025	KCP25B KCP25 KCP30B KCP30 KCM15B
	P40	OC2035	YBC351 YBC352	MC6035 UE6035 UH6400	NC5330	TT8135 TT7100	AC8035P AC830P AC6030M AC630M		CA530 CA5535	GM8035 GX30	GC4325 GC4335	KCP30B KCP30 KCP40B KCP40 KCM25B KCM25 KCM35B KCM35
	M10	OC4015 OC4315		MC7015 US7020	NC9115	TT9215	AC6020M AC610M	T9235 T9135 T6130	CA6515	IP1050S	GC2015 GC1515	KCM15B KCM15
	M20	OC4025 OC4225	YBM151 YBM153	MC7015 US7020 MC7025	NC9115 NC9125	TT9225	AC6020M AC6030M AC610M AC630M	T9215 T9115	CA6525	IP1050S	GC2015 GC2025 GC2020	KCP30B KCP30 KCP40B KCP40 KCM15B KCM15 KCM25B KCM25
	M30	OC4035	YBM151 YBM251	MC7025 US735	NC9125 NC9135	TT9235	AC6030M AC630M AC8035P AC830P	T6120 T9215 T9115		IP100S GX30	GC2025 GC2020	KCP40B KCP40 KCM25B KCM25 KCM35B KCM35
	M40		YB253	US735	NC9135	TT9235	AC6030M AC630M	T6130		IP100S GX30		KCM35B KCM35
	K01	OC3105	YBD052	MC5005 UC5105	NC6310	TT7005	AC4010K AC405K	T5105	CA310 CA4010 CA4505 CA5505	HX3505	GC3210	KCK05B KCK05
	K10	OC3115D OC3215	YBD102	MC5015 UC5115 MY5015	NC6310 NC6315	TT7015	AC4010K AC4015K AC405K AC415K	T5105 T515 T5115 T9215	CA310 CA315 CA4010 CA4115 CA4505 CA4515 CA5505	HX3505 HX3515 HG8010	GC3210	KCK05B KCK05 KCK15B KCK15
	K20	OC3115D OC3215	YBD152 YBD252	MC5015 UC5115 UE6110 MY5115	NC6315	TT7015 TT7025	AC4015K AC415K AC420K AC425K AC8025P	T515 T5115 T5125 T9215	CA315 CA320 CA4115 CA4120 CA4515	HX3515 HG8010	GC3210 GC3225	KCK15B KCK15 KCK20B KCK20
	K30	OC3125		UE6110				T5125	CA320	HG8010	GC3225	KCP05B KCP05 KCPK05 KCP10B KCP10 KCP25B KCP25 KCK20B KCK20

Grade Comparison

	ISO Code	OKE	ZCCCT	MITSUBISHI	Korloy	TaeguTec	SUMITOMO	TUNGALOY	KYOCERA	HITACHI	SANDVIK	KENNAMETAL
CVD Milling	P10					TT7515	ACP2000 ACP100				GC4220 GC4230 GC3040	KC930M KC935P
	P20		YBC301 YBC251	F7030 MC7020	NC5330	TT7515	ACP2000 ACP100	T3225			GC4220 GC4230 GC3040	SC6525 SP6519
	P30	OC4025 OC4225	YBM351	F7030 MC7020	NC5330 NC5340 NCM325	TT7800	ACP2000 ACP100	T3130 T3225			GC4230 GC3040 GC2040 M30B	MP91M SC6525 KCPK30 X500
	P40	OC4035	YBC302		NC5340 NC325 NCM325 NC5350 NCM335	TT7800					GC4240 GC4230 GC3040 GC2040 M30B	KCPK30 X500
	M10						ACM200					
	M20	OC4025 OC4225	YBM251 YBM253	F7030 MC7020	NC5330		ACM200	T3225	CA6535	GX2160 AX2040	GC2040 GC4230	SC6525
	M30	OC4035	YBM302	F7030 MC7020	NC5330 NC5340 NCM325 NC5350	TT7800	ACM200	T3225 T3130			GC2040 GC4230 GC4240 M30B S40T	SC6525 X500
	M40				NCM335 NC5350	TT7800					GC2040 M30B S40T GC4240	X500
	K10	OC3105 OC3115	YBD151	MC5020		TT7515	ACK2000 ACK100 ACK200	T1215 T1115				SC3025 KCK15
	K20	OC3115D OC3115	YBD252	MC5020	NC5330	TT7515	ACK200 ACK200	T1215	CA420M	GX2120	GC3220 K20W	KCK15 SC3025 MP91M
	K30	OC3125	YBD252		NC5340						GC3040	MP91M KCPK30 SC6525

