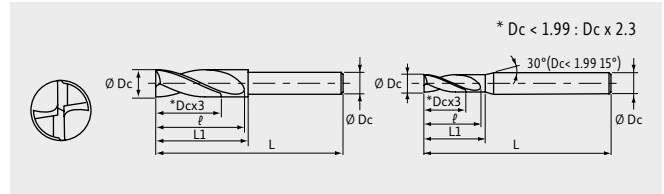


AQUA Drill

EX FLAT 2D



MATERIAL

POINT ANGLE HELIX ANGLE

L9610

Dc	ℓ	L	L1	Ds	Stock
0.2	0.66	47	0.98	3	●
0.25	0.82	47	1.17	3	●
0.3	0.99	47	1.36	3	●
0.35	1.16	47	1.46	3	●
0.4	1.32	47	1.65	3	●
0.45	1.48	47	1.84	3	●
0.5	1.65	47	2.03	3	●
0.55	1.81	47	2.13	3	●
0.6	1.98	47	2.32	3	●
0.65	2.14	47	2.51	3	●
0.7	2.31	47	2.71	3	●
0.75	2.47	47	2.8	3	●
0.8	2.64	47	2.99	3	●
0.85	2.8	47	3.19	3	●
0.9	2.97	47	3.28	3	●
0.95	3.13	47	3.47	3	●
1.0	3.3	47	3.6	3	●
1.1	3.5	47	3.9	3	●
1.2	3.9	47	4.2	3	●
1.3	4.2	47	4.5	3	●
1.4	4.6	47	4.9	3	●
1.5	4.9	47	5.2	3	●
1.6	5.2	47	5.5	3	●
1.7	5.5	47	5.8	3	●
1.8	5.8	47	6.1	3	●
1.9	6.2	47	6.5	3	●
2.0	9	50	9.8	4	●
2.1	11	50	11.4	4	●
2.2	11	50	11.4	4	●
2.3	11	50	11.5	4	●
2.4	12	50	12.6	4	●
2.5	12	50	12.7	4	●
2.6	12	50	12.8	4	●
2.7	14	50	14.9	4	●
2.8	14	50	15.0	4	●
2.9	14	50	15.0	4	●
3.0	14	50	14.4	6	●
3.1	15	50	15.5	6	●
3.2	15	50	15.6	6	●
3.3	15	50	15.7	6	●
3.4	16	50	16.2	6	●
3.5	16	50	16.3	6	●
3.6	16	50	16.4	6	●
3.7	18	50	18.0	6	●
3.8	18	50	18.1	6	●
3.9	18	50	18.2	6	●
4.0	18	50	18.3	6	●
4.1	19	60	20.4	6	●
4.2	19	60	20.4	6	●
4.3	19	60	20.5	6	●
4.4	21	60	22.6	6	●
4.5	21	60	22.7	6	●
4.6	21	60	22.8	6	●
4.7	22	60	22.9	6	●
4.8	22	60	23.0	6	●
4.9	22	60	23.0	6	●
5.0	23	60	23.1	6	●
5.1	24	60	26.2	6	●
5.2	24	60	26.3	6	●

