ACHTECK

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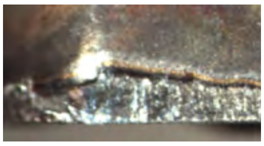
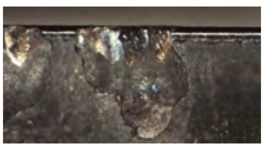
THE EXPERTS OF DIFFICULT MACHINING

CUTTING TOOL CATALOG

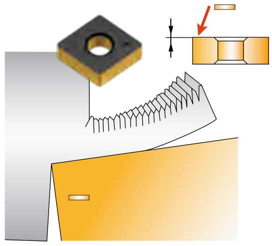
Turning Insert Common Failure Mode & Solutions

Failtures	Picture	Analysis	Solution
Flank wear		• Tool material is too soft • Excessive cutting speed • Too small clearance angle • Too low feed rate • Insufficient cooling	• Choose high wear-resistant insert grade • Reduce cutting speed • Enlarge clearance angle • Increase feed rate
Crater wear		• Tool material is too soft • Excessive cutting speed • Excessive feed rate	• Choose high wear-resistant insert grade • Reduce cutting speed • Reduce feed rate • Increase the flow of coolant
Chipping		• Tool material is too hard • Too low cutting edge strength	• Choose tougher grade • Enhance cutting edge strength
Plastic deformation		• Tool material is too soft • Too fast cutting speed • Excessive cutting depth & feed rate • Insufficient cooling	• Choose high wear-resistant insert grade • Reduce cutting speed • Reduce cutting depth & feed rate • Choose good thermal conductivity grade • Increase the flow of coolant
Built-up edge		• Too low cutting speed • Cutting edge not sharp • Unsuitable grade • Insufficient cooling	• Increase cutting speed • Choose sharp geometry • Choose less adhesion grade • Increase the flow of coolant
Mechanical wear		• Excessive feed rate and cutting depth • Vibration	• Choose tougher grade • Choose a smaller approach angle • Choose bigger corner radius • Change to high rigidity holder
Thermal cracking		• Excessive cutting heat change on edge	• Choose dry cutting or adequate cooling • Choose tougher grade
Notch wear		• Excessive feed rate & cutting speed • Tool material is too soft	• Choose high wear-resistane grade • Select a small entering angle • Reduce cutting speed
Coating peeling		• Sticky chip on the cutting edge • Chip evacuation failure	• Enlarge rake angle for a sharp edge • Use chip breaker with bigger chip space

Negative and Positive Insert Comparison

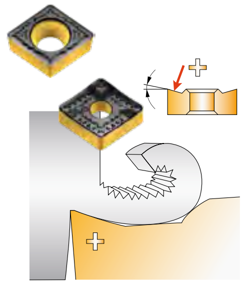
Negative insert

- Double/single sided
- High strength edge
- Zero clearance angle
- First choice for external turning
- For heavy cutting conditions



Positive insert

- Single sided
- Low cutting forces
- With clearance angle
- 1st choice for boring and turning on slender parts

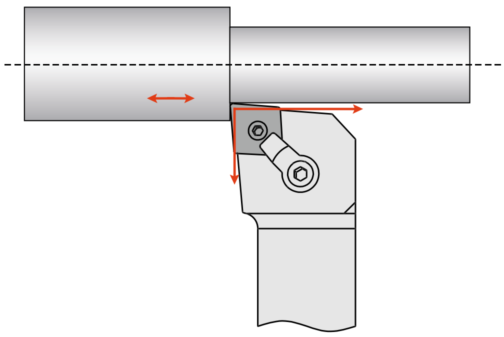


Effects of Approach Angle

Approach angle Kr is the angle between cutting edge and feed direction. It's an important angle in turning that will affect:

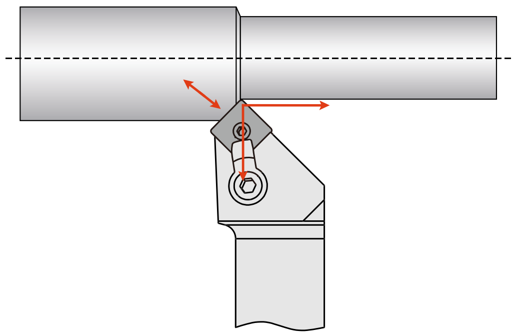
- Chip formation
- Cutting force direction
- Cutting edge length

Large Approach Angle



- Cutting forces along with axis, less tendency for vibration.
- Can turn against the shoulder
- Higher cutting forces at the entrance and exit of cut
- It is easy to get notch wear in heat resistant alloy and hard materials

Small Approach Angle



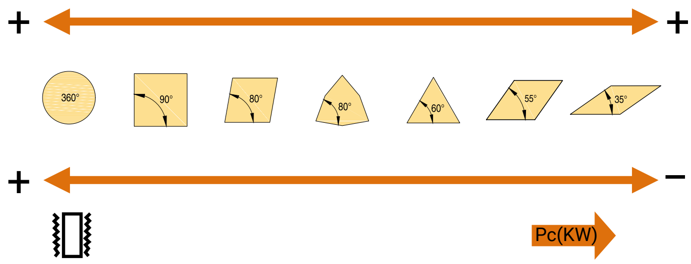
- Reduced the load on the cutting edge.
- Produced a thinner chip, higher feed rate can be used
- Reduced notch wear
- Cannot turn against a shoulder.
- Forces are directed to both axial and radial-vibration tendencies.

Insert Shape

Insert shape should be selected according to the approach angle accessibility of the tool. The largest point angle should be applied to get insert strength and reliability.

Larger point angle and higher cutting edge strength to the left.

Higher edge accessibility and operational versatility to the right.



Higher vibration tendency

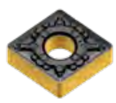
Less power consumption

Factors affecting insert shape selection

Insert shape	R	S 90°	C 80°	W 80°	T 60°	D 55°	V 35°
Roughing (strength)	●	●	●	▲	▲		
Light roughing/semi finishing (number of cutting edges)		▲	●	●	●	●	
Finishing (number of cutting edges)			▲	▲	●	●	●
Vibration tendency				▲	●	●	●
Longitudinal turning (feed direction)			●	▲	▲	●	●
Profiling (accessibility)			▲	▲	▲	●	●
Facing (feed direction)	▲	●	●	●	▲	▲	
Operational versatility	▲		●	▲	▲	●	▲
Limited machine power			▲	▲	●	●	●
Hard material	●	●					
Interrupted machining	●	●	▲	▲	▲		
Large approach angle			●	●	●	●	
Small approach angle	●	●		●	●		

Marked: ● Most suitable ▲ Suitable

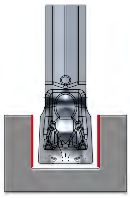
C-style 80°inserts are frequently used as it's suitable for the most applications.



Application Tips for Parting off and Grooving

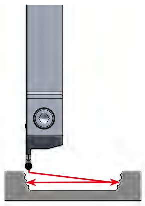
Single grooving

● Single grooving is the most economical and productive method for machining grooves.
● GS chip breaker has width tolerance of +/- 0.0008inch, and works well at low feed.



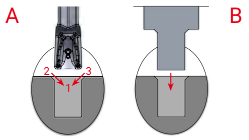
Ramping style grooving

● Ramping style grooving avoids vibration and minimizes radial force. This method can achieve best chip control and reduce notch wear during machining heat resistant alloys
● Higher feed rate can be applied to profiling RM or RA geometry to achieve higher stability and productivity.
● Note: Ramping style grooving doubled the number of passes



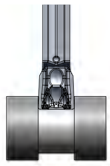
Chamfered corners

● In case of producing high quality grooves, usually the corners on the insert can be used for chamfering. For example, a finish grooving insert is used to chamfer; as per illustration A
● A better way to make grooves with chamfer in mass production is to order a Tailor Made insert with the exact chamfer form as per illustration B.



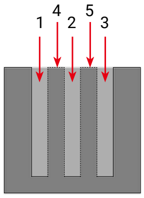
Flatness of the groove bottom

● In case of machining radial grooves, sometimes the flatness of the groove bottom is required.
● Generally, GS, TM, G chip breakers are used to machine completely flat bottom grooves.



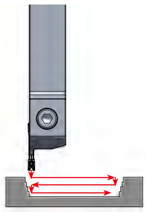
Multiple grooving

● It's the best method for rough grooving when groove depth is bigger than groove width.
● Multiple grooving will improve chip flow and increase tool life.
● Ring's width is generally 0.6-0.8 times insert's width.



Plunge turning

● TS and TM chip breaker can be used for plunge turning and ramping, as the insert design is suitable for axial and radial feed.
● In case of turning axially, depth should not exceed 0.75 x insert width.



CITIZEN

Cincom product series

product	Tool size (Gang-Type)	No	Tool size(Turret-Type)	No	Guide-bushing D(in)	Max.Machining Dia.D(in)
A12	0.394×0.394×3.937	5			0.75/0.787	0.472
A16	0.394×0.394×3.937	5			0.75/0.787	0.63
A20	0.472×0.472×4.724	5-7			1.0	0.787
A25	0.472×0.472×4.724	5-6			1.0	0.984
A32	0.63×0.63×5.906				1.0	1.26
B12/B12E	0.394×0.394×3.937	5			0.75/0.787	0.472
B16E	0.394×0.394×3.937	5			0.75/0.787	0.63
B20	0.472×0.472×4.724	6			0.75/0.787	0.787
BL12	0.394×0.394×2.362-4.724	5			0.787	0.472
BL20	0.472×0.472×4.724	7			0.787	0.787
BL25	0.472×0.472×4.724	7			0.787	0.984
C12	0.394×0.394×3.937	6			0.75	0.472
C16	0.394×0.394×3.937	6			0.75	0.63
C32	0.63×0.63×5.118	5			1.0	1.26
E32			0.63×0.63×3.543	20	1.0	1.26
F10			0.394×0.394×2.362	10	0.75	0.394
F12			0.394×0.394×2.362	10	0.75	0.472
F16			0.394×0.394×2.362	10	0.75	0.63
F20			0.63×0.63×3.543	10	1.0	0.787
F25			0.63×0.63×3.543	10	1.0	0.984
FL25			0.63×0.63×3.543	12	0.63	0.984
FL42			0.63×0.63×3.543	12	0.63	1.654
G10			0.394×0.394×2.362	8		0.394
G16			0.394×0.394×2.362	8		0.63
G32			0.63×0.63×3.543	10		1.26
K12/K12E	0.394×0.394×3.937	7			0.787	0.472
L16/K16E	0.472×0.472×4.724	6			0.787	0.63
L10	0.315×0.315×3.937-5.118	5			0.625	0.394
L16/L16E	0.472×0.472×5.118	7			0.75	0.63
L20/L20E	0.472×0.472×5.118	7			0.75	0.787
L25	0.63×0.63×5.118	5			1.0	0.984
L32	0.63×0.63×5.118	5			1.0	1.26
M12	0.394×0.394×4.724	5	0.394×0.394×2.362	10	0.75	0.472
M16	0.394×0.394×4.724	5	0.394×0.394×2.362	10	0.75	0.63
M20	0.472×0.472×5.118	5	0.63×0.63×3.543	10	1.0	0.787
M32	0.63×0.63×5.118	5	0.63×0.63×3.543	10	1.0	1.26
MSL12	0.394×0.394×4.724		0.394×0.394×2.362	10		0.472
R04	0.315×0.315×4.724	7			0.625	0.157
R07	0.315×0.315×4.724	5			0.625	0.276
RL02	0.63×0.63×2.362-5.906	6			0.63/0.787	0.984
RL21	0.394×0.394×3.543				0.75	1.378

