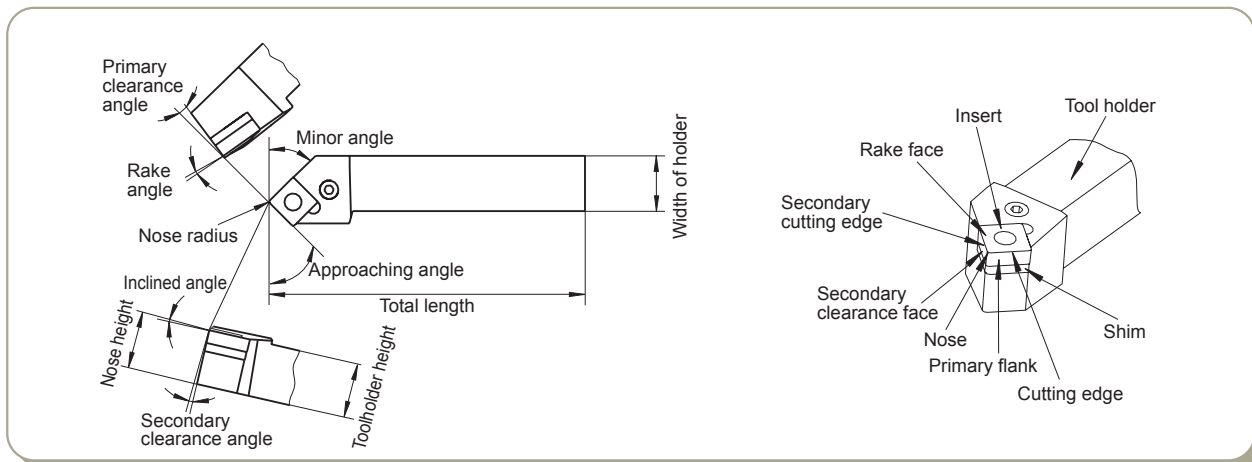


## The functions of each part of turning tools

### 1 The names of each part of turning tools



### 2 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 cutting forces and cutting power, lower cutting temperature, 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 tool life. Please choose rake angle according to machining conditions.

Value selection	Situations
Small rake angle	<ul style="list-style-type: none"> <li>● When machining brittle and hard materials</li> <li>● When roughing and intermittent cutting</li> </ul>
Big rake angle	<ul style="list-style-type: none"> <li>● When machining plastic or soft materials</li> <li>● When finishing</li> </ul>

### 3 Effects of clearance angle

The main function of clearance angle is 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 the sharpness of cutting edge, reduce cutting forces and friction, and then 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 abrasion would occur, reducing tool life.

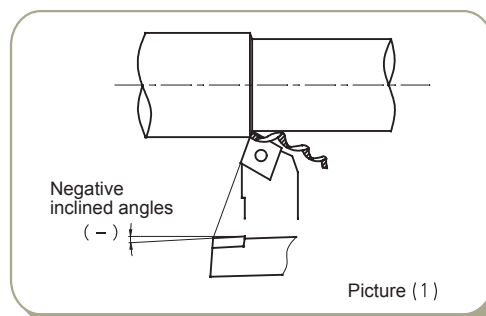
The principle of choosing clearance angle: Choose small clearance angle if friction is not serious.

Value Selection	Situations
Small clearance angle	<ul style="list-style-type: none"> <li>● In order to increase nose strength when roughing</li> <li>● When machining brittle and hard materials</li> </ul>
Large clearance angle	<ul style="list-style-type: none"> <li>● In order to reduce friction when finishing</li> <li>● When machining materials easy to be hardened</li> </ul>

### 4 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.

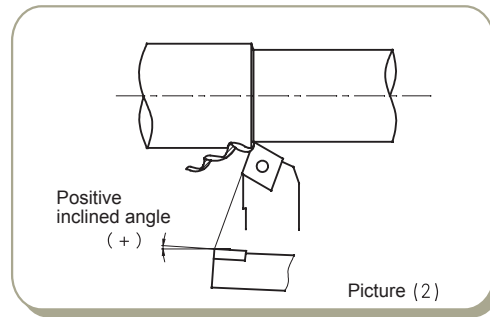
◆ As diagram (1) shows, when the inclined angle is negative, namely nose is in the lowest point as apposed to the bottom of tool, chips flow to the machined surface of workpiece.