Dc	ℓ	L	L1	Ds	Stock
5.3	24	60	26.4	6	●
5.4	25	60	27.5	6	●
5.5	25	60	27.6	6	●
5.6	25	60	27.7	6	●
5.7	27	60	29.7	6	●
5.8	27	60	29.8	6	●
5.9	27	60	29.9	6	●
6.0	27	60	30	6	●
6.1	28	70	31	6	●
6.2	28	70	31	6	●
6.3	28	70	31	6	●
6.4	30	70	33	6	●
6.5	30	70	33	6	●
6.6	30	70	33	6	●
6.7	31	70	33	6	●
6.8	31	70	33	6	●
6.9	31	70	33	6	●
7.0	32	70	33	6	●
7.1	33	70	36	6	●
7.2	33	70	36	6	●
7.3	33	70	36	6	●
7.4	34	70	36	6	●
7.5	34	70	36	6	●
7.6	34	70	36	6	●
7.7	36	70	39	6	●
7.8	36	70	39	6	●
7.9	36	70	39	6	●
8.0	36	70	39	8	●
8.1	37	80	40	8	●
8.2	37	80	40	8	●
8.3	37	80	40	8	●
8.4	39	80	42	8	●
8.5	39	80	42	8	●
8.6	39	80	42	8	●
8.7	40	80	42	8	●
8.8	40	80	42	8	●
8.9	40	80	42	8	●
9.0	41	80	42	8	●
9.1	42	80	45	8	●
9.2	42	80	45	8	●
9.3	42	80	45	8	●
9.4	43	80	45	8	●
9.5	43	80	45	8	●
9.6	43	80	45	8	●
9.7	45	80	48	8	●
9.8	45	80	48	8	●
9.9	45	80	48	8	●
10.0	45	80	48	10	●
10.1	46	90	49	10	●
10.2	46	90	49	10	●
10.3	46	90	49	10	●
10.4	48	90	51	10	●
10.5	48	90	51	10	●
10.6	48	90	51	10	●
10.7	49	90	51	10	●
10.8	49	90	51	10	●
10.9	49	90	51	10	●
11.0	50	90	51	10	●
11.1	51	90	54	10	●

Dc	ℓ	L	L1	Ds	Stock
11.2	51	90	54	10	●
11.3	51	90	54	10	●
11.4	52	90	54	10	●
11.5	52	90	54	10	●
11.6	52	90	54	10	●
11.7	54	90	57	10	●
11.8	54	90	57	10	●
11.9	54	90	57	10	●
12.0	54	90	57	12	●
12.1	55	100	58	12	●
12.2	55	100	58	12	●
12.3	55	100	58	12	●
12.4	57	100	60	12	●
12.5	57	100	60	12	●
12.6	57	100	60	12	●
12.7	58	100	60	12	●
12.8	58	100	60	12	●
12.9	58	100	60	12	●
13.0	59	100	60	12	●
13.1	60	100	63	12	●
13.2	60	100	63	12	●
13.3	60	100	63	12	●
13.4	61	100	63	12	●
13.5	61	100	63	12	●
13.6	61	100	63	12	●
13.7	63	100	66	12	●
13.8	63	100	66	12	●
13.9	63	100	66	12	●
14.0	63	100	66	12	●
14.1	64	105	67	12	●
14.2	64	105	67	12	●
14.3	64	105	67	12	●
14.4	66	105	69	12	●
14.5	66	105	69	12	●
14.6	66	105	69	12	●
14.7	67	105	69	12	●
14.8	67	105	69	12	●
14.9	67	105	69	12	●
15.0	68	105	69	12	●
15.1	69	115	72	12	●
15.2	69	115	72	12	●
15.3	69	115	72	12	●
15.4	70	115	72	12	●
15.5	70	115	72	12	●
15.6	70	115	72	12	●
15.7	72	115	75	12	●
15.8	72	115	75	12	●
15.9	72	115	75	12	●
16.0	72	115	75	16	●
16.5	75	115	78	16	●
17.0	77	125	79	16	●
17.5	79	125	81	16	●
18.0	81	125	84	16	●
18.5	84	135	87	16	●
19.0	86	135	87	16	●
19.5	88	145	91	16	●
20.0	90	145	93	20	●