CITIZEN

Miyano product series

product	Tool size (Gang-Type)	No	Guide-bushing D(in)	Max.Machining Dia.D(in)
ABX-51TH3	0.787×0.787×3.937	12+12/12	0.984	2.008
ABX-64TH3	0.787×0.787×3.937	12+12/12	0.984	2.52
ABX-51THY	0.787×0.787×3.937	12+12/12	0.787/0.984/1.575	2.008
ABX-64THY	0.787×0.787×3.937	12+12/12	0.787/0.984/1.575	2.52
ABX-51SYY	0.787×0.787×3.937	12/12	0.787/0.984/1.575	2.008
ABX-64SYY	0.787×0.787×3.937	12/12	0.787/0.984/1.575	2.52
ABX-51SYY	0.787×0.787×3.937	12/12	0.984	2.008
ABX-64SYY	0.787×0.787×3.937	12/12	0.984	2.52
BNA-34C	0.787×0.787×3.937	8(16)/-	0.984	1.339
BNA-42C	0.787×0.787×3.937	8(16)/-	0.984	1.654
BNA-34S	0.787×0.787×3.937	8(16)/-	0.984	1.339
BNA-42S	0.787×0.787×3.937	8(16)/-	0.984	1.654
BNA-34DHY	0.787×0.787×3.937	8(16)/6	0.984	1.339
BNA-42DHY	0.787×0.787×3.937	8(16)/6	0.984	1.654
BNA-34MSY	0.787×0.787×3.937	8(16)/-	0.984	1.339
BNA-42MSY	0.787×0.787×3.937	8(16)/-	0.984	1.654
BNC-34C5	0.787×0.787×3.937	8/-	0.984	1.339
BNC-34S6	0.787×0.787×3.937	8/-	0.984	1.339
BNC-42C5	0.787×0.787×3.937	8/-	0.984	1.654
BNC-42S6	0.787×0.787×3.937	8/-	0.984	1.654
BND-51C/S2/SY2	0.787×0.787×3.937	12/-	0.984	2.008
BNE-34S5/SY5	0.787×0.787×3.937	12/12	0.984	1.339
BNE-42S6/SY6	0.787×0.787×3.937	12/12	0.984	1.654
BNE-51S5/SY5	0.787×0.787×3.937	12/12	0.984	2.008
BNE-51S6/SY6	0.787×0.787×3.937	12/12	0.984	2.008
BNJ-34S3/SY3	0.787×0.787×3.937	12/6	0.984	1.339
BNJ-42S3/SY3	0.787×0.787×3.937	12/6	0.984	1.654
BNJ-51SY3	0.787×0.787×3.937	12/6	0.984	2.008
BNX-42SY	0.787×0.787×3.937	12/-	0.984	1.654
BX-20S	0.63×0.63×3.937	8/-	0.787	0.787
BX-26S	0.63×0.63×3.937	10/-	0.787	1.024
BX-26T	0.63×0.63×3.937	8/-	0.787	1.024

STAR

product	Tool size (Gang-Type)	No	Tool size(Turret-Type)	No	Guide-bushing(D)	Max.Machining Dia.(D)
ECAS-12	0.394×0.394×3.74-5.906	6			0.866	0.512
ECAS-20	0.472×0.472×3.15-5.669	6			0.866	0.787
ECAS-20T			0.472×0.053×3.15	8 St.×3	0.866	0.787
ECAS-32T	0.63×0.63×3.15-4.724	4	0.63×0.071×2.362-3.071	10 St.×2	0.866/1.26	1.26
JNC-10			0.315×0.035×2.559	6	-	0.394
JNC-16			0.394×0.044×3.15	6	-	0.63
JNC-25/32			0.63×0.071×3.071-4.724	10 St.	0.866	0.984/1.26
KJR-16B/25B			0.63×0.071×3.071-4.724	12 St./6 St.	0.866	0.63/0.984
KNC-16/20			0.63×0.071×2.677	16 St.	0.866	0.63/0.787
KNC-25II/32II			0.63×0.071×3.071	20 St.	0.866/1.26	0.984/1.26
RNC-10/16	0.394×0.394×3.15-4.724	5			0.866	0.394/0.63
RNC-16II/16BII	0.394×0.394×3.15-4.724	5			0.866	0.63
SA-16R	0.394×0.394×3.74-4.724	6			0.866	0.63
SB-12II/16II	0.472×0.472×3.74-5.118	6			0.866	0.472/0.63
SB-16	0.472×0.472×3.74-5.118	6			0.866	0.63
SB-20	0.472×0.472×3.74-5.118	6			0.866	0.787
SR-20J	0.472×0.472×3.937-5.315	6			0.866	0.787
SC-20	0.472×0.472×3.74-5.118	6			0.866	0.787
SE-12/16	0.394×0.394×3.74-4.724	5			0.866	0.512/0.63
SF-25			0.63×0.071×2.874-3.858	10 St.×2	0.866/1.26	0.984
SG-42			0.63×0.071×3.307-3.465	10 St.×2	0.866/1.26	1.654
SH-7	0.315×0.315×3.74-4.724	5			0.866	0.276
SH-12/16	0.394×0.394×3.74-4.724	5			0.866	0.512/0.63
SI-12/12C	0.394×0.394×3.15-5.118	6			0.866	0.512
SR-16/20	0.472×0.472×3.74-4.724	5			0.866	0.63/0.787
SR-32	0.63×0.63×3.937-5.315	6			0.866	1.26
SR-20R	0.472×0.472×3.937-5.315	6			0.866	0.787
SR-10J	0.315×0.315×2.52-4.331	6			0.866	0.394
SR-25J/32J	0.63×0.63×3.74-6.102	6			0.866/1.26	0.984/1.26
SST-16	0.472×0.472×3.74-4.528	5			0.866	0.63
ST-38			0.63×0.071×3.346	8 St.×3	0.866/1.26	1.496
SV-12	0.472×0.472×3.74-5.315	4	0.472×0.053×2.756-3.071	8 St.×3	0.866	0.512
SV-20	0.63×0.63×3.74-5.315	5	0.63×0.071×2.559-2.756	8 St.	0.866	0.787
SV-32	0.63×0.63×3.74-5.315	4	0.63×0.071×3.15-3.465	10 St.×2	0.866/1.26	1.26
SV-32J/32JII	0.63×0.63×3.74-5.315	4	0.63×0.071×2.559-2.756	8 St.	0.866/1.26	1.26
SW-7	0.315×0.315×3.15-4.724	6			0.866	0.276
SW-20	0.472×0.472×3.15-5.669	6			0.866	0.787

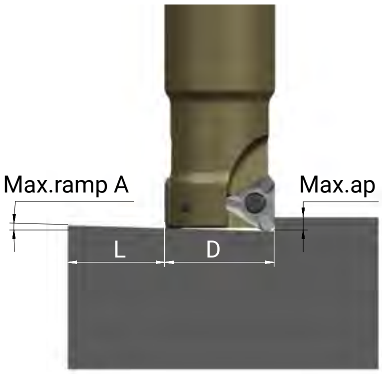
TSUGAMI

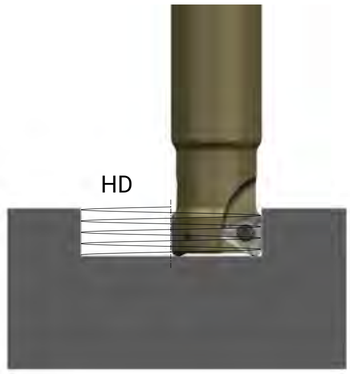
product	Tool size (Gang-Type)	No	Tool size(Turret-Type)	No	Guide-bushing(D)	Max.Machining Dia.(D)
P013H/P014H	0.315×0.315×3.937-4.724	6			0.63	0.039
P033H/P04H	0.315×0.315×3.937-4.724	6			0.63	0.118
B007-III	0.315×0.315×3.346	8			0.984	0.276
B074/B07-V	0.315×0.315×3.346	9			0.787	0.276
B0123/B0124/B0125	0.472×0.472×3.346	9			0.787	0.472
B012F/B012-V/BE12-V	0.472×0.472×3.346	9			0.787	0.472
B016MF	0.472×0.472×3.346	9			0.787	0.63
B018-III	0.472×0.472×3.346	9			0.787	0.709
B0203/B0204/B0205	0.472×0.472×3.346	9			0.787	0.787
B020F/B020-V/BE20-V	0.472×0.472×3.346	9			0.787	0.787
B026-V	0.472×0.472×3.346	6			0.984	1.024
B0385/B0385L	0.63×0.63×4.921	8			1.26	1.496
BA20-III	0.472×0.472×3.346	6			0.984	0.787
BA26-III	0.472×0.472×3.346	6			0.984	1.024
BC18	0.472×0.472×3.346	10			0.984	0.709
BC25	0.472×0.472×3.346	10			0.394/0.984	0.984
BE18	0.472×0.472×3.346	9			0.787	0.709
BH20/BH20Z	0.472×0.472×3.346	4	0.472×0.472×3.346	12 St.	0.984/1.26	0.787
BH38	0.63×0.63×4.921	7	0.787×0.787×4.921	12 St.	0.984/1.26	1.496
BM07	0.315×0.315×3.346	9			0.787	0.276
BM163/BM164/BM165	0.472×0.472×3.346	9			0.787	0.63
BM20-V	0.472×0.472×3.346	9			0.787	0.787
BN12-III	0.472×0.472×3.346	7			0.787	0.472
BN20-III	0.472×0.472×3.346	7			0.787	0.787
BS12-V	0.472×0.472×3.346	8/12			0.787/0.984	0.63
BS18-III	0.472×0.472×3.346	7/10			0.551/0.984	0.709
BS20-V	0.472×0.472×3.346	8/12			0.787/0.984	0.787
BS26(ABC)-V	0.63×0.63×3.937	7/10			0.63/0.984	1.024
BS32C-V	0.63×0.63×3.937	6			0.63/0.984	1.26
BU12	0.472×0.472×3.346	4	0.472×0.472×3.15	8 St.	0.787	2.008
BU20	0.472×0.472×3.346	4	0.472×0.472×3.15	8 St.	0.787	0.787
BU26	0.63×0.63×3.937	7	0.787×0.787×3.15	8 St.	0.787/1.26	1.024
BU38	0.63×0.63×3.937	7	0.787×0.787×3.15	8 St.	0.787/1.26	1.496
BW07-III	0.472×0.472×3.346	7			0.787	0.276
BW12-III	0.472×0.472×3.346	7			0.787	0.472
BW20-III	0.472×0.472×3.346	7			0.787	0.787
C004-III	0.512×0.512×2.362-3.937	6-8			0.394	4.724
C150	0.394×0.394×2.362-3.937	4-6			0.315	3.15
C180	0.472×0.472×2.362-3.937	4-6			0.394	4.724
C220	0.512×0.512×2.362-3.937	6-8			0.394	4.724
C300-III	0.63×0.63×3.937-5.118	6-10			0.551	6.693

TSUGAMI

product	Tool size (Gang-Type)	No	Tool size(Turret-Type)	No	Guide-bushing(D)	Max.Machining Dia.(D)
CH154	0.472×0.472×2.362-3.937	16			0.394	0.591
M34J			0.787×0.787×4.921	12 St.	0.787/1.26	1.339
M42J/M42D/M42SD			0.787×0.787×4.921	12 St.	0.984/1.26	1.654
M50SY-III			0.787×0.787×3.937	12 St.	1.26	2.008
M50J			0.787×0.787×3.937	12 St.	0.787/1.26	2.008
MB25			0.787×0.787×3.15	8 St.×2	0.787/1.26	0.984
MB35-III			0.787×0.787×3.15	8 St.×2	0.787/1.26	1.378
MB38-III			0.787×0.787×3.15	8 St.×2	0.787/1.26	1.496
MB50-III			0.787×0.787×3.15	8 St.×2	0.787/1.26	1.969
MU26			0.787×0.787×3.15	8 St.×2	0.787/1.26	1.024
MU38			0.787×0.787×3.15	8 St.×2	0.787/1.26	1.496
NU50-III			0.787×0.787×3.937	12 St.	0.787/1.26	2.008
S205/S206	0.472×0.472×3.937	8			0.787/0.866	0.787
SS20	0.63×0.63×3.937	8			0.787/0.866	0.787
SS207	0.472×0.472×3.937	8			0.787/0.866	0.787
SS26	0.63×0.63×3.937	7			0.787/0.866	1.024
SS32/SS32L	0.63×0.63×3.937	7			0.787/0.866	1.26
TMB2			0.787×0.787×4.921	16 St.	1.26	2.008
TMU1			0.787×0.787×4.921	16 St.	1.26	1.496

