MOLDINO
The Edge To Innovation

High Feed Radius End Mill for Hardened Steel

EHHRE-TH3

Epoch High Hard Radius

MOLDINO Tool Engineering, Ltd.
New Product News | No.1709E-2 | 2020-4

Adopt the design of indexable high-feed cutter to solid end mill. High feed cutting for high hardness steel possible

Lineup of Φ 1 ~ Φ 12

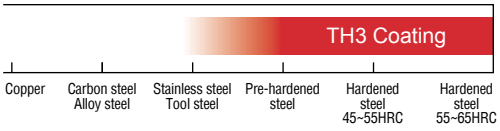
The multi flute end mill enables high efficiency machining even in small precision molds

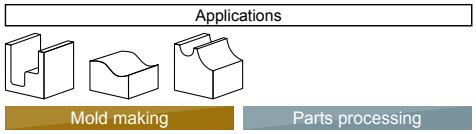
Features of EHHRE-TH3

01 Approximate radius makes much thinner chip than real radius

02 Vibration-free peripheral clearance geometry

03 Newly developed coating "TH3" for hardened steel machining

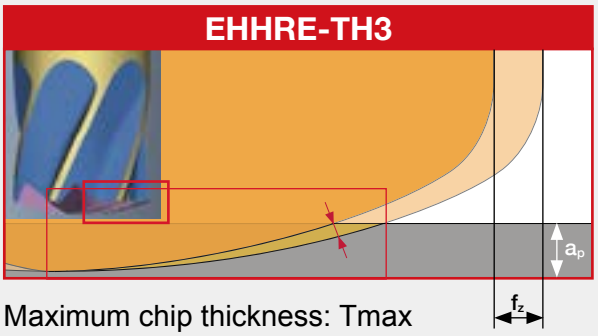




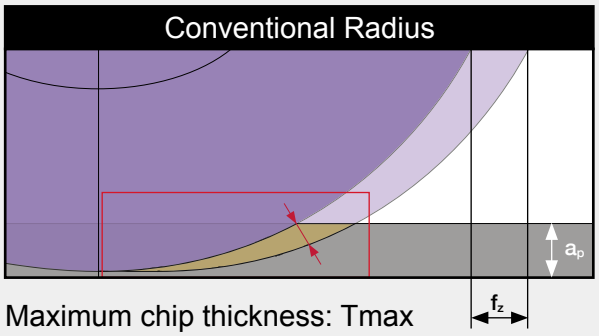
EHHRE-TH3

ϕ1～ϕ12 [13 Items]

Features 01 New Cutting Edge Geometry - Approximate radius makes much thinner chip than real radius

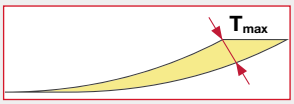


Maximum chip thickness: Tmax



Maximum chip thickness: Tmax

Thinner removed chip

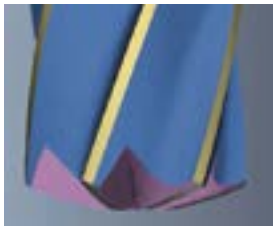


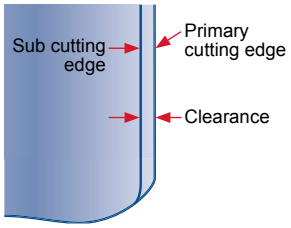
Effect

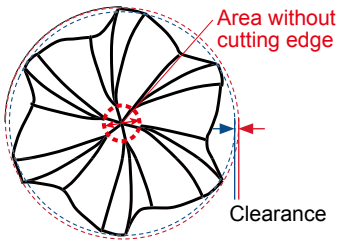
Composite R geometry on bottom cutting edge could create thinner chips than conventional radius geometry (real R), and it enables to reduce cutting force. Furthermore, by making the bottom edge a high helix shape, it improves the chip flow. And achieves excellent chip discharging performance.