●: German Stock

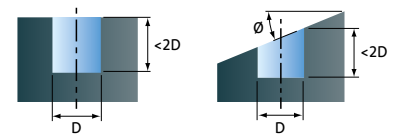
Standard Drilling Conditions

STANDARD DRILLING CONDITIONS AQUA DRILL EX FLAT 2D AND 2D RADIUS																
Work material	Structural Steel, Carbon Steel, Grey Cast Iron St37-2, C50E		Alloy Steel. Pre-Hardened 42CrMo4		Mold Steel 1.2344		Hardened Steel		Stainless Steel 1.4301 1.4401		Ductile Cast Iron GG/GGG		Aluminium Alloy A7075		Cast Aluminium AC ADC	
	-200HB		20-30HRC		30-40HRC		40-50HRC									
mm	min ⁻¹	mm/min	min ⁻¹	mm/min	min ⁻¹	mm/min	min ⁻¹	mm/min	min ⁻¹	mm/min	min ⁻¹	mm/min	min ⁻¹	mm/min	min ⁻¹	mm/min
0.2	32000	40	29000	35	16000	20	14000	10	16000	10	29000	25	60000	120	56000	100
0.3	30000	60	25000	45	15000	30	12000	15	15000	15	25000	35	60000	180	50000	130
0.4	28000	70	23000	55	14000	35	11000	20	14000	20	23000	45	60000	240	47000	170
0.5	25500	80	21000	65	12500	40	10000	20	12500	20	21000	50	60000	300	45000	200
0.6	24000	120	19000	90	11500	60	9000	25	11500	25	19000	70	53000	350	40000	250
0.7	22000	150	18000	125	11000	75	8000	30	11000	30	18000	100	48000	450	36000	300
0.8	21000	200	17000	160	10500	80	7500	30	10500	35	17000	130	45000	550	33000	350
0.9	20000	250	16500	200	10000	100	7000	35	10000	40	16500	160	42000	650	31000	400
1	19100	290	15900	240	9550	110	6400	40	9550	50	15900	190	40000	720	28600	460
1.9	11700	360	10100	310	5900	160	4200	70	5030	50	10100	250	24300	830	17600	540
2	11100	360	9550	310	5550	160	3980	70	-	-	9550	250	23100	830	16700	530
3	7950	420	6900	360	3700	170	2650	80	-	-	6900	310	17000	1020	12500	660
4	5950	420	5150	360	2800	170	2000	80	-	-	5150	310	12500	1020	9550	660
5	4800	420	4150	360	2200	170	1600	80	-	-	4150	310	10000	1020	7650	660
6	4000	420	3450	360	1800	170	1300	80	-	-	3450	310	8500	1020	6400	660
8	3000	420	2600	360	1400	170	1000	80	-	-	2600	310	6350	1020	4750	660
10	2400	420	2050	360	1100	170	800	80	-	-	2050	310	5100	1020	3800	660
12	2000	420	1700	360	950	170	650	80	-	-	1700	310	4250	1020	3200	660
16	1500	420	1300	360	700	170	500	80	-	-	1300	310	3200	1020	2400	660
20	1200	420	1050	360	550	170	400	80	-	-	1050	310	2550	1020	1900	660

Warnings on using the drilling condition tables:

- Adjust drilling condition according to the rigidity of machine or work clamp state.
- For drilling removed forging surfaces.
- These table values are for drilling with water-soluble cutting fluid. When using non-water-soluble cutting fluid, reduce the RPM and feed speeds by 20%.
- For drilling depths of 2D or less. Drilling over 2D is not recommended.
- For drilling stainless steel (SS304, 316, etc.), use it as 1.9mm or less.
- For slope drilling, adjust according to inclined angle (θ). For inclined angle under 30°, reduce the feed to 50%. When drilling on inclined surface over 30°, reduce the rotation to 70% or less and cutting speed to 30% or less.
- Side milling is not possible.

Depth of cut:



STANDARD DRILLING CONDITIONS AQUA DRILL EX FLAT REGULAR 4D													
Work material	Structural Steel, Carbon Steel, Grey Cast Iron St37-2, C50E		Alloy Steel. Pre-Hardened 42CrMo4		Mold Steel 1.2344		Hardened Steel		Ductile Cast Iron GG/GGG		Aluminium Alloy A7075		
	-200HB		20-30HRC		30-40HRC		40-50HRC						
mm	min ⁻¹	mm/min	min ⁻¹	mm/min	min ⁻¹	mm/min	min ⁻¹	mm/min	min ⁻¹	mm/min	min ⁻¹	mm/min	
3	10600	630	9500	430	7400	330	5300	240	9500	430	12700	760	
4	7900	630	7100	430	5550	330	3980	240	7100	430	9500	760	
5	6300	630	5700	430	4450	330	3180	240	5700	430	7600	760	
6	5300	630	4750	430	3700	330	2650	240	4750	430	6400	760	
8	3950	630	3550	430	2790	330	1990	240	3550	430	4780	760	
10	3150	630	2860	430	2230	330	1590	240	2860	430	3800	760	
12	2650	630	2390	430	1860	330	1300	240	2390	430	3180	760	
16	1990	630	1790	430	1390	330	990	240	1790	430	2390	760	
20	1590	630	1430	430	1110	330	800	240	1430	430	1910	760	