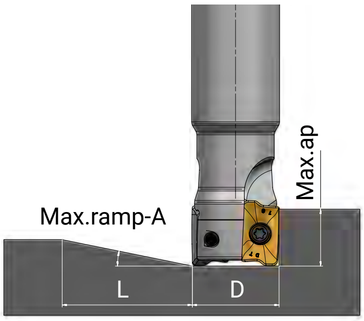
TD15 Milling Cutter Series

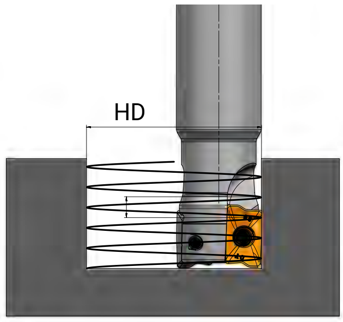




Cutter Dia D(in)	Straight Ramping			Circular interpolate milling		
	Max.ramp-A(°)	Min.length- L(in)	Max.ap (in)	Min.Dia.HD (in)	Max.Dia.HD (in)	Max.pitch (in/rev)
1.25	1.4°	18.858	0.453	2.106		0.055
					2.520	0.083
1.5	1.0°	24.921	0.453	2.760		0.059
					3.150	0.051
2.0	0.8°	32.441	0.453	3.547		0.059
					3.937	0.075
2.5	0.6°	42.244	0.453	4.571		0.059
					4.961	0.071
3.0	0.5°	55.079	0.453	5.917		0.059
					6.299	0.071
4.0	0.3°	84.409	0.453	7.500		0.051
					7.874	0.055
5.0	0.3°	89.055	0.453	9.461		0.063
					9.843	0.067
6.0	0.2°	115.472	0.453	12.217		0.063
					12.598	0.067
8.0	0.2°	145.354	0.453	15.366		0.063
					15.748	0.067

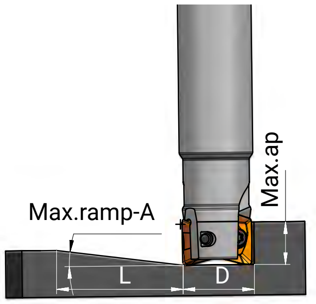
AP17 Milling Cutter Series

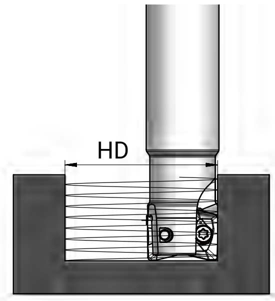




Cutter Dia(D)	Straight Ramping			Circular interpolate milling		
	Max.ramp-A(°)	Min.length- L(in)	Max.ap (in)	Min.Dia.HD (in)	Max.Dia.HD (in)	Max.pitch (in/rev)
1.0	5.0°	7.244	0.634	1.205		0.051
					1.969	0.228
1.25	9.0°	4.016	0.634	1.756		0.209
					2.520	0.531
1.5	5.0°	7.244	0.634	1.598		0.189
					3.150	0.366
2.0	4.4°	8.228	0.634	3.173		0.248
					3.937	0.406
2.5	3.2°	11.339	0.634	4.197		0.256
					4.961	0.370
3.0	2.3°	15.787	0.634	5.535		0.256
					6.299	0.339
4.0	1.8°	20.197	0.634	7.110		0.268
					7.874	0.331

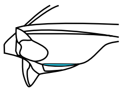
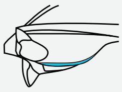
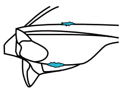
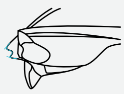
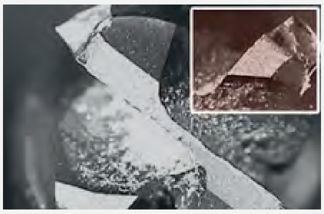
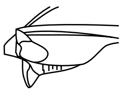
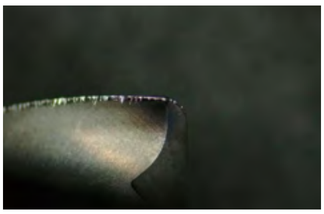
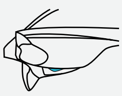
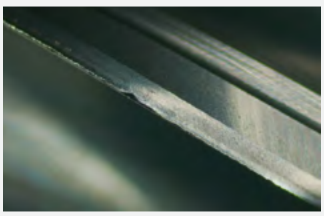
AO12 Milling Cutter Series



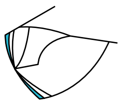
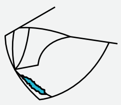
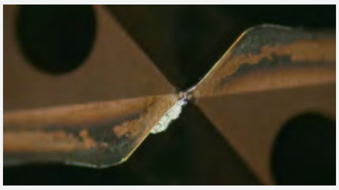
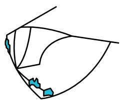
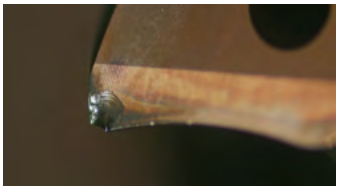
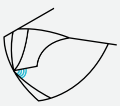
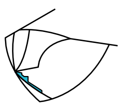
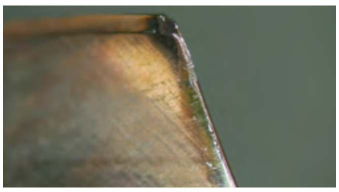


Cutter Dia(D)	Straight Ramping			Circular interpolate milling		
	Max.ramp-A(°)	Min.length- L(in)	Max.ap (in)	Min.Dia.HD(in)	Max.Dia.HD(in)	Max.pitch (in/rev)
0.625	8.1°	3.031	0.433	0.669		0.016
					1.260	0.240
0.75	5.3°	4.709	0.433	0.984		0.047
					1.575	0.193
1.0	3.6°	6.913	0.433	1.378		0.067
					1.969	0.165
1.25	1.7°	14.882	0.433	1.929		0.051
					2.520	0.098
1.388	1.5°	16.713	0.433	2.165		0.055
					2.756	0.094
1.5	1.3°	18.461	0.433	2.559		0.063
					3.150	0.098
2.0	1.3°	19.744	0.433	3.346		0.079
					3.937	0.114
2.5	0.9°	27.898	0.433	4.370		0.079
					4.961	0.102
3.0	0.7°	34.457	0.433	5.709		0.087
					6.299	0.106

Solid Carbide Endmill Failure Mode and Solutions

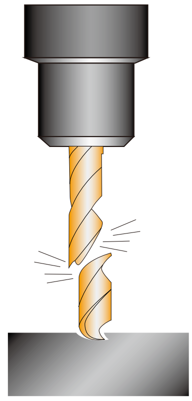
Failure	Picture	Analysis	Solution
Flank wear 		● Abrasion between the work piece and the flank surface leads to flank wear.	● Reduce cutting speed ● Use a more wear-resistant cutting tool material ● Increase feed ● Raise coolant flow (e.g. raise coolant pressure)
Built-up edge 		● The work piece material sticks on the cutting edge leads to built-up edge.	● Raise cutting speed ● Use more positive geometry, use a tool with a sharper cutting edge ● Reduce the feed rate ● Increase the amount of grease in the coolant (e.g. 8% oil content in coolant) ● Use uncoated grade with polished geometry (e.g. for non-ferrous metals)
Fractures 		● Perpendicular cracks along the edge lead to fractures. ● Vibration causes fractures.	● Use a tougher cutting tool material ● Reduce cutting speed ● Change to dry machining ● Adjust feed rate
Plastic deformation 		● High heat and mechanical stress cause plastic deformation.	● Reduce cutting speed ● Reduce feed rate ● Use a more wear-resistant cutting tool material ● Use a less sharp tool ● Optimize the coolant towards to the cutting edge
Thermal cracks 		● Fluctuating temperature (thermal shock) causes thermal cracks.	● Reduce cutting speed ● Reduce feed rate ● Dry machining or use adequate coolant ● Use a PVD-coated (tougher) indexable insert grade
Notch wear 		● Notch wear often occurs during machining work pieces with a hard surface (forged, casted or cold work hardened).	● Change depth of cut ● Use a tougher cutting tool material ● Use a smaller approach angle ● Use a stronger geometry (with chamfer)

Solid Carbide Drill Failure Mode and Solutions

Failures	Picture	Analysis	Solution
Flank wear 		● Abrasion between the work piece and the flank surface leads to flank wear.	● Reduce cutting speed ● Raise feed rate ● Raise coolant flow (e.g. raise coolant pressure)
Built-up edge 		● The work piece material sticks on the cutting edge leads to built-up edge.	● Raise cutting speed ● Raise coolant flow (e.g. raise coolant pressure)
Fracture 		● Perpendicular cracks along the edges, chip eroding, vibration and extremely high wear resistance lead to fractures.	● Replace and recondition the tool sooner ● Improve stability (work piece/tool)
Plastic deformation 		● High heat and mechanical stress cause plastic deformation.	● Reduce cutting speed ● Raise coolant flow (e.g. raise coolant pressure)
Crater wear 		● Tool Material is too soft. ● Too high cutting speed. ● Too high feed rate.	● Choose more wear resistant grade ● Reduce cutting speed ● Reduce feed ● Raise coolant pressure

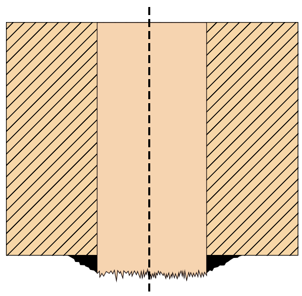
Drill Breakage Analysis

1. Check the tip geometry
2. Check the flute lengths is at least longer than drilling depth +1.5XD
3. Recondition promptly
4. Add pilot hole drilling
5. Improve system rigidity (Work piece / tool)



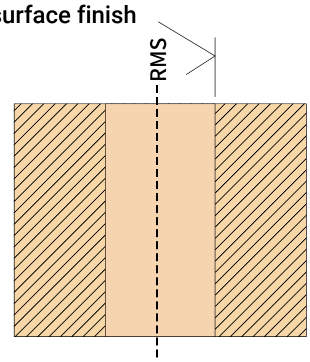
Drilling Wear and Trouble Shooting

Burr on the hole exit



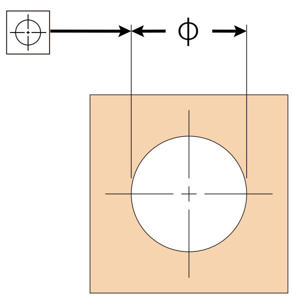
- Blunt cutting edge
- Drill tip outer corner chipped or worn

Bad surface finish



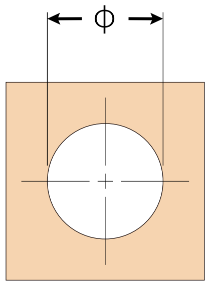
- Check edge wear
- Overcoated

Entry position out of tolerance



- Check edge geometry
- Check tool's cutting edge & chisel edge

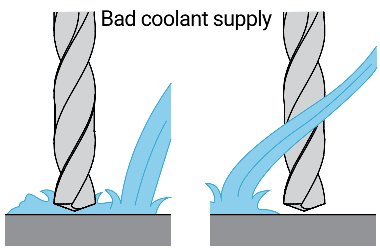
Oversized holes

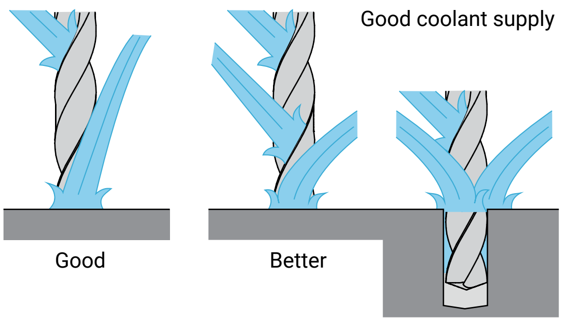


- Check edge geometry
- Overcoated
- Check tool's chisel edge

Check Coolant Supply

For solid carbide drills, internal coolant is always recommended. When the drill length is over 5xDc, internal coolant is essential. Ensure the coolant is with sufficient pressure and aiming to the correct position.





