4 FLUTE 30° HELIX STANDARD

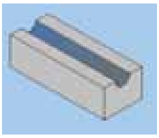
SQUARE AND BALL END

GENERAL INFORMATION

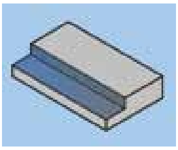
Used for general purpose milling in most materials of medium hardness such as steel, brass, iron and non-ferrous materials. Made from premium submicron grain carbide. All recommendations should be considered as starting points for the application. An increase of 10% increments on both feed and speed is recommended to reach optimal performance. The best way to ensure the optimal cutting action is by examining the chips as they are released from the work piece to make sure they are not too blue in color which would indicate that the tool is running HOT and slower feeds may be needed at this time. Another way to determine optimal cutting rates is by examining the chips as they are released to make sure they are not too long in length and should be little 6's and 9's in shape. If the chips are too long then the material is not breaking away form the mill adequately to ensure a smooth cutting action. Speeds and feeds would need to be adjusted and or another style end mill might need to be used. When using a coating on an end mill, an increase of 20% is normally recommended for both feed and speed rates.

APPLICATION SPECIFICATIONS

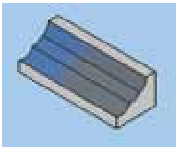
4 flute 30° helix end mills generally are used in finishing applications to ensure dimensional accuracy and, that work piece finishes can be achieved. 4 flute end mills are stronger than either the 2 or 3 flute designs. This added rigidity allows higher metal removal rates with minimum deflection. Limited chip volume area restricts stock removal rates and deep plunge cutting is not recommended. With the evolution of carbide end mills today there are many finishing applications that can and will use additional flutes and nomenclature designs to achieve the best results based on the material being machined.



Slotting



Profiling/ Finishing



Contour Finishing

All general information and application specifications are to be used as guides and starting points only. Because of the multitude of variables used in the milling process, use this information as a guideline only. All speeds and feeds are also suggested starting pints. They may be increased or decreased depending on machine condition, depth of cut, finish requirements, coolant, etc.

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2 & 4 Flute Metric

Uncoated

Material	SFM	Chip load per tooth			
		3mm	6mm	12mm	25mm
Aluminum Alloys	600-1200	.0010	.0020	.0040	.0080
Brass	200-350	.0010	.0020	.0030	.0050
Bronze	200-350	.0010	.0020	.0030	.0050
Carbon Steel	100-600	.0010	.0015	.0030	.0060
Cast Iron	80-350	.0010	.0015	.0030	.0060
Cast Steel	200-350	.0005	.0010	.0020	.0040
Cobalt Base Alloys	20-80	.0005	.0008	.0010	.0020
Copper	350-900	.0010	.0020	.0030	.0060
Die Steel	50-300	.0005	.0010	.0020	.0040
Graphite	600-1000	.0020	.0050	.0080	.0100
Inconel/ Monel	30-50	.0005	.0010	.0015	.0030
Magnesium	900-1300	.0010	.0020	.0040	.0080
Malleable Iron	200-500	.0005	.0010	.0030	.0070
Nickel Base Alloys	50-100	.0002	.0008	.0010	.0020
Plastic	600-1200	.0010	.0030	.0060	.0100
Stainless Steel - Free Machining	100-300	.0005	.0010	.0020	.0030
Stainless Steel - Other	50-250	.0005	.0010	.0020	.0030
Steel - Annealed	100-350	.0010	.0020	.0030	.0050
Steel - Rc 18-24	100-500	.0004	.0008	.0015	.0045
Steel - Rc 25-37	25-120	.0003	.0005	.0010	.0030
Titanium	100-200	.0005	.0008	.0015	.0030

Coated

Material	SFM	Chip load per tooth			
		3mm	6mm	12mm	25mm
Aluminum Alloys	900-1800	.0010	.0020	.0040	.0080
Brass	300-525	.0010	.0020	.0030	.0050
Bronze	300-525	.0010	.0020	.0030	.0050
Carbon Steel	150-900	.0010	.0015	.0030	.0060
Cast Iron	120-525	.0010	.0015	.0030	.0060
Cast Steel	300-525	.0005	.0010	.0020	.0040
Cobalt Base Alloys	30-120	.0005	.0008	.0010	.0020
Copper	525-1350	.0010	.0020	.0030	.0060
Die Steel	75-450	.0005	.0010	.0020	.0040
Graphite	900-1500	.0020	.0050	.0080	.0100
Inconel/ Monel	45-75	.0005	.0010	.0015	.0030
Magnesium	1350-1950	.0010	.0020	.0040	.0080
Malleable Iron	300-750	.0005	.0010	.0030	.0070
Nickel Base Alloys	75-150	.0002	.0008	.0010	.0020
Plastic	900-1800	.0010	.0030	.0060	.0100
Stainless Steel - Free Machining	150-450	.0005	.0010	.0020	.0030
Stainless Steel - Other	75-375	.0005	.0010	.0020	.0030
Steel - Annealed	150-525	.0010	.0020	.0030	.0050
Steel - Rc 18-24	150-750	.0004	.0008	.0015	.0045
Steel - Rc 25-37	38-180	.0003	.0005	.0010	.0030
Titanium	150-300	.0005	.0008	.0015	.0030