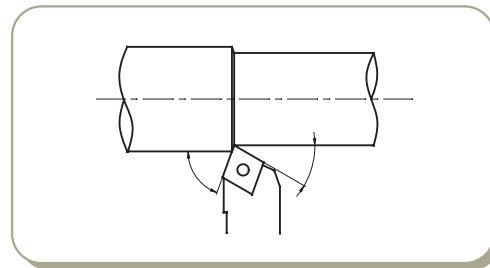
Picture (1)

◆ 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.

◆ 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, protecting 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.



Picture (2)



### 5 Effects of approach angle

Reduced approaching angle increases the strength of tools and enable heat to diffuse easily, improving surface quality. This is because 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 angle	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

### 6 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 there is no vibration. Select large minor angle when finishing.

### 7 Nose radius

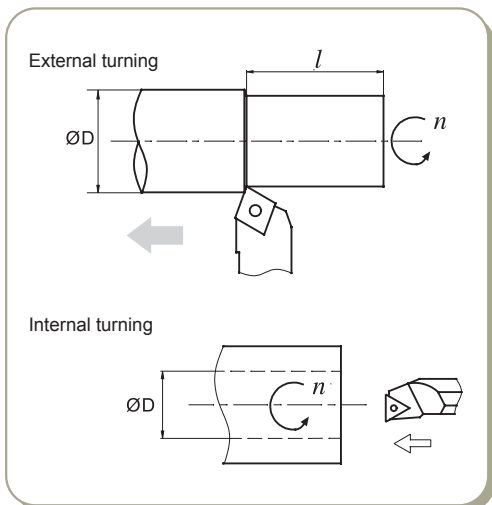
Nose radius significantly affects nose strength and surface quality.

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	<ul style="list-style-type: none"> <li>● Finishing at small cutting depth</li> <li>● Machining parts such as slender shaft</li> <li>● When the rigidity of the machine is not enough</li> </ul>
Large nose radius	<ul style="list-style-type: none"> <li>● When roughing</li> <li>● When machining hard materials (intermittent cutting)</li> <li>● When the rigidity of the machine is not enough</li> </ul>

#### Calculation method of turning parameters

##### 1 Calculation of cutting speed



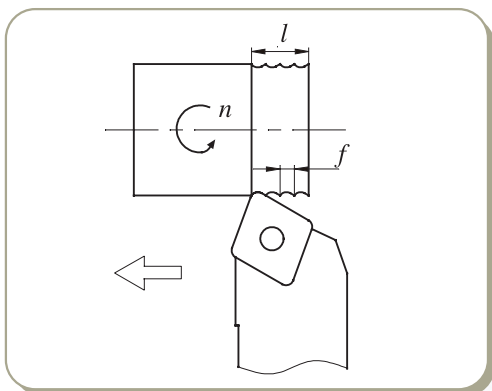
$$V_c = \frac{\pi \times D \times n}{1000} \text{ (m/min)}$$

In the formula:  $V_c$ : 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:

$$V_c = \frac{\pi \times D \times n}{1000} \text{ (m/min)} = 132 \text{ (m/min)}$$