Three coolant pipes should be directly towards the drill tip when it's possible.

Installation and Adjustment Method for Cast Iron Finishing Milling Cutter

1.Clean wiper cartridge (7), completely release adjusting screw(6).

2.Clean each insert pocket, cartridge pocket, clean inserts and cartridges.

3.Install roughing inserts(1), wiper cartridges(7) and use finger to push them to the locating surface and lock the screws.

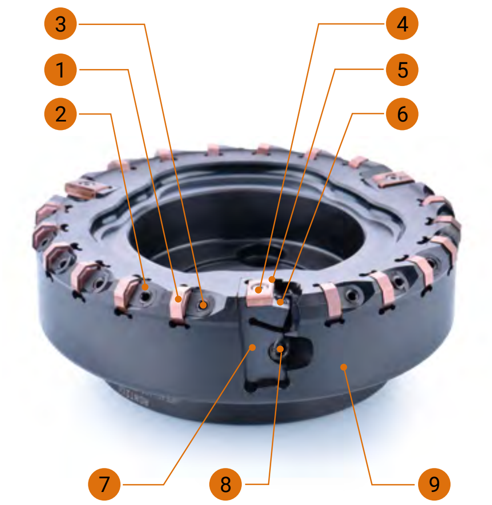
4. Install wiper inserts (5).

5.Measure the axial run out of each roughing and wiper insert.

6.Adjusting wiper inserts height through adjusting screw(6).

7.Wiper inserts Max. run out should be higher than roughing inserts by 0.001-0.002 inch.

1.Roughing inserts(ON..05..)
2.Locking wedge
3.Double-headed wedge Locking screws
4.Wiper insert clamping screw
5.Wiper insert (LN12/15)



6.Adjusting screw
7.Wiper insert cartridge
8.Locking screw for wiper cartridge
9.Cutter

Grade Comparison Table for Turning

CVD coating grade

Classification		Achteck	SANDVIK	KENNAMETAL	SECO	WALTER	ISCAR	TAEGUTEC	MITSUBISHI	TUNGALOY	SUMITOMO	KYOCERA	KORLOY	ZCC.CT	PRAMET	GESAC
P	P01	AC052P	GC4305 GC4205	KCP05B KCP05 KC9105	TP0501 TP0500	WPP05S WPP05	IC8005 IC428	TT8105	UE6005 UE6105	T9005 T9105	AC810P	CA510 CA5505	NC3010		T9310	GP1105
	P10	AC150P	GC4415 GC4315	KCP10B KCP10 KC9110	TP1501 TP1500	WPP10S WPP10	IC9150 IC9015 IC8150	TT8115	UE6110 MC6015 MY5015	T9115 T9215	AC810P AC700G	CA515 CA5515	NC3215	YBC152 YBC151	T9315	GP1115
	P20	AC250P	GC4425 GC4325	KCP25B KC9125	TP2501 TP2500	WPP20S WPP20	IC8250 IC9025 IC9250	TT8125 TT5100	UE6020 MC6025	T9225 T9125	AC8025P AC820P AC2000	CA025P CA525 CA5525	NC3220 NC3225 NC3120	YBC251 YBC252	T9325	GP1125
	P30	AC350P	GC4335	KCP40B KCP40 KC9240	TP300 TP3500	WPP30S WPP30	IC8350 IC9350	TT8135 TT7100	MC6035 UE6035 UH6400	T9135 T9035	AC830P AC630M	CA530 CA5535	NC3030 NC500H NC5330	YBC351 YBC352	T9335	GP1135
M	M10	AC100M	GC2015 GC1515	KCM15 KCM15M			IC6015	TT9215	MC7015 US7020	T6120 T6020	AC610M AC6020M	CA6515	NC9020	YBM151 YBM153		GM1115
	M20	AC200M	GC2025	KCM25	TM2000	WMP20S	IC6025	TT9225	MC7025	T6130	AC630M AC6020M	CA6525	NC9025	YBM251 YBM253	T7325	GM1125
	M30			KCM35 KC9045 KC9245	TM4000			TT9235	MC7035 US735					YBM253		
K	K05	AC100K AC102K	GC3205 GC3210	KCK05 KCK05B	TK0501 TK1001 TK1000	WKK10S WAK10	IC5005 IC9007	TT7005	MC5005 UC5105	T505 T5105	AC405K AC410K	CA310 CA4505	NC6205	YBD052 YBD102	T5305	GK1115
	K20	AC202K ACK15A	GC3215	KCK15 KCK20 KC9315 KC9320	TK2001 TK2000	WKK20S WAK20	IC5010	TT7310 TT7015	MC5015 UC5115	T515 T5115 T5125	AC415K AC420K AC700G	CA315 CA320 CA4515	NC6210 NC6215	YBD152C YBD152	T5315	GK1120 GK1125

Grade Comparison Table for Turning

PVD coating grade

Classification		Achteck	SANDVIK	KENNAMETAL	SECO	WALTER	ISCAR	TAEGUTEC	MITSUBISHI	TUNGALOY	SUMITOMO	KYOCERA	KORLOY	ZCC.CT	PRAMET	GESAC
P	P10	AP100S	GC1025	KC5010 KC5510 KU10T	CP200	WSM10S WSM10	IC507 IC807 IC907		MS6015 VP10MF	AH710	ACZ150 ACZ310	PR930 PR1115 PR1215	PC8110 PC230	YBG102	T6130 T8310 T8315	
	P20	AP200U AP301M	GC1020 GC1025 GC1125 GC4125	KC5025 KC5525 KC7215 KC7315 KU25T	CP250	WSM20S WSM20	IC507 IC807 IC907	TT5030	VP15TF VP20MF VP20RT UP20M	AH7025 AH725 SH725	ACZ330 AC520U	PR1225 PR1625 PR1725	PC8115 PC5300	YBG202	6630	GA4230
	P30		GC1145 GC2145	KC7235 KC7140 KC7040	CP500	WSM30S WSM30	IC328 IC928 IC3028		VP15TF VP20MF UP20M	GH330 AH740 AH9030	AC530U ACZ350	PR1535	PC3545		6640 T8330 T8030"	
M	M10	AP100S	GC1105 GC1115 GC15	KC5510 KC5010	TS2000 TH1000 CP200	WSM10 WSM10S	IC520 IC907 IC808	TT5080	VP10RT VP10MF	AH710	AC510U ACZ150	PR1215 PR1225	PC8110		T6310 T8310 T8315	GS3115
	M20	AP200U AP301M	GC1125 GC4125 GC1025 GC30	KC5025 KC5525 KCU25	CP500	WSM20 WSM20S	IC308 IC908 IC3028 IC830	TT9080	VP15TF VP20RT VP20MF	AH725 AH630 GH330 GH730 SH725 SH730	AC520U ACZ310 AC1030U	PR930 PR1215 RP1225 PR1725 PR1525	PC8115 PC5300	YBG202 YBG205	T8330	GS3125
	M30		GC2035 GC2030	KC7030 KC7225	CP600	WSM30 WSM30S	IC228 IC328 IC928	TT9020 TT8020	MP7035	AH130* AH645*	AC6040 AC530U ACZ330 ACZ350	PR1535	PC9030 PC5400		T8345	GM3225
K	K05		GC1010	KC5010 KC7210	TS2000 CP200		IC807 IC910 IC507 IC908"		VP05RT	GH110 AH110	EH10Z EH510Z AC510U	PR905 PR1215			T8310	
	K20		GC1020 GC1120	KC5025 KC5525 KC7215 KC7315	TS2500 CP200 CP250		IC508 IC908	TT5030	VP10RT VP15TF VP20RT	AH120 AH725	ACZ310 AC520U AC530U AC1030U	PR905 PR1215	PC5300		T8315	GA4230
	K30		GC1030	KC7225	CP500		IC508 IC908"		VP15TF VP20RT		ACZ310				T8330	
S	S10	AP100S	GC1105 GC1115	KC5510 KC5010	CP200 TH1000 TS2000	WSM01 WSM10S	IC808 IC807 IC907	TT5080	VP05RT VP10RT MP9005	AH110 AH905 AH8005	AC510U AC5015S	PR005S PR1305 PR1310	PC8105	YBG102	T6310	GS3115
	S20	AP200U AP301M	GC1025 GC1125	KC5525 KC5025	CP500 TS2500	WSM20 WSM20S	IC808 IC908	TT9080	VP15TF VP20RT MP9015	AH120 AH8015 AH725	AC520U AC5025S	PR015S PR1325 PR1535	PC8115	YBG105 YBG202	6630	GS3125
	S30		GC1125			WSM30 WSM30S	IC328	TT9080 TT8020	MP9025	AH725	AC520U	PR1535	PC5400	YBG212	6640	

Grade Comparison Table for Turning

Uncoated grade

Classification		Achteck	SANDVIK	KENNAMETAL	SECO	WALTER	ISCAR	TAEGUTEC	MITSUBISHI	TUNGALOY	SUMITOMO	KYOCERA	KORLOY	ZCC.CT	PRAMET	GESAC
N	N10	AW100K	H10	K313	H15	WK1	IC20	K10	HTI10	TH10	EH10	KW10 GW05	H01	YD101		GN9115

Cermet

Classification		Achteck	SANDVIK	KENNAMETAL	SECO	WALTER	ISCAR	TAEGUTEC	MITSUBISHI	TUNGALOY	SUMITOMO	KYOCERA	KORLOY	ZCC.CT	PRAMET	GESAC
P	P10	AT202	CT5015 CT525 GC1525*	KT175 HT2 KTP10*	TP1020 CM CMP	WTA43* WTA41*	IC20N IC520N	CT3000 PV3010*	NX2525 AP25N* VP25N*	NS9530 NS520 GT9530* GT530*	T1200A T1500Z*	TN60 TN620 TN6020 PV720*	CN2000 CN20 CC1500* CN1500*	NG151 YNG151C*		GP91TM GT31TM*
K	K10	AT202	CT5015	HTX KT315* KTP10*				CT3000	NX2525 AP25N* VP25N*	NS530 GT530*	T1200A T2000Z*	TN610 PV710* PV7005*	CN1500*	YNG151 YNG151C*		GP91TM GT31TM*