Problems / Solutions

Problem/Cause	Solution
Breakage	
Feed is too heavy	Reduce feed rate
Cut is too heavy	Decrease width and depth-of-cut
Overhang of tool is too much	Hold shank deeper, use shorter end mill
Wear is too much	Regrind at earlier stage
Wear	
Speed is too fast	Decrease spindle speed, use another coolant
Hard work material	Use Coatings (TiN, TiCN, TiAlN)
Improper speed and feed (too slow)	Increase feed and speed
Improper helix angle	Change tool to correct helix angle
Primary relief angle is too large	Change to smaller relief angle
Recutting chips	Change feed and speed, Change chip size or clear chips with more coolant or air pressure
Short Tool Life	
Cutting friction is too much	Regrind at earlier stage
Hard work material	Use Coatings (TiN, TiCN,TiAlN)
Improper helix and relief angle	Change to correct helix angle and primary relief
Chipping	
Feed rate too heavy	Reduce feed rate
Feed too heavy on first cut	Reduce feed rate on first cut
Lack of rigidity (machine & holder)	Use better machine or tool holder or change parameters
Lack of rigidity (tool)	Use shorter tool, hold shank deeper, try climb milling
Tool cutting corner too sharp	Decrease primary relief and cutting angle, reduce radial width-of-cut
Chip Packing	
Cut too heavy	Decrease width and depth-of-cut
Not enough chip clearance	Use end mill with less flutes
Not enough coolant	Use higher coolant pressure and reposition nozzle to point of cut or use air pressure

Problems / Solutions

Burrs	
Wear on primary relief is too much	Regrind earlier stage
Incorrect feed and speed rates	Correct cutting parameters
Improper helix angle	Change to correct cutting angle
Rough Surface Finish	Start operation with initial surface cut
Feed rate too heavy	Reduce feed rate
Cutting speed is too slow	Increase RPM
Wear is too much	Regrind at earlier stage
No end tooth concavity	Grind concave angle on bottom teeth
Recutting chips	Change feed and speed, change chip size or clear chips with coolant or air pressure
Chattering	
Feed and speed too fast	Correct feed and speed
Lack of rigidity (machine & holder)	Use better machine or tool holder or change parameters
Poor set up	Improve clamping rigidity
Cut is too heavy	Decrease width and depth of cut
Overhang of tool is too much	Hold shank deeper, use shorter end mill
Lack of relief	Decrease relief angle, make margin: (touch primary with oil stone)
Side Wall Taper in Work piece	
Feed rate too heavy	Reduce feed rate
Overhang of tool is too much	Hold shank deeper, use shorter end mill
Too few flutes	Use multi flute end mills, use end mill with higher rigidity
No Dimensional Accuracy	
Cut is too heavy	Decrease width and depth of cut
Lack of accuracy (machine & holder)	Repair machine or holder
Rigidity is not enough (machine & holder)	Change machine or tool holder or change parameters
Too few flutes	Use multi flute end mills, use end mill with higher rigidity

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Rushmore USA Coating Information

Coating	TiN Titanium Nitride	TiCN Titanium Carbontride	AlTiN Aluminum Titanium Nitride
Applications	General purpose coating for machining ferrous materi-als. Less expensive than AlTiN coating. Good low cost alternative to AlTiN in applications not generating extreme heat.	Steels over 40 Rc and aluminum alloys.	High performance coating for ferrous materials. Excellent high temperature resistance and hardness. Maintains high surface hardness at elevated temperature improving tool life and allowing faster feed rates. Produces aluminum oxide layer at high temperature which reduces thermal conductivity transferring heat into the chip.
Materials	General purpose ferrous materials	Alloy steels, stainless steels, and in high speed cutting where moderate tempera-tures are generated at the cutting edges.	Alloy steels, stainless steels, tool steels, titanium, inconel, nickel and other aerospace materials.
Color	Gold	Brown	Dark Grey - Black
Structure	Mono-layer	Multi-layer	Multi-layer
Hardness	24GPa	37GPa	Up to 38GPa
Thermal Stability	1100° F	750° F	1450° F