Grade Comparison

	ISO Code	OKE	ZCCCT	MITSUBISHI	Korloy	TaeguTec	SUMITOMO	TUNGALOY	KYOCERA	HITACHI	SANDVIK	KENNAMETAL
PVD Turning	P10	OP1102	YBG102	VP10MF MS6015	PC8105		AC1030U ACZ150 AC5025S AC520U	AH710	PR930 PR1005 PR1025 PR1115 PR1215 PR1425 PR1225		GC1025 GC1125	KCS10 KCU10 KC5010
	P20	OP1205	YBG202	VP10RT VP20RT VP15TF VP20MF	PC8110 PC230	TT9020 TT9030	AC1030U AC5025S AC520U AC530U	AH120 AH725 AH730 SH725 SH730 J740	PR930 PR1025 PR1115 PR1215 PR1225 PR1625	IP2000	GC1025 GC1125	KCS10 KCU10 KCU25 KC5010 KC5025
	P30	OP1302	YBG202	VP10RT VP20RT VP15TF VP20MF	PC5300 PC8115	TT8020 TT8080 TT9030	AC1030U AC530U	AH120 AH725 AH7025 AH730 SH725 SH730 GH730 GH330 J740	PR1025 PR1225 PR1535	IP3000 CY250	GC1025 GC1125	KCU25 KC5025
	P40					TT8020 TT8080 TT9080	AC1030U	AH120 AH725 AH645		IP3000	GC1025	
	M10	OP1102 OP1205 OP1305	YBG202 YBG205	VP10MF MS6015	PC8105 PC8110	TT5080	AC515S AC5025S AC510U AC520U ACZ150	AH8005 AH630	PR1025 PR1215 PR1225	IP050S IP100S JP9105 JP9115	GC1115 GC1125	KCS10 KCU10 KC5010
	M20	OP1202 OP1215 OP1315 OP1525	YBG202 YBG205	VP10RT VP20RT VP15TF VP20MF	PC8110 PC8110 PC5300	TT5080 TT9080	AC5015S AC5025S AC1030U AC520U	AH8015 AH630 AH120 AH7025 AH725 SH725 SH730	PR930 PR1025 PR1125 PR1215 PR1425 PR1225 PR1515	IP100S HS9115	GC1115 GC1125 GC2035	KCS10 KCU10 KCU25 KC5010 KC5025
	M30	OP1205H OP1215 OP1302		VP10RT VP20RT VP15TF VP20MF MP7035	PC9030 PC5300 PC5400	TT8020 TT8080 TT9020 TT9080	AC5025S AC6040M AC1030U AC520U AC530U	AH645 AH120 AH725 SH725 SH730 J740	PR1125 PR1535		GC1125 GC2035	KCU25 KC5025
	M40			MP7035	PC5400	TT8020 TT8080 TT9020 TT9080	AC6040M AC1030U AC530U	AH645		GX30	GC2035	
	K10	OP1102					AC1030U AC510U ACZ150	GH110 AH110	PR905 PR1215	HX3305 HG3305 HX3515 HG8010 TH315 ATH10E	GC3330 GC3220 K20W K20D K20M K15W	KCS10 KCU10 KC5010
	K20	OP1202		VP10RT VP20RT VP15TF	PC5300		AC1030U AC510U AC530U ACZ150	AH120 AH7025	PR905 PR1215		GC3330 GC3220 GC3040 K20W K20D GC4230 K20M K15W	KCS10 KCU10 KCU25 KC5010 KC5025
	K30			VP10RT VP20RT VP15TF			AC1030U AC530U	AH120 GH130			GC3330 GC3040 K20W GC4240 GC4230	