Grade Comparison Table for Turning

CBN

Classification		Achteck	SANDVIK	KENNAMETAL	SECO	WALTER	ISCAR	TAEGUTEC	MITSUBISHI	TUNGALOY	SUMITOMO	KYOCERA	KORLOY	ZCC.CT	PRAMET	GESAC
K	K10	PB90			CBN20 CBN600				MB4120 MBS140	BX950 BX90S	BN7000 BNS800		DBN350			
H	H10	PB30	CB7105 CB7050"	KBH10 KB1615 KB5610	CBN150 CBN060K CBN200	WCB30	IB50	TB610	MB8025 MB825	BXA40 BC330 BX360						
	H20	PB60	CB7025 CB7525	KBH20 KB1340	CBN350 CBN500	WCB50	IB55	TB650	MB8025	BX380						
	H30		CB7525	KB5630			IB55	TB670	MB835	BX380						

PCD

Classification		Achteck	SANDVIK	KENNAMETAL	SECO	WALTER	ISCAR	TAEGUTEC	MITSUBISHI	TUNGALOY	SUMITOMO	KYOCERA	KORLOY	ZCC.CT	PRAMET	GESAC
N	N20	PD20		KD1425	PCD30 PCD30M	WDN10			MD230	DX110 DX120	DA1000 DA2200	KPD001 KPD010 KPD230 KPD250				DNN130P

Grade Comparison for Milling Grade

Classification		Achteck	SANDVIK	KENNAMETAL	SECO	WALTER	ISCAR	TAEGUTEC	MITSUBISHI	TUNGALOY	SUMITOMO	KYOCERA	KORLOY	ZCC.CT
P	P10		GC1025 GC1010	KC715M		WXM15			F7010		ACP100	PR1225	PC33525	YBG252
	P20	AP251U	GC1130 GC1030 GC4220 GC4020 GC4030	KC522M KC525M KCPM20	MP1500 T250M T25M T20M	WKP25S	IC330 IC250 IC950 IC520M	TT7080 TT7030	MC7020 MP6120 MV1020 UP20M F7030	T313W AH725	ACP200 ACP2000 ACP2500	PR1525 PR1225 PR1230	PC3535 PC3500	YBC301 YBC302 YBM251 YBG202 YBG252
	P30	AP351U AP351M AC301P	GC1130 GC4040 GC4230 GC4330	KC994M KC725M KC792M KC530M	MP2500 T250M T25M F25M F30M	WSM35S WSM36 WKP35S WKP35G	IC330 IC328 IC830 IC908	TT9080 TT9030 TT7080	MP6130 VP15TF VP30RT F7030	T3130 GH330 AH120 AH330 AH730	AC230 ACP300	PR1230 PR1535	PC5300 PC9530 PC3600	YBM351 YBM251 YBM301 YBG302
	P40	AP403M	GC4040 GC4240 GC4340	KC735M	MP300 T350M T60M T25M	WKP45S WSP46	IC635 IC928 IC4050	TT9030	VP30RT	AH140	AC230 ACZ330 ACZ350		PC9530	YBC302 YBG302 YBG351
M	M10		GC1025 GC1030	KC522M				TT9300	F7010	T6120 T6020	ACM100 ACM200	PR1225	NC5330	YBG252
	M20	AP251U	GC2030 GC2334 GC2044 S30T	KC730M KC525M	MS2050 MP2500 T250M T25M F20M	WXM15	IC380 IC908 IC928	TT9300	MC7020 VP15TF VP20RT MP7030 MP7130	T6130	ACM200 ACP200 ACU2500	PR1525 PR1225	PC5300 PC3545 PC9530	YBM251 YBM253 YBC302 YBG205 YBG252
	M30	AP351U AP351M	GC1040 GC2040 S40T	KC994M KC725M KCPK30	T350M T250M F40M	WSM35S WSM36	IC380 IC328 IC330	TT9080 TT8020	F7030 VP30RT MO7140		ACM300 ACP300 ACZ350	CA6535 PR1535	PC3545 PC5300	YBC302 YBG351 YBG302
	M40	AP403M			MM4500	WKP45S WSP46	IC830	TT8080 TT8020 TT9300	VP30RT		ACZ350		PC9530	YBG302
K	K01				MH1000		IC5100 IC4100			T505 T5105	ACK100			
	K10		GC1010 GC3220 K15W	KCK15 KC915M	MK1500 T150M F15M	WXM15 WAK15 WSN10	IC5100 IC4010 IC910 IC810	K10	MP8010 MC5020 MV1020 VP10RT	T515 T5115 T5125	ACK2000 ACK200 AC211	PR1500 PR1210 PR905	PC215K	YBD152 YBG102 YBG252
	K20	AP251K AP351K AC301K	GC1020 GC3020 GC3330 GC3334	KCC520M KC920M KC925M	MP1500 T250M MK2000 MK2050	WKP25S WKK25S	IC810 IC910 IC928	TT6080 TT7515	VP15TF VP20RT	AH120 AH725 T1215	EH20Z ACZ310 ACK300 ACK3000	CA420M PR1210 CA415D PR905	PC6510 PC5300	YBD152 YBD252 YBG152
	K30		GC3040 GC4040	KC930M	MK3000 T250M	WKP35S	IC928	TT7515		GH130				YBD252 YBG152
S	S10		GC1030 GC1025 GC1010	KC510M	MS2050		IC903 IC807 IC808 IC908	K10	MP9120 VP15TF		ACM100 ACM200	CA6535 PR1535 PR1210		YBG202 YBS203
	S20		GC1030 GC2030 GC1130	KC525M	MP2050	WSM35S WSM36	IC903 IC807 IC808 IC908 IC830	TT9080 TT9030 TT5525	MP9120 VP15TF MP9130 MP9030		ACU2500 ACM200	CA6535 PR1535 PR1210		YBS203 YBS303
	S30	AP403S	GC2040 S40T	KC725M KCSMN40	F40M	WSP45S WSP46 WSM42X WMP45G	IC328 IC330	TT8080 TT8020 TT9300	MP9140		ACM300	PR1535		YBS303

Chip Breaker Comparison Table for Negative Turning Insert

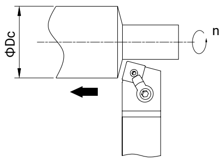
ISO Classification	Application	Achteck	SANDVIK	KENNAMETAL	SECO	WALTER	ISCAR	TAEGUTEC	MITSUBISHI	TUNGALOY	SUMITOMO	KYOCERA	KORLOY	ZCC.CT
P	Finishing	PB1	QF	FF	FF1 MF2 FF2	NF3 FP5	SF F3P	FS FA FLP FG FC	FP FH FY FS	TF	FA FB FL SU	GP PP XP XF	VG VL VF	SF DF
P	Semi finishing	PB3 PC3	PF LC	FN	MF5	NS6	NF	MLP	C SA SH	TSF	LU SX NSE	CQ XQ HQ	VC HC	NM
P	Medium	PL5	K		UX			V FS	ES 2G	S	GX HM	LD ST	SH	
P	Medium	PD3	PM PMC QM	MN CT	M3	NM4 MP5	M3P TF PP	MT MC MP MGP	MA MP MV MH	TM ZM AM NM	GU UX UG UP	GS PS PG	VM LP MP	PM DM
P	Medium	PC4			M4			MG-	Standard	Standard	UZ	Standard	B25	
P	Roughing	PD5	PR	RN RP RW	M5 M6 MR7	NM6 NM9 RP5 RP7	NR R3P	RT RGP	RP GH	TH	MU, MX	PT GT	HR GR	DR ER
P	Heavy roughing	PD8 PC8	PR QR	RM	R4 R5	NR6 NRF	MH	RX RH	HZ HL	TRS	HG MP		GH	DR
P	Heavy roughing	PC9	HR	RP	R7 R8	NR8		HT HD	HX HR	TU TUS	HF		VT	HDR
P	Heavy roughing	PD9		RH	RR9	NRR	HR	HY HZ	HV		HU HW		VH	HPR
M	Finishing	SC1 MB2	MF	FF LF FP	MF2	NF NF4 FM5	NF F3M	FG EA SF	LS FS SA	SS TF SF HRF	SU EF	MQ	VP1	EF
M	Semi finishing	SL3		MS	MF1	MS3	PP	ML	MJ	28	UP	TK	HA	
M	Semi finishing	MC3	MM MMC	MP UP	MF4 MF3	NM NM4	M3M	EM MP	MS GM MM MA	HRM SM SA	EX GU	MS MU SU	HS	EM
M	Roughing	MC4	MR MMR	RP	M5 MR7	NR4 RM5	R3M MR	ET	RM GH	TU SH	MU	HU	VM	ER
K	Medium	PC4	KM	UN CT	M4	MK5 NM5 NM6	NR	Standard	MK GK Standard	CM Standard	UZ MU	KG Standard	B25	Standard
K	Roughing	KC4 KD5	KR	RP- NMA	MR7 Plane	RK5 RK7 Plane	Plane	KT RT Plane	GH RK Plane	CH Plane	GZ	ZS GC KH PH Plane	GR VR VK- Plane	DR
N	Semi finishing		QM 23	MS MP			PP	ML	MJ	P	UP GX AG	A3 AH	HA	
S	Finishing	SC1 MB2	MF SF	FS	MF2	NF4	NF	EA SF"	FS LS	TF	SU	MQ SQ	VP1	EF
S	Medium	SL3		MS	MF1	MS3	PP	ML	MJ	28	UP	TK	HA	
S	Medium	SC3	SM SMC	UP	MR3	NMS NMT	TF	MP SU MK	MS	HMM SA HRM	EG EX	MS MU	VP3	NM
S	Roughing	MC4	SR SMR	RP	MR4	NRS NRT	NR		GJ RS		MU	SG	VM	SNR

Chip Breaker Comparison Table for Positive Turning Insert

ISO Classification	Application	Achteck	SANDVIK	KENNAMETAL	SECO	WALTER	ISCAR	TAEGUTEC	MITSUBISHI	TUNGALOY	SUMITOMO	KYOCERA	KORLOY	ZCC.CT
P	Finishing	LF										CK		
		UF PB1 BS	UF PF	11 UF	FF1 MF2	PF4 FP4	PF	FA FG FX	FV FP	PF	FP LU	GP VF	VL	HF
	Semi finishing	PC2	PM UM	LF MF	F2 M5	FP6 PS5 MP4	SM 14	PC	MP MV	PM 23 24	SU SC	HQ XQ GK	HMP	HM
	Roughing	KC2	PR			PM5 RP4	17 19	MT	no code		MU		C25	
M	Finishing	PB1	MF UF	11 UF	FF1 MF2	PF4 FM4	PF	FA FG	FM FV LM	PF	LU	MQ	VL	EF
	Semi finishing	PC2	MM UM	LF MF	F2 M5	PS5 MM4	SM 14	FM	MV MM	PS PM	SC SU	MS	MP	EM
	Roughing	KC2	MR UR			PM5 RM4	17	MT			MU	MU	C25	HR
K	Semi finishing	KC2	KM	MF	F2 M3	MK4	14	MT PMR	MK	CM	MU		C25	HM
	Roughing	KD5	KR		M5	RK4 RK6 Plane		CMX		Plane				HR
N	Semi finishing	NC2	AL	HP	AL	PM2	AF, AS	FL	AZ	AL	AW, AG	AH	AK, AR	LH
S	Finishing	UF PB1	MF	HP	F1	PF5 PF4	PF	FA	FJ		LU	MQ	VP1 VL	NF NGF
	Medium	PC2	MM UM	LF	F2	PS5 PM5	SM	FG	MS	PS	SU	HQ	MP	
	Roughing													SNR

Turning Machining Formula

● Cutting speed



$$Vc = \frac{\pi * Dc * n}{12} \text{ (ft/min)}$$

Vc:Cutting speed(ft/min) π: ≈3.14
Dc:Workpiece diameter(in) n:Spindle speed(rev/min)

● Feed speed

$$Vf = f * n \text{ (in/min)}$$

Vf:Feed Speed(in/min) f:Feed rate(in/rev)
n:Spindle speed(rev/min)