##### 2 Calculation of feed rate

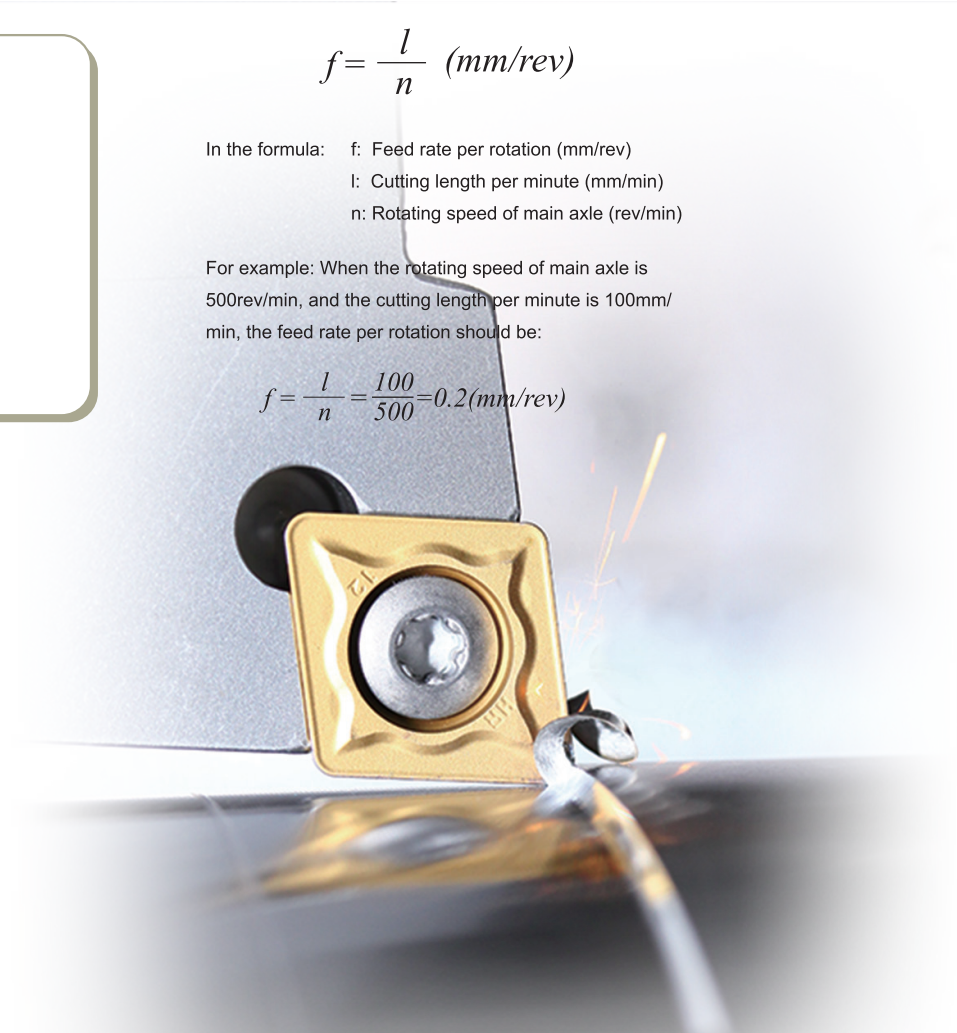


$$f = \frac{l}{n} \text{ (mm/rev)}$$

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 rotation should be:

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





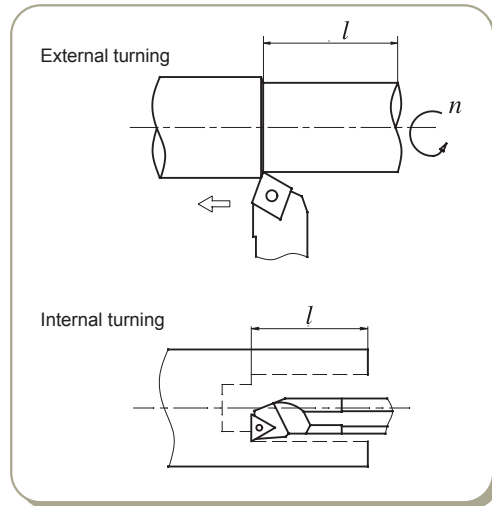
**3 Cutting time calculation of external and internal turning**

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

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 0.2mm/rev, the time needed for a cutting length of 150mm should be:

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

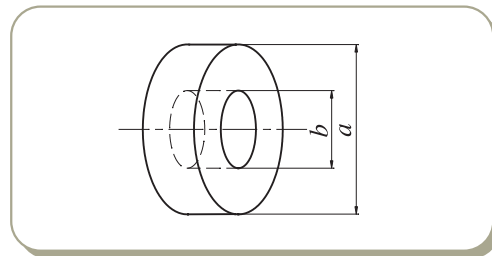


**4 Time calculation for end surface turning (constant linear speed)**

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

In the formula: T: Cutting time (min)  
 V<sub>c</sub>: Cutting speed (m/min)  
 f: Feed rate (mm/rev)

For end surface without hole, b=0, the formula is still valid.



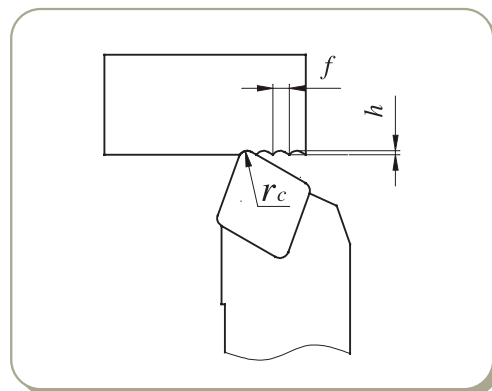
**5 Theoretical value calculation of machined surface roughness**

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

In the formula: R: Theoretical roughness value of machined surface  
 f: Feed rate (mm/rev)  
 r<sub>c</sub>: 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:

