

Milling with NTK Grades by Application

General Guidelines for Successful Milling

- Select the best grade for the application
- Select cutter diameter 1.5 times greater than the workpiece width
- Eliminate any overhang to increase stability
- Choose the strongest nose radius
- No Coolant. Use compressed air
- Check clamp and part rigidity



Guidelines for Successful Milling by Material

Heat resistant alloy / PH stainless steel

- Down or climb milling where the chip thins upon exit is the preferred method for HNBA materials
- Reduce feed rate 50% upon entrance and exit
- Do not recut side walls as this can cause work hardening
- Use balanced shell mill adapter or shrink fit for end-mills
- As DOC gets thinner the feed must be increased to compensate for heat loss
- Use RPG geometries if tool pressure is a problem
- E01, E02 edge preparation recommended

Hardened Steel / Die mold / Chilled iron / Overlay

- Larger edge preparations need to be used
- Speed is reduced as hardness goes up

Cast Iron / Ductile Cast Iron

- Parts that are cast are more difficult to machine than forged • decrease feed rates by 25%
- Maximize feed rates for gray cast irons

Trouble shooting

Material	Insert Grade	NTK Grade	Problem	Solution					
				Speed	Feed	DOC	Edge Prep.	Insert Grade	Others
Hardened Steel	Ceramic	HC7 WA1	Chipping	—	↘	—	Wider	—	—
			Break	↘	↘	—	—	—	—
Cast Iron	Silicon Nitride	SX6 SP9	Chipping	↘	↘	—	Wider	—	—
			Break	↘	↘	↘	—	Tougher	Larger radius
			Thermal Crack	↘	↘	—	—	—	—
			Crater Wear	—	—	—	Sharper	—	—
Heat Resistant Alloy	SiALON	SX9 SX7	Notching	↗	↗	Vary / ↘	Wider	—	Pre-chamfer parts
			Flank Wear	↘	↗	—	—	Harder	—
			Chipping	—	—	—	Wider	Tougher	—
			Break	↘	—	↘	—	Tougher	—
			Tool Pressure	—	—	—	—	—	Use RPG insert

Hard Milling with WA1

Mill hardened materials (HRC 45 - 62) Reduce costs and eliminate grinding

- Rapid metal removal rates
- Achieve outstanding surface finishes
- Increased tool life vs carbides
- Versatile round insert geometries provide clearance in every direction



Target Industries

- Mold Shops
- Food processing
- Tool & Die
- Forging
- Mining

Application Materials

- Tool Steels
- Chilled Irons
- Stellite
- Mold Steels
- Powered Metal
- Weld Overlays

Cutters



Insert

- Grade
WA1
- Shape
RPG: Low tool pressure
RNG: More rigidity

Recommend Cutting Conditions

INSERT	DOC	HRC 45-55		HRC 55-60		HRC 60-62	
		Cutting Speed (SFM)	Feed (IPT)	Cutting Speed (SFM)	Feed (IPT)	Cutting Speed (SFM)	Feed (IPT)
RPG-21.51	.030"	850 - 1000	.004"	700 - 900	.003"	550 - 800	.0025"
RPG-32	.045"	850 - 1200	.0045"	700 - 1100	.003"	550 - 1000	.0025"
RPG-43	.050"	850 - 1300	.005"	700 - 1200	.0035"	550 - 1100	.003"
RNG-32	.045"	850 - 1200	.0045"	700 - 1100	.0045"	550 - 1000	.0025"
RNG-43	.045"	850 - 1400	.0045"	700 - 1300	.045"	550 - 1200	.003"
RNG45	.075"	850 - 1400	.005"	700 - 1300	.004"	550 - 1200	.003"

Note: Speeds and Feeds are approximately starting points

Guidelines for Success

- Minimize overhang and have ridged set-ups
- Keep cutter engagement to 1/2 to 5/8 of the cutter diameter
- Reduce feed upon entrance and exit of the cut by 25%
- Use air blast without coolant
- Use helical interpolation to ramp down into a cavity
- Increase feed rates in corners to compensate for heat loss
- Use climb milling
- Use shrink fit holders whenever possible
- Safety first-do not exceed SFM
- As DOC gets smaller speed should accelerate to compensate for heat loss
- Adjust speed to maximize plastic deformation