● Chip thickness

$$h = f * \sin kr \text{ (in)}$$

h:Chip thickness(in) f:Feed rate(in/rev)
kr: Entering angle

● Chip width

$$b = \frac{ap}{\sin kr} \text{ (in)}$$

b:Chip width(in) ap:Axial depth of cut (in)
kr: Entering angle

● Chip area

$$A = h * b = ap * f \text{ (in}^2\text{)}$$

A:Chip area(in^2) ap:Axial depth of cut (in)
f:Feed rate(in/rev)

● Cutting power

$$Pmot = \frac{Kc * Vc * Dc * f}{132{,}000 * \eta} \text{ (HP)}$$

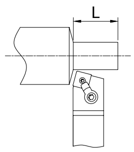
Pmot:Cutting power(HP) Kc:Unit cutting force(lbs/in^2)
Vc:Cutting speed(ft/min) Dc:Workpiece diameter(in)
f:Feed rate(in/rev) η:Mechanical efficiency

● Chip removal

$$Q = ap * f * Vc * 12 \text{ (in}^3\text{/min)}$$

Q:Chip removal(in^3/min) ap:Axial depth of cut (in)
f:Feed rate(in/rev) Vc:Cutting speed(ft/min)

● Work time



$$Tc = \frac{L}{f * n} \text{ (min)}$$

Tc:Work time f:Feed rate(in/rev)
n:Spindle speed(rev/min) L: Working length(in)

Milling General Formula

● Cutting speed

$$Vc = \frac{\pi * Dc * n}{12} \text{ (ft/min)}$$

Vc:Cutting speed(ft/min) π: ≈3.14
Dc:Cutter diameter(in) n:Spindle speed(rev/min)

● Spindle speed

$$n = \frac{12 * Vc}{\pi * Dc} \text{ (rev/min)}$$

Vc:Cutting speed(ft/min) π: ≈3.14
Dc:Cutter diameter(in) n:Spindle speed(rev/min)

● Feed speed

$$Vf = fz * n * Z \text{ (in/min)}$$

Vf:Feed speed(in/min) fz:Feed per tooth(in/z)
n:Spindle speed(rev/min) Z:Number of teeth

● Feed rate per rev.

$$fz = \frac{Vf}{n * Z} \text{ (in)}$$

fz:Feed rate per rev.(in) Vf:Feed speed(in/min)
n:Spindle speed(rev/min) Z:Number of teeth

● Feed rate per rev.

$$f = \frac{Vf}{n} \text{ (in/rev)}$$

f:Feed rate per rev.(in/rev) Vf:Feed speed(ft/min)
n:Spindle speed(rev/min)

● Time of cut

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

Tc:Time of cut(min) L:Length of feed(in)
Vf:Feed speed(in/min)

● Power demand

$$Pmot = \frac{ap * ae * Vf * Kc}{396000 * \eta} \text{ (HP)}$$

Pmot:Cutting power(HP) ap:Cutting depth ae:Cutting width
Kc:Unit cutting force(lbs/in²) η:Machine efficiency coefficient(0.7-0.95)

● Average chip thickness

$$hm = fz * \sqrt{\frac{ae}{Dc}} \text{ (in)}$$

hm:Average chip thickness fz:Feed per tooth(in/z)
ae:Cutting width Dc:Cutter diameter(in)

● Feed force

Cutter in the center site

$$\psi s = 2 * \arcsin\left(\frac{ae}{Dc}\right) \ [°]$$

Cutter in excentric site

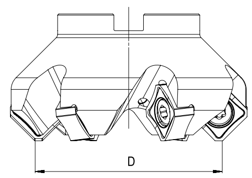
$$\psi s = 90° + \arcsin\frac{ae-(Dc/2)}{(Dc/2)} \ [°]$$

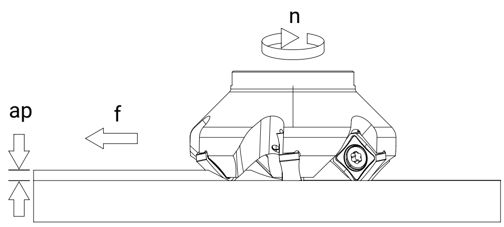
ψs:Pressure angle ae:Cutting width
Dc:Cutter diameter(in)

● Chip removal

$$Q = ap * ae * Vf * 12 \ (in^3/min)$$

Q:Chip removal(in³/min) ap:Cutting depth
ae:Cutting width Vf:Feed speed(ft/min)





Drilling General Recommendation

- **Cutting speed**

$$Vc = \frac{\pi * Dc * n}{12} (ft/min)$$

Vc:Cutting speed(ft/min) π:≈3.14
Dc:Drill diameter((in) n:Spindle speed(rev/min)

- **Spindle speed**

$$n = \frac{12 * Vc}{\pi * Dc} (rev/min)$$

Vc:Cutting speed(ft/min) π: ≈3.14
Dc:Drill diameter(in) n:Spindle speed(rev/min)

- **Feed speed**

$$Vf = fz * n * Z \ (in/min)$$

Vf:Feed speed(in/min) fz:Feed per tooth(in/z)
n:Spindle speed(rev/min) Z:Number of teeth

- **Feed rate per rev.**

$$fz = \frac{Vf}{n * Z} (in)$$

fz:Feed rate per rev.(in) Vf:Feed speed(in/min)
n:Spindle speed(rev/min) Z:Number of teeth

- **Feed rate per rev.**

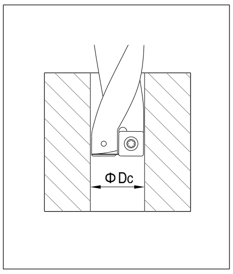
$$f = \frac{Vf}{n} \ (in/rev)$$

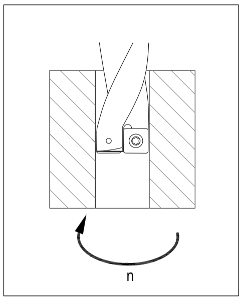
f:Feed rate per rev.(in/rev) Vf:Feed speed(in/min)
n:Spindle speed(rev/min)

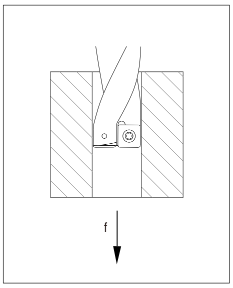
- **Chip removal**

$$Q = \frac{Vf * \pi * Dc^2}{4} (in^3/min)$$

Q:Chip removal(in^3/min) Vf:Feed speed(in/min)
π:≈3.14 Dc:Drill diameter(in)







- **Horse power**

$$Hp = \frac{Pmot}{0.75}$$

Hp:Horsepowe Pmot:Cutting power(KW)

- **Power demand**

$$Pmot = \frac{Kc * Vc * Dc * f}{132{,}000 * \eta} \ (HP)$$

Pmot:Cutting power(HP) Kc:Unit cutting force(lbs/in²)
Vc:Cutting speed(ft/min) Dc:Workpiece diameter(in)
f:Feed rate(in/rev) η:Mechanical efficiency

- **Torque**

$$Mc = \frac{Dc^2 * Kc * fz}{8} \ (in*lbs)$$

Mc:Torque Dc:Drill diameter(in)
Kc:Unit cutting force(lbs/in²) f:Feed rate per rev.(in/rev)

- **Cutting thickness**

$$h = fz * \sin k \ (in)$$

h:Cutting thickness(in) fz:Feed rate(in/rev)

Hardness Conversion Table

Brinell Hardness 10 ball load 3000Kg		Micro Vickers Hardness HV	Rockwell Hardness				Shore's Hardness	Tensile Strength (approximate) kgf/mm
Master ball	WC ball HB		A scale 60kgf diamond brale HRA	B scale 100kgf 1/16in ball HRB	C scale 150kgf diamond brale HRC	D scale 100kgf diamond brale HRD		
-	-	1865	92.0	-	80	-	-	-
-	-	1787	91.5	-	79	-	-	-
-	-	1710	91.0	-	78	-	-	-
-	-	1633	90.5	-	77	-	-	-
-	-	1556	90.0	-	76	-	-	-
-	-	1478	89.5	-	75	-	-	-
-	-	1400	89.0	-	74	-	-	-
-	-	1323	88.5	-	73	-	-	-
-	-	1245	88.0	-	72	-	-	-
-	-	1160	87.0	-	71	-	-	-
-	-	1076	86.5	-	70	-	-	-
-	-	1004	86.0	-	69	-	-	-
-	-	940	85.6	-	68.0	76.9	97	-
-	-	920	85.3	-	67.5	76.5	96	-
-	-	900	85.0	-	67.0	76.1	95	-
-	767	880	84.7	-	66.4	75.7	93	-
-	757	860	84.4	-	65.9	75.3	92	-
-	745	840	84.1	-	65.3	74.8	91	-
-	733	820	83.8	-	64.7	74.3	90	-
-	722	800	93.4	-	64.0	73.8	88	-
-	712	-	-	-	-	-	-	-
-	710	780	83.0	-	63.3	73.3	87	-
-	698	760	82.6	-	62.5	72.6	86	-
-	684	740	82.2	-	61.8	72.1	-	-
-	682	737	82.2	-	61.7	72.0	84	-
-	670	720	81.8	-	61.0	71.5	83	-
-	656	700	81.3	-	60.1	70.8	-	-
-	653	697	81.2	-	60.0	70.7	81	-
-	647	690	81.1	-	59.7	70.5	-	-
-	638	680	80.8	-	59.2	70.1	80	-
-	630	670	80.6	-	58.8	69.8	-	-
-	627	667	80.5	-	58.7	69.7	79	-
-	601	640	79.8	-	57.3	68.7	77	-
-	578	615	79.1	-	56.0	67.7	75	-
-	555	591	78.4	-	54.7	66.7	73	210
-	534	569	77.8	-	53.5	65.8	71	202
-	514	547	76.9	-	52.1	64.7	70	193
	495	528	76.3		51.0	63.8	68	186
-	477	508	75.6	-	49.6	62.7	66	177
-	461	491	74.9	-	48.5	61.7	65	170
-	444	472	74.2	-	47.1	60.8	63	162
429	429	455	73.4	-	45.7	59.7	61	154
415	415	440	72.8	-	44.5	58.8	59	149
401	401	425	72.0	-	43.1	57.8	58	142
388	388	410	71.4	-	41.8	56.8	56	136
375	375	396	70.6	-	40.4	55.7	54	129
363	363	383	70.0	-	39.1	54.6	52	124
352	352	372	69.3	(110.0)	37.9	53.8	51	120
341	341	360	68.7	(109.0)	36.6	52.8	50	115
331	331	350	68.1	(108.5)	36.6	51.9	48	112
321	321	339	67.5	(108.0)	34.3	51.0	47	108
311	311	328	66.9	(107.5)	33.1	50.0	46	105
302	302	319	66.3	(107.0)	32.1	49.3	45	103
293	293	309	65.7	(106.0)	30.9	48.3	43	99
285	285	301	65.3	(105.5)	29.9	47.6	-	97
277	277	292	64.6	(104.5)	28.8	46.7	41	94