Grade Comparison

	ISO Code	OKE	ZCCCT	MITSUBISHI	Korloy	TaeguTec	SUMITOMO	TUNGALOY	KYOCERA	HITACHI	SANDVIK	KENNAMETAL
PVD Turning	P10		YBG252		PC2005 PC2010 PC2015	TT2510 TT7080	ACP2500 ACP200	AH120 AH725	PR830 PR1025 PR1225	PCA12M PN15M PN215 JP4115	GC1010 GC1025 GC1030	KC5010M KC515M
	P20	OP1205 OP1305 OP2202	YBG202 YBG205 YBG9320 YBG252	MP6120 VP15TF	PC2505 PC2510	TT2510 TT7080 TT8020 TT9030 TT9080	ACP3000 ACU2500 ACP200 ACP300	AH120 AH725 AH3135 AH9030 AH3225 AH9130	PR1525 PR830 PR1025 PR1225 PR1230	CY150 CY9020 JP4120	GC1025 GC1030 GC2030	KC522M KC525M KCSM30 SP6519
	P30	OP1030 OP1130 OP1215 OP1302 OP1315 OP1325	YBG302	MP6120 VP15TF MP6130 VP30RT	PC3600 PC3500 PC210F PC5300	TT8020 TT8080 TT9030 TT9080	ACP3000 ACU2500 ACP200 ACP300	AH120 AH725 AH3135 AH130 AH3225 AH9130	PR1230 PR1535	HC844 CY25 CY250 CY259V JS4045	GC1030 GC1010 GC2030	KC525M KC530 KC725M KC735M KCPM40 KCSM30 X400
	P40		YBG302	VP30RT	PC5400	TT8020 TT8080 TT9030 TT9080	ACP3000 ACU2500 ACP300	AH140		PTH30E PTH40H JS4060 GX2140	GC1030 GC2030	KC725M KC735M KCPM40
	M10		YBG252		PC210F		ACU2500 ACM100 ACK300 ACP300	AH725	PR1025 PR1225	PN15M PN215	GC1010 GC1030	KC515M SP4019 SP6519
	M20	OP1202 OP1215 OP1205H	YBG202 YBG205 YBG9320 YBG252	VP15TF MP7130 MP7030 VP20RT	PC5300	TT9030 TT9080	ACU2500 ACK300 ACP300	AH725 AH3135 AH130 AH6030 AH3225 AH9130	PR1525 PR1025 PR1225	JP4120	GC1030 GC1040 GC2030 S30T	KC522M KC525M SP4019 SP6519 X700
	M30	OP1302	YBG302	VP15TF MP7130 MP7030 VP20RT MP7140	PC9530 PC5400	TT8020 TT8080 TT9030 TT9080	ACM300	AH3135 AH130 AH9130	PR1535	HC844 CY250 JS4045	GC1040 S30T GC2030	KC522M KC525M KC725M KC735M KCPM40 KCSM30 KCSM40 SC6525 X700
	M40		YBG302	MP7140 VP30RT	PC5400	TT8020 TT8080 TT9030 TT9080	ACM300	AH140		PTH30E PTH40H JM4160 GX2160 AX2040		KC725M KCPM40 KCSM40
	K10	OP1102	YBG102 YBG252	MP8010	PC8110 PC6510	TT6080	ACK3000 ACU2500	AH110 GH120	PR510 PR905 PR1210	ATH10E TH315 CY100H	GC1010 GC1020	KC514M KC515M KCK20 SP4019
	K20	OP1202 OP2212	YBG152	VP15TF VP20RT	PC5300	TT6080	ACK3000 ACU2500 ACK300	AH120 AH9030 AH9130	PR905 PR1210	CY9020 CY150 PTH13S JP4120 GX2120	GC1020	KC514M KC520M KC524M KCK20 SP6519
	K30	OP1205 OP1205H		VP15TF VP20RT			ACK3000 ACU2500 ACK300	AH120		CY250 JS4045 GX2040		KC522M KC524M SP6519