Features 02 Peripheral clearance geometry to reduce vibration

Vibration-free peripheral clearance geometry



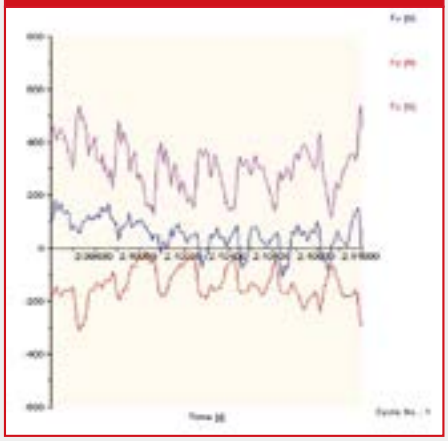




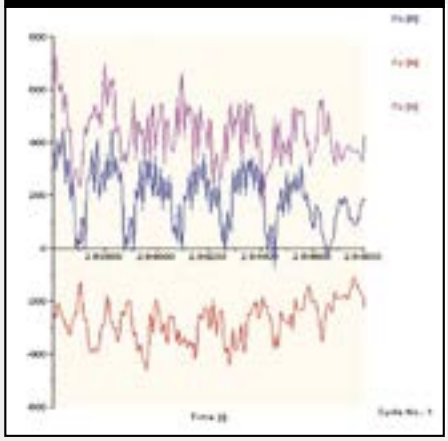
Effect to suppress vibration at corner milling

Work material：DAC㊍ 49HRC　Machine：Vertical MC (HSK-A63)　Tool：EHHRE6100-TH3
Cutting conditions：n=6,000min^{-1}(v_c=188m/min)　v_f=1,800mm/min (f_z=0.05mm/t)
Cutting amount：0.3mm,　Dry with air blow

EHHRE-TH3

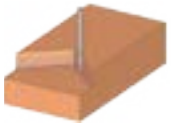


Conventional



Effect

It is possible to minimize chatter vibrations at high speed machining and at corners,
that can suppress unexpected chipping due to chatter vibration and efficiency reduction at corners.



90 degree corner milling

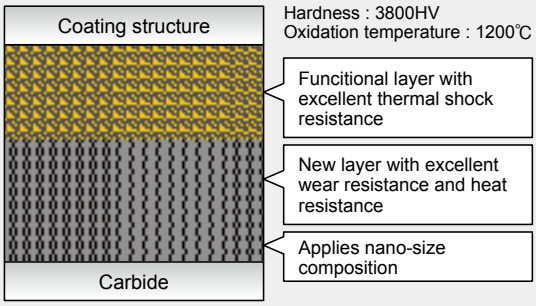
Features 03 Newly developed coating "TH3" for hardened steel machining

Features and performance

- High hardness coating with excellent wear resistance and heat resistance
- Has excellent thermal shock resistance enables to suppress sudden chipping
- Long tool life when cutting high-hardness materials (50HRC or higher) such as hardened steel

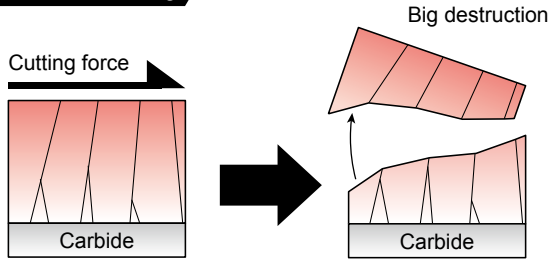
Target steel grade

- Hardened steel (especially 50HRC or higher), high-speed steel

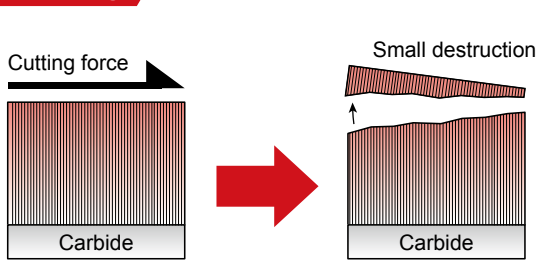


! Point New coating achieves to reduce destruction unit of layer by applying "nano-size composition".