Hardness Conversion Table

Brinell Hardness 10 ball load 3000Kg		Micro Vickers Hardness HV	Rockwell Hardness				Shore's Hardness	Tensile Strength (approximate) kgf/mm
Master ball	WC ball HB		A scale 60kgf diamond brale HRA	B scale 100kgf 1/16in ball HRB	C scale 150kgf diamond brale HRC	D scale 100kgf diamond brale HRD		
269	269	284	64.1	(104.0)	28	45.9	40	91
262	262	276	63.6	(103.0)	27	45.0	39	89
255	255	269	63.0	(102.0)	25	44.2	38	86
248	248	261	62.5	(101.0)	24	43.2	37	84
241	241	253	61.8	100	23	42.0	36	82
235	235	247	61.4	99	22	41.4	35	80
229	229	241	60.8	98.2	21	40.5	34	78
223	223	234	-	97.3	(18.8)	-	-	
217	217	228	-	96.4	(17.5)	-	33	74
212	212	222	-	95.5	(16.0)	-	-	72
207	207	218	-	94.6	(15.2)	-	32	70
201	201	212	-	93.8	(13.8)	-	31	69
197	197	207	-	92.8	(12.7)	-	30	67
192	192	202	-	91.9	(11.5)	-	29	65
187	187	196	-	90.7	(10.0)	-	-	63
183	183	192	-	90	(9.0)	-	28	63
179	179	188	-	89	(8.0)	-	27	61
174	174	182	-	87.8	(6.4)	-	-	60
170	170	178	-	86.8	(5.4)	-	26	58
167	167	175	-	86	(4.4)	-		57
163	163	171	-	85	(3.3)	-	25	56
156	156	163	-	82.9	(0.9)		-	53
149	149	156	-	80.8		-	23	51
143	143	150	-	78.7		-	22	50
137	137	143	-	76.4		-	21	47
131	131	137	-	74		-	-	46
126	126	132	-	72		-	20	44
121	121	127	-	69.8		-	19	42
116	116	122	-	67.6		-	18	41
111	111	117	-	65.7		-	17	39

Material Conversion Table

ISO	Country and standard										
	China	International	Germany	U.S.A.	U.K.		France	Sweden	Italy	Spain	Japan
	GB	DIN	W.-nr	AISI/SAE	BS	EN	AFNOR	SS	UNI	UNE	JIS
P	Structural steel										
	15	C15	1.0401	1015	080M15	-	CC12	1350	C15C16	F.111	-
	20	C22	1.0402	1020	050A20	2C	CC20	1450	C20C21	F.112	-
	35	C35	1.0501	1035	060A35	-	CC35	1550	C35	F.113	-
	45	C45	1.0503	1045	080M40	-	CC45	1650	C45	F.114	-
	55	C55	1.0535	1055	070M55	-	-	1655	C55	-	-
	60	C60	1.0601	1060	080A62	43D	CC55	-	C60	-	-
	Y15	9SMn28	1.0715	1213	230M07	-	S250	1912	CF9SMn28	11SMn28	SUM22
	-	9SMnPb28	1.0718	12L13	-	-	S250Pb	1914	CF9MnPb28	11SMnPb28	SUM22L
	-	10SPb20	1.0722	-	-	-	10PbF2	-	CF10Pb20	10SPb20	-
	-	35S20	1.0726	1140	212M36	8M	35MF4	1957	-	F210G	-
	Y13	9SMn36	1.0736	1215	240M07	1B	S300	-	CF9SMn36	12SMn35	-
	-	9SMnPb36	1.0737	12L14	-	-	S300Pb	1926	CF9SMnPb36	12SMnP35	-
	55Si2Mn	55Si9	1.0904	9255	250A53	45	55S7	2085	55Si8	56Si7	-
	-	60SiCr7	1.0961	9262	-	-	60SC7	-	60SiCr8	60SiCr8	-
	15	Ck15	1.1141	1015	080M15	32C	XC12	1370	C16	C15K	S15C
	40Mn	40Mn4	1.1157	1039	150M36	15	35M5	-	-	-	-
	25	Ck25	1.1158	1025	-	-	-	-	-	-	S25C
	35Mn2	36Mn5	1.1167	1335	-	-	40Mn5	2120	-	36Mn5	SMn438(H)
	30Mn	28Mn6	1.117	1330	150M28	14A	20M5	-	C28Mn	-	SCMn1
	35Mn	Cf35	1.1183	1035	060A35	-	XS38TS	1572	C36	-	S35C
	Ck45	45	1.1191	1045	080M46	-	XC42	1672	C45	C45K	S45C
	55	Ck55	1.1203	1055	070M55	-	XC45	-	C50	C55K	S55C
	50	Cf53	1.1213	1050	060A52	-	XC48TS	1674	C53	-	S50C
	60Mn	Ck60	1.1221	1060	080A62	43D	XC60	1678	C60	-	S58C
	-	Ck101	1.1274	1095	060A96	-	-	1870	-	-	SUP4
	-	X120Mn12	1.3401	-	Z120M12	-	X120M12	-	XG120Mn12	X120Mn12	SCMnH/1
	GCr15	100Cr6	1.3505	52100	534A99	31	100C6	2258	100Cr6	F.131	SUJ2
	-	15Mo3	1.5415	ASTM A204Gr.A	1501-240	-	15D3	2912	16Mo3KW	16Mo3	-
	-	16Mo5	1.5426	4520	1503-245-420	-	-	-	16Mo5	16Mo5	-
	-	14Ni6	1.5622	ASTM A350LF5	-	-	16N6	-	14Ni6	15Ni6	-
	-	X8Ni9	1.5662	ASTM A353	1501-509; 510	-	-	-	X10Ni9	XBNi09	-

Material Conversion Table

ISO	Country and standard										
	China	International	Germany	U.S.A.	U.K.		France	Sweden	Italy	Spain	Japan
	GB	DIN	W.-nr	AISI/SAE	BS	EN	AFNOR	SS	UNI	UNE	JIS
	Structural steel										
P	-	12Ni19	1.5680	2515	-	-	Z18N5	-	-	-	-
	-	36NiCr6	1.5710	3135	640A35	111A	35NC6	-	-	-	SNC236
	-	14NiCr10	1.5732	3415	-	-	14NC11	-	16NiCr11	15NiCr11	SNC415 (H)
	-	14NiCr14	1.5752	34153310	655M13655A12	36A	12NC15	-	-	-	SNC815 (H)
	-	36CrNiMo4	1.6511	9840	816M40	110	40NCD3	-	38CrNiMo4 (KB)	35CrNiMo4	-
	-	21NiCrMo2	1.6523	8620	850M20	362	20NCD2	2503	20NiCrMo2	20NiCrMo2	SNCCM220 (H)
	-	40NiCrMo2	1.6546	8740	311-Type7	-	-	-	40NiCrMo2 (KB)	40NiCrMo2	SNC240
	40CrNiMoA	34CrNiMo6	1.6582	4340	817M40	24	35NCD6	2541	35CrNiMo6 (KB)	-	-
	-	17CrNiMo6	1.6587	-	820A16	-	18NCD6	-	-	14CrNiMo1	-
	15Cr	15Cr3	1.7015	5015	523M15	-	12C3	-	-	-	SCr415(H)
	35Cr	34Cr4	1.7033	5132	530A32	18B	32C4	-	34Cr4(KB)	35Cr4	SCr430(H)
	40Cr	41Cr4	1.7035	5140	530M40	18	42C4	-	41Cr4	42Cr4	SCr440(H)
	40Cr	42Cr4	1.7045	5140	-	-	-	2245	-	42Cr4	SCr440
	18CrMn	16MnCr15	1.7131	5115	(527M20)	-	16MC5	2511	16MnCr15	16MnCr15	-
	20CrMn	55Cr3	1.7176	5155	527A60	48	55C3	-	-	-	SUP9(A)
	30CrMo	25CrMo4	1.7218	4130	1717CDS110	-	25CD4	2225	25CrMo4 (KB)	55Cr3	SCM420; SCM430
	35CrMo	34CrMo4	1.7220	4137;4135	708A37	19B	35CD4	2234	35CrMo4	34CrMo4	SCM432; SCRRM3
	40CrMoA	41CrMo4	1.7223	4140;4142	708M40	19A	42CD4TS	2244	41CrMo4	41CrMo4	SCM440
	42CrMo 42CrMnMo	42CrMo4	1.7225	4140	708M40	19A	42CD4	2244	42CrMo4	42CrMo4	SCM440(H)
	-	15CrMo5	1.7262	-	-	-	12CD4	2216	-	12CrMo4	SCM415(H)
	-	13CrMo44	1.7335	ASTMA182F11; F12	1501-620Gr.27	-	15CD3.5; 15CD4.5	-	14CrMo44	14CrMo45	-
	-	32CrMo12	1.7361	-	722M24	40B	30CD12	2240	32CrMo12	F.124.A	-
	-	10CrMo910	1.7380	ASTMA182F.22	1501-622Gr.31;45	-	12CD9;10	2218	12CrMo9,10	TU.H	-
	-	14MoV63	1.7715	-	1503-660-440	-	-	-	-	13MoCrV6	-
	50CrVA	50CrV4	1.8159	6150	735A50	47	50CV4	2230	50CrV4	51CrV4	SUP10
	-	41CrAlMo7	1.8509	-	905M39	41B	40CAD6,12	2940	41CrAlMo7	41CrAlMo7	-
	-	39CrMoV139	1.8523	-	897M39	40C	-	-	36CrMoV12	-	-

Material Conversion Table

ISO	Country and standard										
	China	International	Germany	U.S.A.	U.K.		France	Sweden	Italy	Spain	Japan
	GB	DIN	W.-nr	AISI/SAE	BS	EN	AFNOR	SS	UNI	UNE	JIS
	Tool steel										
	T10	C105W1	1.1545	W.110	-	-	Y1105	1880	C98KU C100KU	F.515 F.516	-
	T12A	C125W	1.1663	W.112	-	-	Y2120	-	C120KU	(C120)	SK20
	GCr15	100Cr6	1.2067	L3	BL3	-	Y100C6	-	-	100Cr6	-
	Cr12	X210Cr12	1.2080	D3	BD3	-	Z200Cr12	-	X210Cr13KU X250Cr12KU	X210Cr12	SKD1
	4Cr5MoVSi	X40CrMoV5 1	1.2344	H13	BH13	-	Z40CDV5	2242	X35CrMoV05KU X40CrMoV51KU	X40CrMoV5	SKD61
	Cr6WV	X100CrMoV5 1	1.2363	A2	BA2	-	Z100CDV5	2260	X100CrMoV51KU	X100CrMoV5	SKD12
	CrWMo	105WCr6	1.2419	-	-	-	105WC13	2140	10WCr6 107WCr5KU	105WCr5	SKS31 SKS2 SKS3
	Cr12W	X210CrW12	1.2436	-	-	-	-	2312	X215CrW12 1KU	X210CrW12	SKD2
	5CrNiMo	45WCrV7	1.2542	S1	BS1	-	-	2710	45WCrV8KU	45WCrSi8	-
P	3Cr2W8V	X30WCrV93 X30WCrV93KU	1.2581	H21	BH21	-	Z30WCV9	-	X28W09KU X30WCrV9 3KU	X30WCrV9	SKD5
	Cr12MoV	X165CrMoV 12	1.2601	-	-	-	-	2310	X165CrMoW12KU	X160CrMoV12	SKD11
	5CrNiMo	55NiCrMoV6	1.2713	L6	-	-	55NCDV7	-	-	F.250.S	SKT4
	V	100V1	1.2833	W210	BW2	-	Y1105V	-	-	-	SKS43
	W6Mo5Cr4V2Co5	S6-5-2-5	1.3243	-	-	-	Z85WDKCV	2723	HS6-5-2-5	HS6-5-2-5	SKH55
	W18Cr4VCo5	S18-1-2-5	1.3255	T4	BT4	-	Z80WKCV 10-05-04-01	-	X78WCo1805KU	HS18-1-1-5	SKH3
	W6Mo5Cr4V2	S6-5-2	1.3343	M2	BM2	-	Z85WDCV 06-05-04-02	2722	X82WMo0605KU	HS6-5-2	SKH9
	-	S2-9-2	1.3348	M7	-	- Z -	Z100WCWV 09-02-04-02	2782	HS2-9-2	HS2-9-2	-
	W18Cr4V	S18-0-1	1.3355	T1	BT1	-	Z80WCV 18-04-01	-	X75W18KU	HS18-0-1	SKH2
	W6Mo5Cr4V3	S6-5-3	-	M3	-	-	-	-	-	-	SKH52
	-	-	-	M42	BM42	-	-	-	-	-	SKH59