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



General turning

Parting and grooving

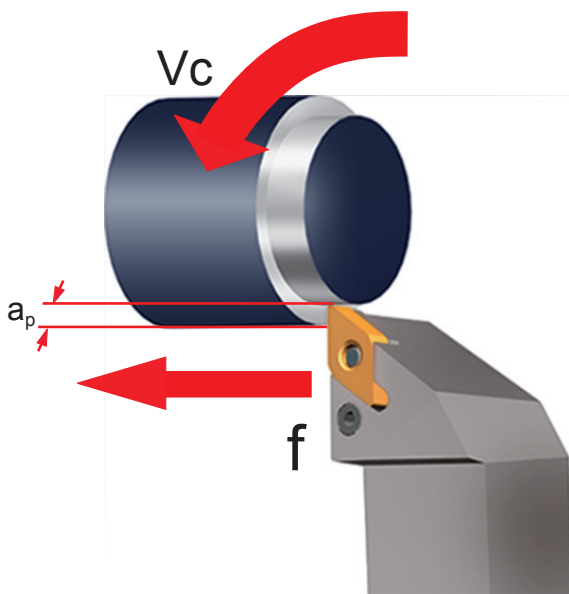
Threading

General technical information for turning

## Effect of three main turning parameters on machining

### 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 ( $V_c$ )

When the workpiece is rotating on the machine, the number of its 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 speed is considered to measure the effect of cutting speed on machining.

### Effect of cutting speed

Cutting speed has significant effect on 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 workpiece. The below conclusions 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.

### Feed rate ( $f_n$ )

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

### Effect of feed rate

Feed rate is a key factor that determines surface quality. Meanwhile 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, greatly reducing tool life.

### Cutting depth ( $a_p$ )

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 allowance and shape of workpiece, power and rigidity of machine, 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 nose just cutting the hardened layer of workpiece.



Comparison table for turning inserts chipbreaker

Comparison table for turning insert chipbreaker

Negative inserts

ISO	Machining range	ZCCCT	SANDVIK	KORLOY	TaeguTec	WALTER	SECO	MITSUBISHI	SUMITOMO	KENNAMETAL	DIJET	HITACHI	TUNGALOY	KYOCERA	VALANTTE	
<b>P</b>	For extra finishing		QF LC	HU	FA FX	FP5	FF1 FF2	PK※ FH, FY FP, FS	FB FA, FL	FF		FE	01※, TF, ZF 11	DP※, GP, PP, VF, XP XP-T, XF	F1	
	For finishing	DF	PF XF	HF	FG FM	MP3, FV5 NF3, NF4	MF2	LP, C SA, SH	FE, SU, LU, SX, SE	LF, FN	PF, UR UA, UT	BE, CE B, BH	NS, 27 TSF, AS, TQ	HQ, CQ PQ	F2(2B), F5(5C)	
	For finishing (Soft steel)	SF		HF	FC			SY					17	XQ, XS		
	For finishing (Wiper)	WGF	WL WF	HW	WS	NF	W-MF2	SW	LUW SEW	FW			AFW, ASW FW, SW	WF WP, WQ		
	For semi-finishing	DM PM	PM QM XM	HA HC HM	PC FT MT SM MP	MF3 MF5 MV5	MF3 M3 M5	MP MA MH	GU UG UX GE	P MN		PG UB	NM, ZM TM, DM 37, AM 33, 38	PG, CJ, GS, PS HS, PT	F3, F4(8A), M2(2C), M3 M4, M5(5B), M6, M7, 55, M8	
	For semi-finishing (Wiper)	WGM	WMX WM		WT	NM	W-M6 W-M3 W-MF5	MW	GUW	MW RW					WE	
	For light roughing	LR <sup>(Single-side)</sup> DR <sup>(Double-side)</sup>	PR, HM XMR		RT	NM6, RP5 NM9, RP7	MR7 MR6	RP GH	MU, MX ME, UZ	RN RP		UD, GG	Y, RE	TH	RH, GT	
	For heavy roughing	HDR HPR	QR PR HR MR	HR HH	RX, HD HY, HT RT, RH HZ, EH	NR6 NRF NRR	R5, R56 R4, R6 R7, PR9 R57, RR6 R8	HM, HL HZ, HX HV, HR	MP, HG HP, HU HW, HF	MR, RM RH	UC	TE, UE HX, HE H	TU, TRS TUS	PX	R3, R4, R6(9A) R7(9B), R9(9C)	