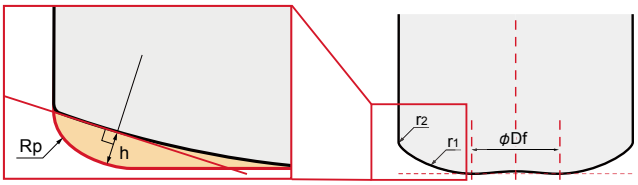
Conventional coating

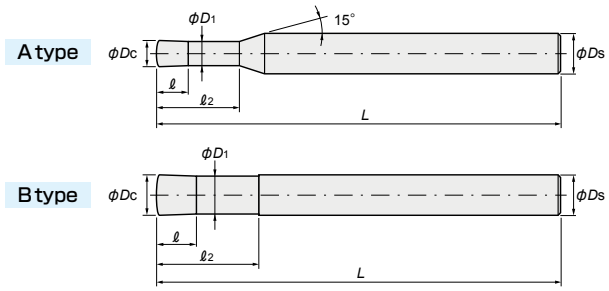


New coating



Line Up, Re-grinding





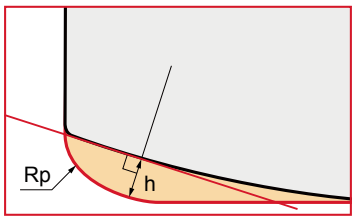
EHHRE○○○○(-S○)-TH3

Roughing | Carbide | 72 HRC | TH3 Coated | 0 -0.02 | Helix 20° | h5 | 4 Flutes | 6 Flutes

Item code	Stock	Size (mm)										No. of flutes	Type
		Tool dia. *Dc*	Approx radius Rp	Lowest point diameter Df	End R r1	Corner radius r2	Under Neck length ℓ2	Flute length ℓ	Neck dia. *D1*	Overall Length *L*	Shank dia. *Ds*		
EHHRE4010-S4-TH3	●	1	0.134	0.28	1.1	0.1	3	1	0.95	50	4	4	A
EHHRE4010-S6-TH3	●							1	0.95	50	6	4	A
EHHRE4020-S4-TH3	●	2	0.194	0.56	2.2	0.1	6	2	1.9	50	4	4	A
EHHRE4020-S6-TH3	●							2	1.9	50	6	4	A
EHHRE4030-S4-TH3	●	3	0.328	0.84	3.3	0.2	9	3	2.9	60	4	4	A
EHHRE4030-S6-TH3	●							3	2.9	60	6	4	A
EHHRE6040-S4-TH3	●	4	0.387	1.12	4.4	0.2	12	4	3.9	60	4	6	B
EHHRE6040-S6-TH3	●							4	3.9	60	6	6	A
EHHRE6050-TH3	●	5	0.521	1.4	5.5	0.3	15	5	4.7	60	6	6	A
EHHRE6060-TH3	●	6	0.581	1.68	6.6	0.3	18	6	5.7	60	6	6	B
EHHRE6080-TH3	●	8	0.849	2.24	8.8	0.5	24	8	7.6	75	8	6	B
EHHRE6100-TH3	●	10	0.968	2.8	11	0.5	30	10	9.5	80	10	6	B
EHHRE6120-TH3	●	12	1.088	3.36	13.2	0.5	36	12	11.5	100	12	6	B

● : Stocked items.

Precaution for creating machining program



- When entering corner radius into CAM as radius end mill, Please use approximate R for your programing corner radius.
- For precise tool definition for the CAM system please download DXF data from "TOOL SEARCH" program on our website.