Hardness Comparison

Hardness				Tensile Strength
Rockwell Hardness(RH)		Vickers Hardness(VH)	Brinell Hardness(BH)	
HRC	HRA	HV	HB	
70.0	86.6	1037		
69.5	86.3	1017		
69.0	86.1	997		
68.5	85.8	978		
68.0	85.5	959		
67.5	85.2	941		
67.0	85.0	923		
66.5	84.7	906		
66.0	84.4	889		
65.5	84.1	872		
65.0	83.9	856		
64.5	83.6	840		
64.0	83.3	825		
63.5	83.1	810		
63.0	82.8	795		
62.5	82.5	780		
62.0	82.2	766		
61.5	82.0	752		
61.0	81.7	739		
60.5	81.4	726		
60.0	81.2	713		2555
59.5	80.9	700		2500
59.0	80.6	688		2450
58.5	80.3	676		2395
58.0	80.1	664		2345
57.5	79.8	653		2295
57.0	79.5	642		2250
56.5	79.3	631		2205
56.0	79.0	620		2160
55.5	78.7	609		2115
55.0	78.5	599		2075
54.5	78.2	589		2035
54.0	77.9	579		1995
53.5	77.7	570		1955
53.0	77.4	561		1920
52.5	77.1	551		1885
52.0	76.9	543		1850
51.5	76.6	534		1815

Hardness				Tensile Strength
Rockwell Hardness(RH)		Vickers Hardness(VH)	Brinell Hardness(BH)	
HRC	HRA	HV	HB	
51.0	76.3	501		1780
50.5	76.1	494		1750
50.0	75.8	488		1720
49.5	75.5	481		1690
49.0	75.3	474		1660
48.5	75.0	468		1630
48.0	74.7	461		1605
47.5	74.5	455		1575
47.0	74.2	449		1550
46.5	73.9	442		1525
46.0	73.7	436		1500
45.5	73.4	430		1475
45.0	73.2	424		1450
44.5	72.9	418		1430
44.0	72.6	413		1405
43.5	72.4	407		1385
43.0	72.1	401		1360
42.5	71.8	396		1340
42.0	71.6	391		1320
41.5	71.3	385		1300
41.0	71.1	380		1280
40.5	70.8	375		1260
40.0	70.5	370		1245
39.5	70.3	365		1225
39.0	70.0	360		1210
38.5		355		1190
38.0		350		1175
37.5		345		1160
37.0		341		1140
36.5		336		1125
36.0		332		1110
35.5		327		1095
35.0		323		1080
34.5		318		1065
34.0		314		1050
33.5		310		1035
33.0		306		1020
32.5		302		1010

A
B
C
D
E/5

Hardness Comparison

Hardness				Tensile Strength
Rockwell Hardness(RH)		Vickers Hardness(VH)	Brinell Hardness(BH)	
HRC	HRA	HV	HB	
32.0		304	298	995
31.5		300	294	980
31.0		296	291	970
30.5		292	287	960
30.0		289	283	950
29.5		285	280	935
29.0		281	276	920
28.5		278	273	910
28.0		274	269	900
27.5		271	266	890
27.0		268	263	880
26.5		264	260	870
26.0		261	257	860
25.5		258	254	850
25.0		255	251	835
24.5		252	248	830

Hardness				Tensile Strength
Rockwell Hardness(RH)		Vickers Hardness(VH)	Brinell Hardness(BH)	
HRC	HRA	HV	HB	
24.0		249	245	820
23.5		246	242	810
23.0		243	240	800
22.5		240	237	790
22.0		237	234	785
21.5		234	232	775
21.0		231	229	765
20.5		229	227	760
20.0		226	225	750
19.5		223	222	745
19.0		221	220	735
18.5		218	218	730
18.0		216	216	725
17.5		214	214	715
17.0		211	211	710