Coating	nACo Aluminum Titanium Nitride + Silicon Nitride	ZrN Zirconium Nitride
Applications	Is an extremely high heat resistance coating with high nanohardness. Especially suited for high performance milling and drilling with rigid set ups. nACo's hardness comes from it's nano-composite structure. Coating consists of nano crystalline AlTiN grains embedded in an amorphous silicon nitride matrix.	High hardness, lubricity and abrasion resistance. Improves performance over uncoated carbide in a wide variety of non-ferrous materials. Less expensive alternative to diamond.
Materials	Alloy steels, stainless steels, tool steels, titanium, inconel, nickel and other aerospace materials.	Abrasive non- ferrous alloys such as Brass, Bronze, Copper and Abrasive Aluminum Alloys
Color	Black	Light Gold
Structure	Multi-layer	Mono-layer
Hardness	45GPa	24.6GPa
Thermal Stability	1652° F	1100°F

Rushmore USA Coating Information

Material	Hardness	1st Choice	2nd Choice
Aluminum		ZrN	TiCN
Alloy Steel	16-23 HRc	AlTiN	TiCN
Alloy Steel	23-38 HRc	AlTiN	nACo
Alloy Steel	>38 HRc	nACo	AlTiN
Carbon Steel	16-23 HRc	AlTiN	TiCN
Carbon Steel	23-38 HRc	AlTiN	nACo
Carbon Steel	>38 HRc	nACo	AlTiN
Hardened Steel	>42 HRc	nACo	AlTiN
Low Carbon Steel	13-23 HRc	AlTiN	TiCN
Low Carbon Steel	23-38 HRc	AlTiN	nACo
Low Carbon Steel	>38 HRc	nACo	AlTiN
Gray Cast Iron	18-22 HRc	nACo	AlTiN
Nodular Cast Iron	22-32 HRc	TiCN	nACo
Austenetic Stainless Steel	<35 HRc	TiCN	nACo
Martinsitic Stainless Steel	<35 HRc	nACo	AlTiN
Martinsitic Stainless Steel	>=35 HRc	nACo	AlTiN
Ni Alloys		nACo	AlTiN
PH Stainless Steel	<35 HRc	nACo	AlTiN
PH Stainless Steel	>=35 HRc	nACo	AlTiN
Ni, Co, Fe, Based Superalloys		nACo	AlTiN
High Si Aluminum		ZrN	TiCN
Titanium		nACo	AlTiN

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Technical Guide

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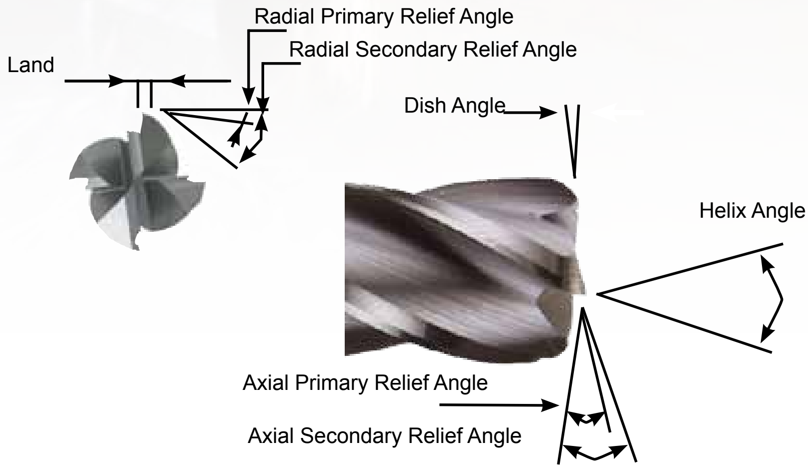
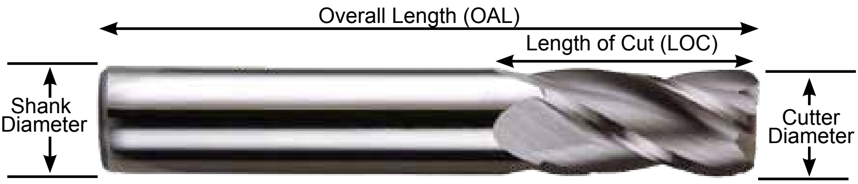
Solid carbide end mills are rapidly replacing high speed steel end mills because production costs can be reduced as a result of the extreme metal removal rates which can be achieved with solid carbide end mills. When combined with the appropriate coating and the correct set up, optimal performance may be achieved.

It is important to comply with the following for the best performance results:
Machine Capability: The machine must have the necessary rigidity to minimize spindle deflection and sufficient horsepower to perform at recommended speeds and feeds.
Holders: Tool holders and collets must provide good concentricity between tool and machine spindle.
Workpiece: A secure and rigid workpiece to minimize deflection is needed. This is most important in climb milling operations. Because of the rigidity factor required in climb milling, speeds and feeds may be reduced by up to 25%.





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