Tool Dia. *Dc*	Approx radius and maximum remains at CAM input		Ramping angle *θ*	Possible helical hole dia. D
	Approx radius Rp	Max remains h		
Φ1	0.134	0.026	0.5° or less	1.3~1.9
Φ2	0.194	0.068		2.6~3.8
Φ3	0.328	0.094		3.9~5.7
Φ4	0.387	0.136		5.2~7.6
Φ5	0.521	0.162		6.4~9.5
Φ6	0.581	0.204		7.7~11.4
Φ8	0.849	0.255		10.3~15.2
Φ10	0.968	0.34		12.8~19.0
Φ12	1.088	0.424		15.4~22.8

※For helical machining, Please set feed rate to 70% of recommended cutting condition.

Re-grinding compatibility range table

Item Code	Product	Line up tool dia. (mm)	Shape	Re-grinding compatibility range (mm)	
				Outer Dia.	End
EHHRE-TH3	Epoch High Hard Radius	1~12		×	2~12

Recommended Cutting Conditions

General cutting conditions (Emphasis on tool life)

Work material		Hardened steels (50～55HRC) ※1				Hardened steels (55～62HRC)			
Tool dia. Dc (mm)	No. of flutes	Cutting speed vc=80m/min				Cutting speed vc=60m/min			
		n (min-1)	Vf (mm/min)	ap (mm)	ae (mm)	n (min-1)	Vf (mm/min)	ap (mm)	ae (mm)
1	4	25,500	3,670	0.040	0.55	19,100	1,720	0.023	0.55
2	4	12,700	3,660	0.080	1.1	9,600	1,730	0.046	1.1
3	4	8,500	3,840	0.120	1.65	6,400	1,800	0.069	1.65
4	6	6,400	5,840	0.160	2.2	4,800	2,740	0.092	2.2
5	6	5,100	5,940	0.200	2.75	3,800	2,760	0.115	2.75
6	6	4,200	5,870	0.240	3.3	3,200	2,790	0.138	3.3
8	6	3,200	6,140	0.320	4.4	2,400	2,880	0.184	4.4
10	6	2,500	6,000	0.400	5.5	1,900	2,850	0.230	5.5
12	6	2,100	5,750	0.480	6.6	1,600	2,740	0.276	6.6

Work material		Hardened steels (62～66HRC)				Hardened steels (66～72HRC)			
Tool dia. Dc (mm)	No. of flutes	Cutting speed vc=50m/min				Cutting speed vc=40m/min			
		n (min-1)	Vf (mm/min)	ap (mm)	ae (mm)	n (min-1)	Vf (mm/min)	ap (mm)	ae (mm)
1	4	15,900	1,070	0.019	0.55	12,700	570	0.013	0.5
2	4	8,000	1,080	0.038	1.1	6,400	580	0.026	1
3	4	5,300	1,120	0.057	1.65	4,200	590	0.039	1.5
4	6	4,000	1,710	0.076	2.2	3,200	910	0.052	2
5	6	3,200	1,750	0.095	2.75	2,500	910	0.065	2.5
6	6	2,700	1,770	0.114	3.3	2,100	920	0.078	3
8	6	2,000	1,800	0.152	4.4	1,600	960	0.104	4
10	6	1,600	1,800	0.190	5.5	1,300	980	0.130	5
12	6	1,300	1,670	0.228	6.6	1,100	940	0.156	6

Cutting conditions for high-efficiency cutting (Emphasis on efficiency)

Work material		Hardened steels (50～55HRC) ※1				Hardened steels (55～62HRC)			
Tool dia. Dc (mm)	No. of flutes	Cutting speed vc=100m/min				Cutting speed vc=70m/min			
		n (min-1)	Vf (mm/min)	ap (mm)	ae (mm)	n (min-1)	Vf (mm/min)	ap (mm)	ae (mm)
1	4	31,880	4,730	0.038	0.7	22,280	2,070	0.022	0.7
2	4	15,880	4,710	0.076	1.4	11,200	2,080	0.044	1.4
3	4	10,630	4,940	0.114	2.1	7,470	2,170	0.066	2.1
4	6	8,000	7,510	0.152	2.8	5,600	3,290	0.087	2.8
5	6	6,380	7,650	0.190	3.5	4,430	3,320	0.109	3.5
6	6	5,250	7,550	0.228	4.2	3,730	3,350	0.131	4.2
8	6	4,000	7,910	0.304	5.6	2,800	3,460	0.175	5.6
10	6	3,130	7,740	0.380	7	2,220	3,430	0.219	7
12	6	2,630	7,410	0.456	8.4	1,870	3,290	0.262	8.4