Warnings on using the drilling condition tables:

- Adjust drilling condition according to the rigidity of machine or work clamp state.
- These table values are for drilling with water-soluble cutting fluid. When using non-water-soluble cutting fluid, reduce the RPM and feed speeds by 20%.
- Use the table values for drilling depths under 4xD.
- Drilling stainless steel (SS304, 316, etc.) is not recommended. We recommend the Aqua Drill EX Flat OH3D5D.
- When for hole drilling require: 1: centering hole larger than the diameter or 2: same diameter guide hole. (1: Recommend the AG Starting Drill for centering holes. 2: Recommend the Aqua Drill EX Flat for guide holes.)
- Side milling is not possible.

AQUA Drill EX FLAT Series

AQUA Drill EX FLAT. Regular. Long Shank. Oil Hole. Radius

- ▶ New Drilling Technology
- ▶ Expanded the AQUA Flat drill series to 7 type 1028 sizes
- ▶ AQUA EX coating realize long tool life. by improved heat and wear resistance
- ▶ Adoption of double margin provides stable drilling and improves hole accuracy



AQUA EX COATING

Excellent drilling performance

- Anti-adhesion layer
- AlCrTiX Anti-oxidant layer
- TiAlX Anti-wear layer
- High-strength carbide material



CUTTING CONDITIONS

Tool	AQUA EX Flat Ø10
Cutting Speed	75m/min
Feed Speed	240mm/min
Work Material	C50 carbon steel
Cutting Fluid	Water-soluble

180° FLAT DRILL

Realize high accurate counter bore surface in once

AQUA DRILL EX FLAT	2Flute end mill
Flat bottom	Bottom is not flat

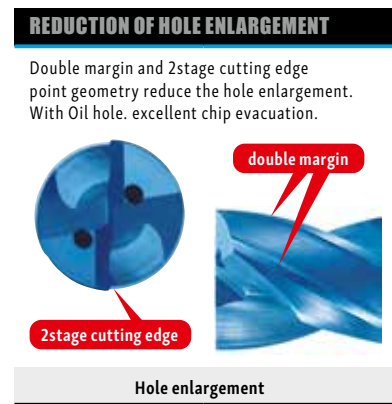
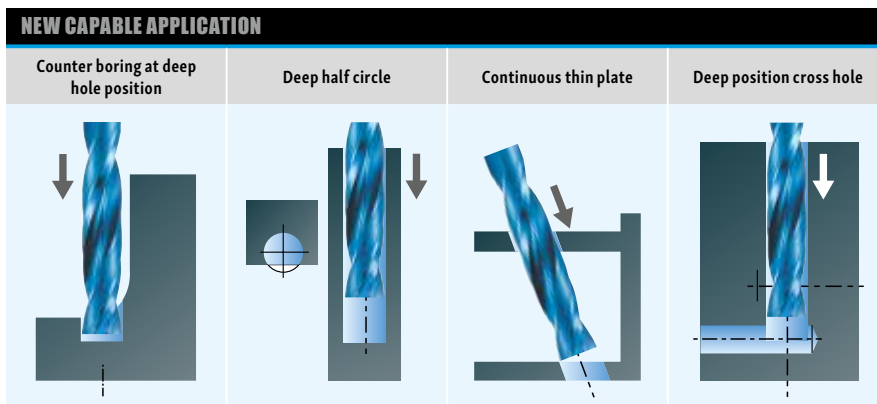
NEW DRILLING TECHNOLOGY