Machine power requirements ~ Quick Check Table ~

Calculation ※Assuming that normal cast iron is machined at a cutting speed of 2600 SFM

$$\text{Required mechanical power (hp)} = \text{○○\%} \times \text{○○hp}$$

Width of cutting a_e = ___ % of the cutter diameter

The value ___ hp determined from the applicable table below

(Example of calculation)

Cutter used : HVM ϕ 4" - 10 teeth Width of cutting a_e = 1.2" → This is 30% of the cutter diameter
Cutting conditions : 2600 SFM .008 IPT .118 DOC → The value 54hp in the table is located.

The required power (hp) = 30% × 54hp = 16hp

HVM Series 	HSM Series 	XFM Series 																																																																																													
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Unit : kW

Tips for utilizing the above tables

- ① The assumption is that gray cast iron is machined at a cutting speed of 2600 SFM, with the cutter diameter shown as the width of cut (a_e = 100% of the cutter diameter).
- ② The required power becomes approximately half (50%) if the cutting width a_e or depth of cut a_p is halved. (The power is proportional to a_e or a_p .)
- ③ The required power is reduced to approximately 60% if the number of blades is halved.
- ④ Machines that have an output of 30 hp or greater are recommended.

*Please make use of the above tables, understanding that they are approximations as only a guide.

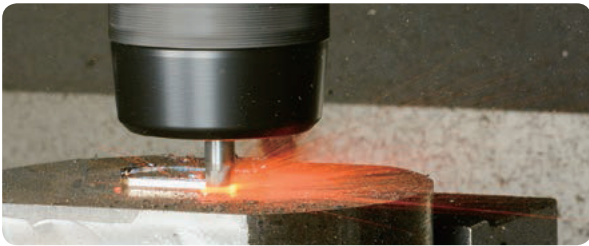
NEW Solid Ceramic End Mill



Features

- Extremely high speed machining for HRSA materials with our durable SiAlON grade "SX9"
- More than 15 times higher productivity than a Carbide end mill
- 4, 6 and 8 flutes are available
- Unique patent pending design provides toughness to the edge

RCE for HRSA materials



● Ceramic specialist's design

Helix angle

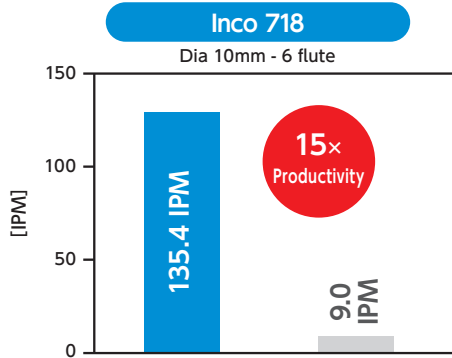
- Designed for the purpose of:
 - 4-flute: toughness
 - 6-flute: less tool pressure and better chip evacuation



- SX9(SiAlON)**
 - Well balanced for toughness and wear resistance
- Flute**
 - Optimized for HRSA materials
 - Excellent toughness

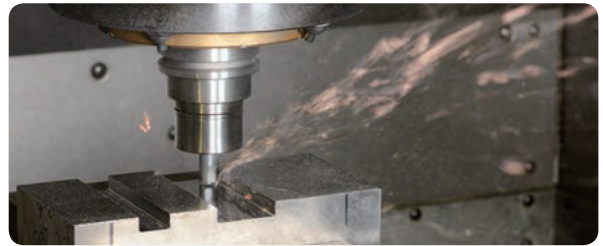
Bottom edge

- Unique shape provides toughness



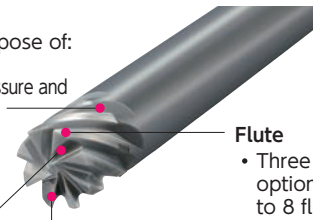
	SX9	Carbide
SFM	1970	130
IPT	.0012	←
DOC	.118	←

RCS for Cast iron / HRSA materials



Helix angle

- Designed for the purpose of:
 - 4-flute: toughness
 - 6/8-flute: less tool pressure and better chip evacuation