Work material		Hardened steels (62～66HRC)				Hardened steels (66～72HRC)			
Tool dia. Dc (mm)	No. of flutes	Cutting speed vc=60m/min				Cutting speed vc=50m/min			
		n (min-1)	Vf (mm/min)	ap (mm)	ae (mm)	n (min-1)	Vf (mm/min)	ap (mm)	ae (mm)
1	4	19,080	1,330	0.018	0.7	15,880	740	0.012	0.6
2	4	9,600	1,330	0.036	1.4	8,000	740	0.025	1.2
3	4	6,360	1,390	0.054	2.1	5,250	760	0.037	1.8
4	6	4,800	2,110	0.072	2.8	4,000	1,170	0.049	2.4
5	6	3,840	2,160	0.090	3.5	3,130	1,170	0.062	3
6	6	3,240	2,190	0.108	4.2	2,630	1,180	0.074	3.6
8	6	2,400	2,220	0.144	5.6	2,000	1,240	0.099	4.8
10	6	1,920	2,220	0.181	7	1,630	1,260	0.124	6
12	6	1,560	2,060	0.217	8.4	1,380	1,220	0.148	7.2

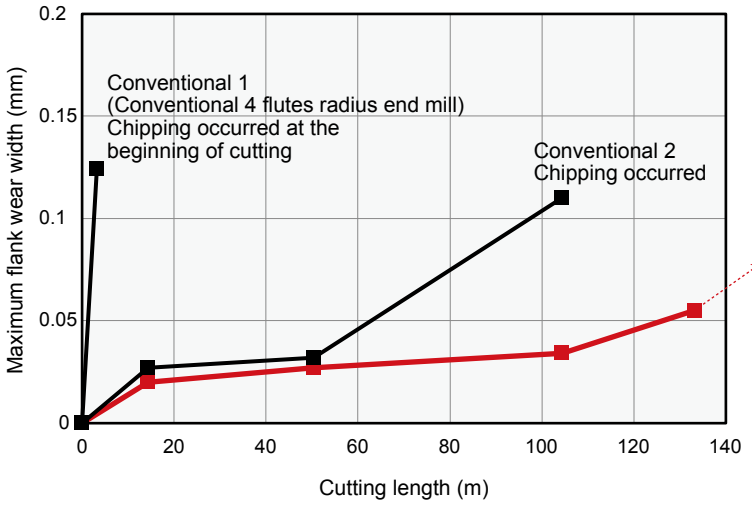
【Note】
① Use the appropriate coolant for the work material and machining shape.
② Use a highly rigid and accurate machine as possible.
③ These Recommended Cutting Conditions indicate only the rule of a thumb for the cutting conditions. In actual machining, the condition should be adjusted according to the machining shape, purpose and the machine type.
④ If the rpm available is lower than that recommended please reduce the feed rate to the same ratio.
⑤ **Please use for contouring process.**
⑥ **Setting pick feed (ae) larger than lowest point diameter will remain cusp.**

※1 Since EHHRE-TH3 adopts a cutting edge geometry for high hardness steel cutting, it is not suitable for sticky hard material such as hot forging material SKD61 (reformed). EMBE-ATH is recommended for cutting SKD61 (reformed).