Slope. Counter Boring. Thin Plate. Cross Hole. Hole correction in one drill

Slope	Counter boring	Thin plate	Pre hole of blind hole tapping	Cross hole	Eccentric hole correction

NEW AQUA DRILL EX FLAT LINEUP			
Hole depth, hole position depth ↑	AQUA EX FLAT Long Shank 2D		•
	AQUA EX FLAT Oil Hole 5D		•
	AQUA EX FLAT Regular 4D		•
	AQUA EX FLAT Oil Hole 3D	NEW	•
	AQUA EX FLAT Radius 2D		•
	AQUA EX FLAT 2D		•
	AQUA EX FLAT SHORT*		○
	SGEZ, SG Flat (FMX)		•

○: Japan Stock | ●: German Stock | *On request: Available in extra short version over Japan Stock.



FEATURES AND SPECIFICATIONS									
Tool	Depth	Feature					Drill Feature		
		Deep position	Efficiency	Slope	Hole accuracy	Corner radius	Guide hole	Double margin	Internal coolant
AQUA FLAT 2D	2D		•	•			no		
AQUA FLAT 2D Radius	2D		•	•		•	no		
AQUA FLAT 4D	4D	•			○		need*	○	
AQUA FLAT Long Shank	deep position (2D)	•			○		need*	○	
AQUA FLAT Oil Hole 3D	3D		•	•	•		no need	○	○
AQUA FLAT Oil Hole 5D	5D	•	○		○		need	○	○
SG FLAT 1D	1D			•			no need		

● Excellent | ○ Good | X Not Applicable | * Depending on the part. material. condition. guide may not be necessary

APPLICABLE WORK MATERIALS												
Tool	Structural Steels	Carbon Steels	Pre-Hardened Steels Alloy Steels	Hardened Steels Mold Steels	Hardened Steels		Stainless Steels		Titanium Alloys Nickel Alloys	Cast Irons	Aluminium Alloys	Copper Alloys
	St37-2	C45E	42CrMo4	30-40HRC	40-50 HRC	50-60 HRC	1.4301/ 1.4401	1.4021		GG/GGG	AC/ADC	Cu
AQUA FLAT 2D												
AQUA FLAT 2D Radius												
AQUA FLAT 4D	•	•	•	•	○			•			○	○
AQUA FLAT Long Shank												
AQUA FLAT Oil Hole 3D	•	•	•	•	○		○	•		•	•	•
AQUA FLAT Oil Hole 5D	•	•	•	•	○		○	•		•	•	•
SG FLAT 1D	•	•	•	○	x	x	○	○	○	•	•	•