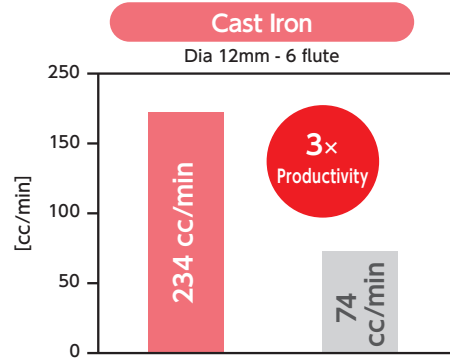
- Flute**
 - Three flute options up to 8 flute

End Gash

- Bigger end gash brings toughness

Edge

- Added chamfer provides toughness for cast iron machining



	SX9	Carbide
SFM	2300	360
IPT	.002	←
DOC	.138	.275

4-flute



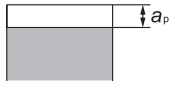


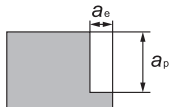


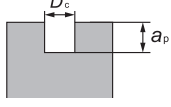




6-flute



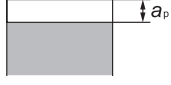


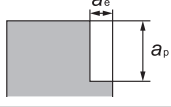


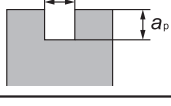


8-flute



● Recommend Cutting Conditions for HRSA material

Application	Grade	ϕD_c	Flute	Cutting Speed (SFM)			Feed (IPT)	Depth of cut (a_p —inch)	Width of cut (a_e —inch)	Coolant
				500	2000	3500				
Face Milling 	SX9	3/8"	4/6/8			.0012	.056	—	DRY 	
		1/2"					.075			
		5/8"					.094			
		3/4"					.113			
		8mm					.047			
		10mm					.059			
		12mm					.071			
		16mm					.094			
		20mm					.118			
Side Milling 	SX9	3/8"	4/6/8			.0012	.187	.037	DRY 	
		1/2"					.250	.050		
		5/8"					.313	.063		
		3/4"					.375	.075		
		8mm					.157	.031		
		10mm					.197	.039		
		12mm					.236	.047		
		16mm					.315	.063		
		20mm					.394	.079		
Slotting 	SX9	3/8"	4			.0012	.094	—	DRY 	
		1/2"					.125			
		5/8"					.156			
		8mm					.079			
		10mm					.098			
		12mm					.118			
		16mm					.157			
		SX9	3/8"	6			.0012	.056	—	DRY 
			1/2"					.075		
			5/8"					.094		
			8mm					.047		
			10mm					.059		
			12mm					.071		
			16mm					.094		
			3/4"					.113		
16mm	.118									

● Recommended cutting conditions for Cast Iron

Application	Grade	ϕD_c	Flute	Cutting Speed (SFM)			Feed (IPT)	Depth of cut (a_p —inch)	Width of cut (a_e —inch)	Coolant
				500	2000	3500				
Face Milling 	SX9	1/2"	4/6/8			.004	.094	—	DRY 	
		5/8"					.156			
		3/4"					.187			
		12mm					.118			
		16mm					.158			
		20mm					.197			
Side Milling 	SX9	1/2"	4/6/8			.004	.375	.083	DRY 	
		5/8"					.469	.104		
		3/4"					.563	.125		
		12mm					.354	.079		
		16mm					.472	.098		
		20mm					.591	.130		
Slotting 	SX9	1/2"	4/6/8			.004	.094	—	DRY 	
		5/8"					.156			
		3/4"					.187			
		12mm					.118			
		16mm					.157			
		20mm					.197			

For Maximum Productivity

- A continuous cut is recommended. An interrupted cut may cause chipping or breakage.
- When using a Hydraulic or Shrink chuck, blow air to the arbor body, DON'T blow air to the endmill itself.
- A Minimum speed of 980 SFM is required. (Don't run at lower speed.)
- A 1.5 degree ramping angle is recommended. Run at 50% lower feed rate when ramping cut.

When cutting HRSA materials

- Continue to machine even if you see BUE, removing BUE may cause chipping or breakage to the edge.
- High speed machining work hardens the material. For this reason, leave at least 0.3mm of material for a finishing process.