Field data

Tool life evaluation of cutting SKD11Ⓗ

Tool size：ϕ10×6 flutes　Work material：SKD11Ⓗ(60HRC)　Machine：Vertical MC (HSK-F63)
Cutting conditions：n=1,900min^{-1} (v_c=60m/min)　v_f=2,850mm/min (f_z=0.25mm/t)　a_p 0.2mm　a_e 5.5mm
OH＝30mm　Coolant：Air-blow

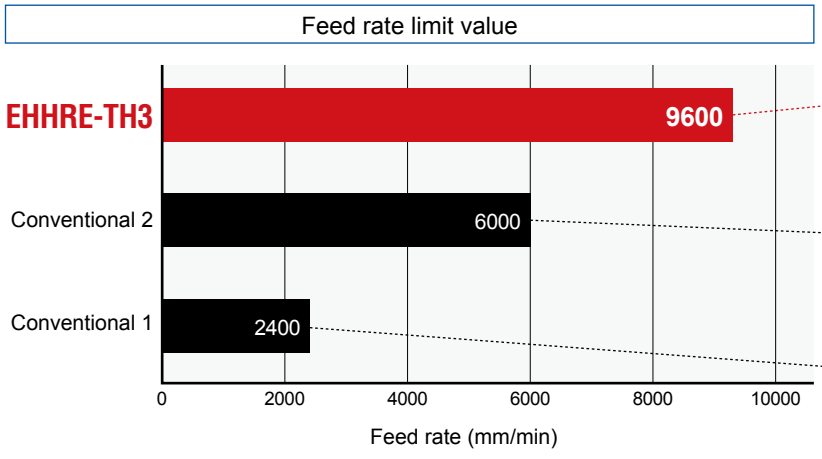


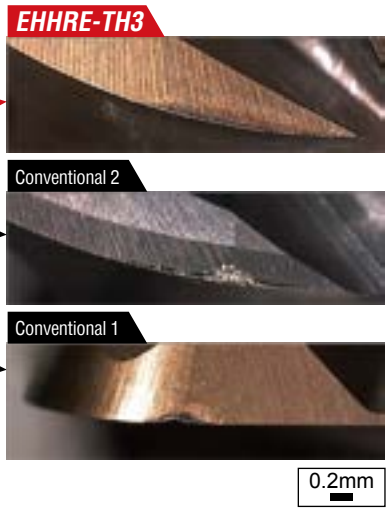
EHHRE-TH3 achieves more than twice the tool life of conventional products

High feed cutting of high hardness steel which was difficult with conventional radius geometry was realized.

Marginal test to evaluate feed limit for cutting powder high-speed steel

Tool size：ϕ10×6 flutes　Work material：HAP40(65HRC)　Machine：Vertical MC (HSK-F63)
Cutting conditions：n=2,000min^{-1}(v_c=63m/min)　v_f=Refer to below table　a_p 0.15mm　a_e 3mm　OH＝30mm
Coolant：Air-blow





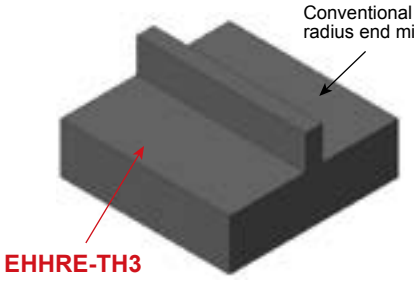
High feed cutting of high hardness steel is possible by synergistic effect of low cutting force radius geometry and TH3 coating.

Example of high-efficiency roughing of matrix high-speed steel

Work size：100×100mm　Work material：YXR33(58HRC)　Machine：Vertical MC(BT40)　Coolant：Air-blow

Tool	Tool Dia. [mm]	R [mm]	Revolution [min^{-1}]	Cutting speed [m/min]	Feed rate [mm/min]	Feed per tooth [mm/t]	a_p [mm]	a_e [mm]	Chip removal volume [cm^3/min]	Machining time
EHHRE6100-TH3	10	0.968	2,200	69	4,000	0.3	0.2	6	4.8	24 min
Conventional (4 flutes radius)	10	2	2,100	66	2,000	0.24	0.15	3	0.9	1hr. 25min.