● Excellent | ○ Good | X Not Applicable

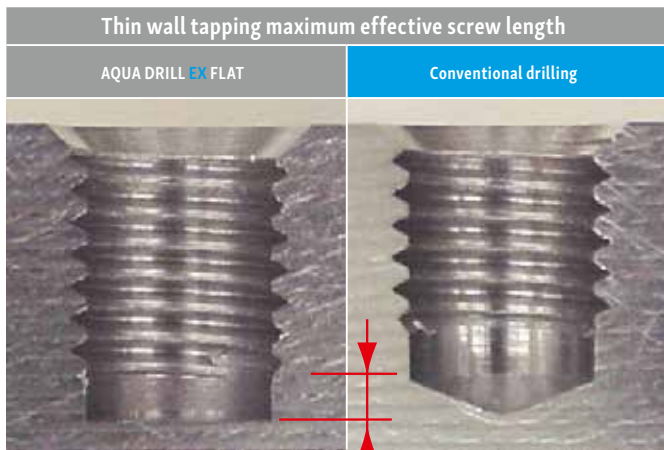
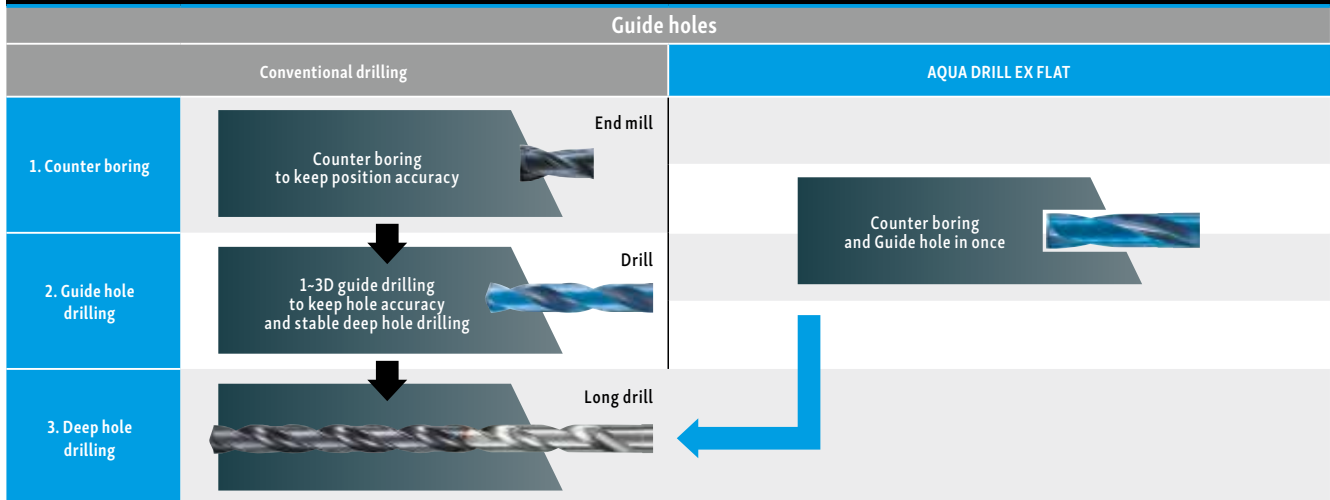
AQUA DRILL EX FLAT SERIES

COMPARISON OF PERFORMANCE

Excellent cutting edge. tool life. precision and efficiency

Smaller burrs at the exit of hole on thin plate drilling:		High-efficiency. Direct drilling without pilot hole:	
<p>AQUA DRILL EX FLAT burr height 0.3mm</p>		<p>Competitor carbide drill burr height 1.1mm</p>	
<p>AQUA DRILL EX FLAT surface</p>		<p>2flute carbide end mill surface</p>	
Cutting Conditions	Tool	AQUA EX Flat Ø 10	
	Cutting Speed	75m/min	
	Feed Speed	420mm/min	
	Feed	0.18mm/rev	
	Work Material	SS400 structure steel	
Cutting Fluid	Water-soluble		
Drilling time	19sec. Non-step drilling only 19sec to drill 2D depth slope 40% efficiency		32sec. 5mm-step drilling

APPLICATIONS



Suitable for tap pre-hole too. Blind hole in thin wall. effective thread length is kept that eliminates post-processing.

Web-Video

WEB VIDEO
Product introduction

AQUA DRILL EX FLAT

2Flute end mill

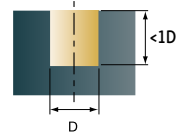
Standard Drilling Conditions

STANDARD DRILLING CONDITIONS SG DRILL FOR LARGE DIAMETERS														
Work material	Structural Steel, Carbon Steel St37-2, C50E		Alloy Steel, Pre-Hardened 42CrMo4		Mold Steel 1.2344		Stainless Steel 1.4301, 1.4401		Ductile Cast Iron GG/GGG		Aluminium Alloy Copper Alloy A5052 C1100		Titanium Alloys, Nickel Alloys	
	-200HB		20-30HRC		30-40HRC									
mm	min ⁻¹	mm/min	min ⁻¹	mm/min	min ⁻¹	mm/min	min ⁻¹	mm/min	min ⁻¹	mm/min	min ⁻¹	mm/min	min ⁻¹	mm/min
20	400	80	320	65	240	38	160	32	400	100	480	100	80	13
22	360	80	290	65	220	38	140	32	360	100	440	100	70	13
24	330	80	265	65	200	38	130	32	330	100	400	100	70	13
26	300	80	245	65	185	38	120	32	300	100	370	100	60	13
28	280	70	230	55	170	33	110	28	280	80	340	90	60	11
30	260	70	210	55	160	33	100	28	260	80	320	90	50	11
32	250	70	200	55	150	33	100	28	250	80	300	90	50	11