※ Periphery grinding type

Comparison table for turning inserts chipbreaker

Threading

Parting and grooving

General turning



### Comparison table for turning inserts chipbreaker

#### Comparison table for turning insert chipbreaker

#### Negative inserts

ISO	Machining range	ZCCCT	SANDVIK	KORLOY	TaeguTec	WALTER	SECO	MITSUBISHI	SUMITOMO	KENNAMETAL	DIJET	HITACHI	TUNGALOY	KYOCERA	VALANTTE
<b>M</b>	For finishing	EF	MF	HA	SF	NF4, FM5	MF1	SH, LM	SU, EF	FP, LF※		MP, AB BH	SS	MQ GU	F1, F2(2B), F5(5C)
	For semi-finishing	EM	MM, QM XM, K	HS	ML, EM MM, VF	MM5 RM5 NM4	MF4	MS, ES GM, MM MA	EX, EG UP, GU HM	MP	SF, SG SZ	DE PV SE AH	SF, SA, SM, S	MS, MU SU, HU, ST, TK	F3, F4(8A), M2(2C), M3 M4, M5(5B), M6, M7, 55, M8
	For roughing	ER	MR	GS, HM	MT	NR4 NR5	M5, MR7 RR6	GH, HZ RM, HL	EM, MU MP	UP RP		AE	TH, SH		R3, R4, R6(9A) R7(9B), R9(9C)
<b>K</b>	For finishing	PM	KF			MK5	MF2, M3 MF5, M4	VA AH		FN		VA, AH	CF	KQ	F2(2B)
	For Semi-Finishing	PM	KM	Through chip-breaker, HM	MC	RK5 NM5	M5	V AE	UZ, GZ UX	RP, UN	PG	V, AE	CM	KG, C	M5(5B), M6, M8
	For roughing	Without chip-breaker	KR KRR	GR, HR GH	KT	RK7		RE			GG	RE		KH, GC	R3, R4, R7(9B)
<b>S</b>	For finishing	NF/NGF	SF SGF※		EA	NF4, NFT MS3	MF5, MF1 MF4	FJ※, LS MJ, MJ※	EF, SU※	FS, LF※ MS			HRF	MQ	F5(5C), M2(2C)
	For semi-finishing	NM	NGP※, SM			NMT, NMS	M1	MS	EG, EX SU※, UP	NGP※ UP, P		VI	HRM, SA HMM	SQ, MS MU, TK	M4, M5(5B), M7, 55
	For roughing	SNR	SR SMR		ET	NRS NRT	MR3 MR4	GJ RS	MU	RP				SG SX	

※ Periphery grinding type

General turning

Parting and grooving

Threading

Comparison table for turning inserts chipbreaker



Comparison table for turning inserts chipbreaker

Comparison table for turning insert chipbreaker

Positive inserts

ISO	Machining range	ZCCCT	SANDVIK	KORLOY	TaeguTec	WALTER	SECO	MITSUBISHI	SUMITOMO	KENNAMETAL	DIJET	HITACHI	TUNGALOY	KYOCERA	VALANTTE
<b>P</b>	For finishing	SF, HF	PF, UF XF	HFP	FA, FG FX	PF4 FP4	FF1 F1	FV, SV FP, LP	FP, LU SU, SK	11, UF LF, FP		JQ	PF, PSF PS, PSS	GP, XP VF, PP	PF4 JQ, JZ
	For finishing (Wiper)		WF			PF2* PF, PF5*	W-F1	SW	LUW SDW	FW				WP	
	For semi-finishing	HM	UM, XM PM, PR XR	HMP C25	MT, PC	PS5 PM5 FP6	F2 MF2, M5	MV, MP	MU	MF, MP	FT	JE	PM 23, 24	HQ, XQ GK MF*	PM2 PM4
	For semi-finishing (Wiper)		WM		WT	PM	W-F2 W-M3	MW		MW					
<b>M</b>	For finishing	EF	MF	HFP		FM4	F1, F2	FM, LM	FC*, SI* LU, SU	MF		MP	PF, PSF PS, PSS	CF*, CK* GQ*, GF* MQ, SK	1A, 2A
	For semi-finishing	EM	MM	HMP C25		MM4 RM4		MM	MU	MP			PM	HQ GK	PM2 PM4
<b>K</b>	For semi-finishing	HM, HR without chip-breaker	KF KM KR	HMP C25		FK6	F1 M3, M5	MK Without chip-breaker	MU Without chip-breaker	Without chip-breaker			CM Without chip-breaker	Without chip-breaker*	PM2 PM4
	For finishing/ For semi-finishing	NGF						FS*, LS* FJ*, FS-P* LS-P*	SL*	LF*, HP*				MQ	PM2, 1A 2A
<b>N</b>	For general turning	LH	AL	TAAK MA	FL	PM2, FN2 MN2	AL*	AZ*	AG	HP*	ALU ACB ASF		AL*	AH*	1L, 1A 2A

\* Periphery grinding type

General turning

Parting and grooving

Threading

Comparison table for turning inserts chipbreaker