Work shape：100×45×Depth10mm



Wear condition after cutting

Micro wear, possible to use continuously

Chipping occured on R edge

EHHRE achieved 5 times cutting efficiency than conventional tool. Good wear condition that can use continuously.

High-efficiency cutting example of powder high-speed steel

Work size：50×50mm　Work material：HAP40 (65HRC)　Machine：Vertical MC(HSK-F63)

Process	Tool	Tool Dia. [mm]	R [mm]	Revolution [min^{-1}]	Cutting speed [m/min]	Feed rate [mm/min]	Feed per tooth [mm/t]	a_p [mm]	a_e [mm]	Removal stock [mm]	Coolant	Machining time
Contour roughing ❶	EHHRE4030-S6-TH3	3	0.328	6,360	60	1,390	0.055	0.054	2	0.05	Air-blow	1hr. 3min.
Contour roughing ❷	EHHRE4030-S6-TH3	3	0.328	6,360	60	1,390	0.055	0.054	2	0.05	Air-blow	1hr. 3min.

Figure　Work model

Cubic shape size：5×5×6mm, Space 5mm

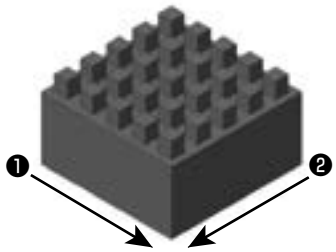


Figure　Work after cutting

Figure　Wear condition after roughing

Normal wear even after 1 hour cutting

EHHRE can perform high-efficiency machining even for small work-piece of high hardness steel

After roughing by EHHRE-TH3, recommended semi-finishing and finishing with the following tool.

Epoch High Hard Ball (EHHB-ATH), Epoch Deep Ball Evolution Hard -TH3 (EPDBEH-TH3)

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The diagrams and table data are examples of test results, and are not guaranteed values.

⚠ Attentions on Safety

1. Cautions regarding handling

(1) When removing the tool from its case (packaging), be careful that the tool does not pop out or is dropped. Be particularly careful regarding contact with the tool flutes.
(2) When handling tools with sharp cutting flutes, be careful not to touch the cutting flutes directly with your bare hands.

2. Cautions regarding mounting

(1) Before use, check the outside appearance of the tool for scratches, cracks, etc. and that it is firmly mounted in the collet chuck, etc.
(2) If abnormal chattering, etc. occurs during use, stop the machine immediately and remove the cause of the chattering.

3. Cautions during use

(1) Before use, confirm the dimensions and direction of rotation of the tool and milling work material.
(2) The numerical values in the standard cutting conditions table should be used as criteria when starting new work. The cutting conditions should be adjusted as appropriate when the cutting depth is large, the rigidity of the machine being used is low, or according to the conditions of the work material.
(3) Cutting tools are made of a hard material. During use, they may break and fly off. In addition, cutting chips may also fly off. Since there is a danger of injury to workers, fire, or eye damage from such flying pieces, a safety cover should be attached when work is performed and safety equipment such as safety goggles should be worn to create a safe environment for work.
(4) There is a risk of fire or inflammation due to sparks, heat due to breakage, and cutting chips. Do not use where there is a risk of fire or explosion. **Please caution of fire while using oil base coolant, fire prevention is necessary.**
(5) Do not use the tool for any purpose other than that for which it is intended.

4. Cautions regarding regrinding

(1) If regrinding is not performed at the proper time, there is a risk of the tool breaking. Replace the tool with one in good condition, or perform regrinding.
(2) Grinding dust will be created when regrinding a tool. When regrinding, be sure to attach a safety cover over the work area and wear safety clothes such as safety goggles, etc.
(3) This product contains the specified chemical substance cobalt and its inorganic compounds. When performing regrinding or similar processing, be sure to handle the processing in accordance with thelocal laws and regulations regarding prevention of hazards due to specified chemical substances.

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