Warnings on using the drilling condition tables:

- Adjust cutting conditions according to the rigidity of machine, work clamp and work shape. In case of no rigid machines, pre-drilling hole is required.
- This cutting condition is for drilling with water-soluble cutting fluid.
- Provide sufficient cutting fluid to the cutting point and in the flute.
- This cutting condition table is applied for hole depth 1D or less.
- Cutting chip may scatter. The covering is required. When the chip grows, add step feed and break into cutting chip.
- Side milling is not possible.

Depth of cut:



User Guide

PREVENTION OF HOLE ENLARGEMENT AND VIBRATION BY AQUA EX FLAT(2D) AND OIL HOLE 3D

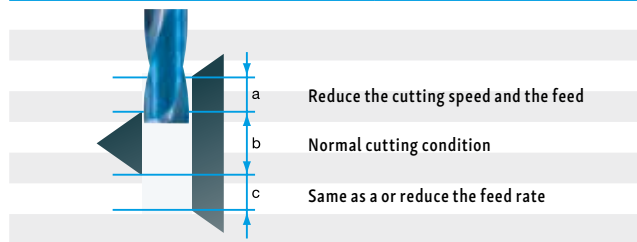
- For flat surface, maintain the guide hole by small steps (G73)
- For slope surface, reduce the feed rate AQUA EX FLAT Long Shank (2D)



Please make the chamfer 1st when the hole is larger than drill diameter such as tap holes



CUTTING CONDITION OF SLOPE DRILLING



AQUA EX FLAT REGULAR(4D). LONG SHANK(2D). OIL HOLE 5D DRILLING

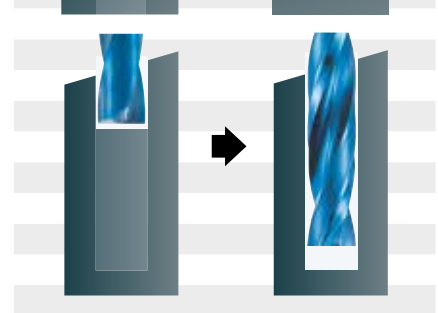
Please make a guide hole with AQUA EX Flat 2D (In case of stainless steel, please use AQUA EX Flat Oil Hole 3D)



Chamfering with AG Starting drill

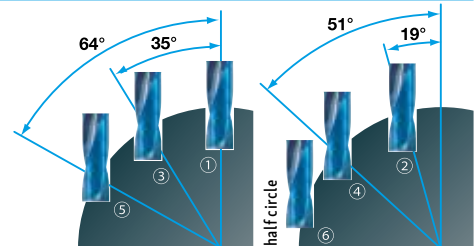


Please make a guide hole with AQUA EX Flat 2D (In case of stainless steel, please use AQUA EX Flat Oil Hole 3D)



CUTTING CONDITION COMPARISON ON SLOPE DRILLING

No.	Position	Cutting Speed			Feed			
		angle	mm/min	min ⁻¹	ratio	mm/min	mm/rev	ratio
1	0		75	2400	100%	420	0.18	100%
2	19°					210	0.09	50%
3	35°					120	0.07	40%
4	51°		52	1650	70%	120	0.07	40%
5	64°					90	0.06	33%
6	half circle					60	0.04	20%



Cutting Conditions Tool AQUA EX Flat Drill Ø 10 Hole Depth 15mm Cutting Fluid Water-soluble Work Material C45 Carbon steel