Material Conversion Table

ISO	Country and standard										
	China	International	Germany	U.S.A.	U.K.		France	Sweden	Italy	Spain	Japan
	GB	DIN	W.-nr	AISI/SAE	BS	EN	AFNOR	SS	UNI	UNE	JIS
	Stainless steel										
M	0Cr13; 1Cr12	403	1.4000	403	403S17	-	Z6C13	2301	X6Cr13	F.3110	SUS403
	-	-	1.4001	-	-	-	-	-	-	F.8401	-
	1Cr13	410	1.4006	410	410S21	56A	X12Cr13	2302	X12Cr13	F.3401	SUS410
	1Cr17	430	1.4016	430	430S15	60	X8Cr17	220	X8Cr17	F.3113	SUS430
	2Cr13	410	1.4021	40	S62	56B;56C	X20C13	-	X20C13	F.3401	SUS410
	-	-	1.4027	-	420C29	56B	-	-	-	-	SCS2
	4Cr13	-	1.4034	-	420S45	56D	X40Cr14	2304	X40Cr14	F.3405	SUS420J2
	1Cr17Ni2	431	1.4057	431	431S29	57	X16CNi16	2321	X16CNi16	F.3427	SUS431
	Y1Cr17	430F	1.4104	430F	-	-	X10CrS17	2383	X10CrS17	F.3117	SUS430F
	1Cr17Mo	434	1.4113	434	434S17	-	X8CrMo17	2325	X8CrMo17	-	SUS434
	-	-	1.4313	-	425C11	-	-	-	-	-	SCS5
	-	-	1.4408	-	316C16	-	-	-	-	F.8414	SCS14
	4Cr9Si2	HW3	1.4718	HW3	401S45	52	X45CrSi8	-	X45CrSi8	F.322	SUH1
	0Cr13Al	405	1.4724	405	403S17	-	X10CrAl12	-	X10CrAl12	F.311	SUS405
	Cr17	430	1.4742	430	430S15	60	X8Cr17	-	X8Cr17	F.3113	SUS430
	8Cr20Si2Ni	HNV6	1.4757	HNV6	443S65	59	X80CrSiNi20	-	X80CrSiNi20	F.320V	SUH4
	2Cr25N	446	1.4762	446	-	-	X16Cr26	2322	X16Cr26	-	SUH446
	Austenitic stainless steel										
	0Cr18Ni9	X5CrNi1810	1.4301	304	304S15	58E	Z6CN18.09	2332	X5CrNi1810	F.3551 F.3541; F.3504	SUS304
	1Cr18Ni9MoZr	X10CrNiS189	1.4305	303	303S21	58M	Z10CNF18.09	2346	X10CrNiS18.09	F.3508	SUS303
	0Cr19Ni10	X2CrNi1911	1.4306	304L	304S12	-	Z2CN18.10	2352	X2CrNi18.11	F.3503	SCS19
	-	G-X6CrNi189	1.4308	-	304C15	-	Z6CN18.10M	-	-	-	SCS13
	Cr17Ni17	X12CrNi177	1.4310	301	-	-	Z12CN17.07	2331	X12CrNi1707	F.3517	SUS301
	-	X2CrNiN1810	1.4311	304LN	304S62	-	Z2CN18.10	2371	-	-	SUS304LN
	0Cr19Ni9	X5CrNi189	1.4350	304	304S31	58E	Z6CN18.09	-	X5CrNi1810	-	SUS304
	0Cr17Ni11Mo2	X5CrNi Mo1712	1.4401	316	316S16	Z6CND 17.11	1.4401	2347	X5CrNiMo1712	F.3543	SUS316
	00Cr17Ni13Mo2	X2CrNi MoN17133	1.4429	316LN	-	-	Z2CND17.13	2375	-	-	SUS316LN
	0Cr27Ni12Mo3	X2CrNi Mo18143	1.4435	316L	316S12	-	Z2CDN17.13	2353	X2CrNiMo1713	-	SCS16
	00Cr19Ni13Mo3	X2CrNi Mo17133	1.4438	317L	317S12	-	Z2CND19.15	2367	X2CrNiMo18.16	-	SUS317L
	-	X8CrNiMo275	1.4460	329L	-	-	-	2324	-	-	SUS329L; SCH11; SCS11

Material Conversion Table

ISO	Country and standard										
	China	International	Germany	U.S.A.	U.K.		France	Sweden	Italy	Spain	Japan
	GB	DIN	W.-nr	AISI/SAE	BS	EN	AFNOR	SS	UNI	UNE	JIS
M	Austenitic stainless steel										
	1Cr18Ni9Ti	X6CrNi Ti1810	1.4541	321	2337	321S12	Z6CNT18.10	58B	X6CrNiTi1811	F.3553	SUS321
	1Cr18Ni11Nb	X6CrNi Nb1810	1.4550	347	347S17	58F	Z6CNNb18.1	2338	X6CrNiTi1811	F.3552	SUS347
	Cr18Ni12Mo2Ti	X6CrNi MoTi17122	1.4571	316Ti	320S17	58J	Z6NDT17.12	2350	X6CrNiMoTi17	F.3535	-
	-	G-X5CrNi MoNb1810	1.4581	-	318C7	-	Z4CNDNb1812M	-	XG8CrNiMo18	-	SCS22
	Cr17Ni12Mo3Nb	X10CrNi MoNb1812	1.4583	318	-	-	Z6CNDNb1713B	-	X6CrNiMoTiNb17	-	-
	1Cr23Ni13	X15CrNi Si2012	1.4828	309	309S24	-	Z15CNS20.1	-	-	-	SUH309
	0Cr25Ni20	X12CrNi2521	1.4845	310S	310S24	-	Z12CN2520	2361	X6CrNi2520	F.331	SUH310
	Cr15Ni36W3Ti	X12NiCr Si3616	1.4864	330	-	-	Z12CNS35.1	-	-	-	SUH330
	-	G-X40NiCr Si3818	1.4865	-	330C11	-	-	-	XG50NiCr3919	-	SCH15
	5Cr2Mn9Ni4N	X53CrMn NiN219	1.4871	EV8	349S54; 321S12	– 58B	Z52CMN21.0	-	X53CrMnNiN219	-	SUH35
	1Cr18Ni9Ti	X12CrNi Ti189	1.4878	321	321S320	58C	Z6CNT18.12	-	X6CrNiTi1811	F.3523	SU321

ISO	Country and standard								
	China	Germany	U.S.A.	U.K.	France	Sweden	Italy	Spain	Japan
	GB	W.-nr	AISI/SAE	EN	AFNOR	SS	UNI	UNE	JIS
K	Nodular cast iron								
	QT400-18	GGG40	60-40-18	400/17	FGS370-17	0717-02	GS370-17	FGE38-17	FCD400
	QT450-10	--	65-45-12	420/12	FGS400-12	--	GS400-12	FGE42-12	FCD450
	QT500-7	GGG50	70-50-05	500/7	FGS500-7	0727-02	GS500-7	FGE50-7	FCD500
	QT600-3	GGG60	80-60-03	600/7	FGS600-2	0732-03	GS600-2	FGE60-2	FCD600
	QT700-2	GGG70	100-70-03	700/2	FGS700-2	0737-01	GS700-2	FGE70-2	FCD700
	QT800-2	GGG80	120-90-02	800/2	FGS800-2	0864-03	GS800-2	FGE80-2	FCD800
	QT900-2	--	--	900/2	--	--	--	--	--
	Grey cast iron								
	--	GG40	NO.60	--	FGL400	0140	--	--	
	HT350	GG35	NO.50	350	FGL350	0135	G35	FG35	FC350
	HT300	GG30	NO.45	300	FGL300	0130	G30	FG30	FC300
	HT250	GG25	NO.35	250	FGL250	0125	G25	FG25	FC250
	HT200	GG20	NO.30	200	FGL200	0120	G20	FG20	FC200
	HT150	GG15	NO.20	150	FGL150	0115	G15	FG15	FC150
	HT100	--	--	100	--	0110	G10	--	FC100

ACHTECK

Material Conversion Table

ISO	Country and standard									
	China	International	Germany	U.S.A.	U.K.	France	Sweden	Italy	Spain	Japan
	GB	DIN	W.-nr	AISI/SAE	BS	AFNOR	SS	UNI	UNE	JIS
N	Al-based alloy									
	ZAlSi7Mg	Al-Si7Mg(Fe)	~AlSi7Mg	356	LM25	A-S7G	4244	3599	-	AC4C
	ZAlSi7MgA	Al-Si7Mg	AlSi7Mg	A356.0	2L99	A-S7G03	-	8024	-	AC4C
	ZAlSi12	Al-Si12	AlSi12	413;B413.0	LM6	A-S13	4261	4514	-	AC3A
	ZAlSi9Mg	~Al-Si10Mg	AlSi9Mg	360	LM9	A-S9G;A-S10G	4253	3051	-	AC4A
	-	Al-Si5	AlSi5Mg	A 443.0	-	-	-	5077	-	-
	-	Al-Si5Fe	-	B443.0	-	-	-	GD-AlSi5Fe	-	-
	-	(AlSi7Fe)	-	A444.0	-	-	-	-	-	-
	-	Al-Si12Fe	-	413	LM20	~A-S12	4260	5079	-	ADC1

ISO	Country and standard									
	China	International	Germany	U.S.A.	U.K.	France	Sweden	Italy	Spain	Japan
	GB	DIN	W.-nr	AISI/SAE	BS	AFNOR	SS	UNI	UNE	JIS
S	Ni-based alloy									
	-	S-NiCr13A16MoNb	LW2 4670	5391	mar – 46	NC12AD	-	-	-	-
	-	NiCo15Cr10MoAlTi	LW2 4674	AMS 5397	-	-	-	-	-	-
	-	NiFe35Cr14MoTi	LW2.4662	5660	-	ZSNCDT42	-	-	-	-
	-	NiCr19Fe19NbMo	LW2.4668	5383	HR8	NC19eNB	-	-	-	-
	-	NiCr20TiAk	2.4631	-	Hr401.601	NC20TA	-	-	-	-
	-	NiCr19Co11MoTi	2.4973	AMS 5399	-	NC19KDT	-	-	-	-
	-	NiCr19Fe19NbMo	LW2.4668	AMS 5544	-	NC20K14	-	-	-	-
	-	-	2.4603	5390A	-	NC22FeD	-	-	-	-
	-	NiCr22Mo9Nb	2.4856	5666	-	NC22FeDNB	-	-	-	-
	-	NiCr20Ti	2.4630	-	HR5.203-4	NC20T	-	-	-	-
	-	NiCu30AL3Ti	2.4375	4676	3072-76	-	-	-	-	-
	Co-based alloy									
	-	CoCr20W15Ni	-	5537C,AMS	-	KC20WN	-	-	-	-
	-	CoCr22W14Ni	LW2.4964	5772	-	KC22WN	-	-	-	-
	Ti-alloy									
	-	TiAl5Sn2.5	3.7115.1	UNS R54520	TA14/17	T-A5E	-	-	-	-
	-	-	-	-	-	UNS R56400	-	-	-	-
	-	TiAl6V4	3.7165.1	-	TA10-13/ TA28	UNS R56401	-	T-A6V	-	-
	-	TiAl5V5Mo5Cr3	-	-	-	-	-	-	-	-
	-	TiAl4Mo4Sn4Si0.5	3.7185	-	-	-	-	-	-	-