MILLSTAR® Application Data

Extrusion Die for Aluminum

Objective

The objective of this machining test was to rough and finish machine a large extrusion die (462 mm diameter x 220 mm thickness / 18.188 inch dia. X 8.662 inch) for Aluminum in hardened hot work die steel. The test was to be performed on a vertical machining center. The main objective was to replace days long and costly EDM machining and subsequent polishing with hardened metal machining.

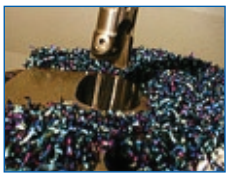
Machining Summary

The machining strategy selected was to machine the die from both sides, first from the rear (180 degree - side) and second from the front (0 degree - side). Index pins guaranteed the same zero position for both sides. Due to the very long reach (tool extension) of almost 10 times D (tool diameter), the selection of cutting tools and rigid tool shank was critical. The tool path strategy selected was roughing in a continuous spiral to form an elongated slot (Fig. 1) and finish machine in multiple Z-Level step-down passes (Fig. 2). The strategy was used on both sides. The continuous spiral strategy was used to achieve constant tool pressure and minimal but constant tool deflection to achieve straight walls. The Z-Level finish machining strategy was used to achieve an accurate geometric result with a superior finish in the shortest amount of time possible.

Machining Parameters	
Customer	Major aluminum extrusion maker
Workpiece	Extrusion die for aluminum
Machine	MAKINO model V55 vertical Machining Center
Tool supplier	MILLSTAR
Material	
Dimensions	Ø 462 mm x 220 mm (18.188 x 8.66 inch), solid
Material spec.	Similar to H13/H12 or 1.2344/1.2606 or SKD 61/62
Hardness	49 - 50 HRc

Machining of the Back-Side (180 degree - side)

Roughing	
Tool Adapter	Power Chuck
Tool Holder	CY32-300-32 SC-HM (MILLSTAR)
Holder material	Solid carbide + modular tool head
Neck diameter	D2=22 mm (0.866 inch)
Neck length	L1=150 mm (6.0 inch)
Insert, back draft	BD-32-N (R 2.6) MILLSTAR
Tool coating	Exalon™ (AlTiN)
Toolpath Strategy	Spiral-type removing of material
Cutting Depth	0 - 115 mm (0 - 4.528 inch)
Stock remaining	0.2 mm (0.008 inch)
Feed / spiral, ap	< 0.26 degree (ap ~ 1mm per pass)
Feed	2000 mm/min (78.75 inch/min.)
Spindle speed	1600 RPM (min/1)
Machining time	28 minutes



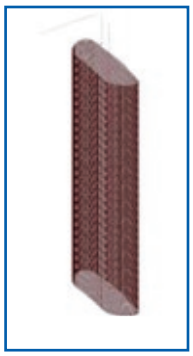


Fig. 1

Extrusion Die for Aluminum (cont'd)

Machining of the Back-Side (180 degree - side)

Finishing	
Tool Adapter	Power Chuck
Tool Holder	CY32-300-32 SC-HM (MILLSTAR)
Holder material	Solid carbide + modular tool head
Neck diameter	D2=22 mm (0.866 inch)
Neck length, step 1	L1=75 mm (3.00 inch)
Neck length, step 2	L2=150 mm (6.00 inch)
Insert, back draft	BD-32-N MILLSTAR
Tool coating	Exalon™ (AlTiN)
Toolpath Strategy	Z-LEVEL machining
Cutting Depth	0 - 60 mm (2.36 inch)
Stock remaining	0 mm
Step down / pass, ap	0.23 mm (0.009 inch)
Feed	1600 mm/min (63.0 inch/min.)
Spindle speed	1300 RPM (min/1)
Machining time	18 minutes

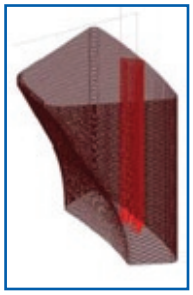


Fig. 2

Machining of the Front-Side (0 degree - side)

Roughing	
Tool Adapter	Power Chuck
Tool Holder	CY32-300-32 SC-HM (MILLSTAR)
Holder material	Solid carbide + modular tool head
Neck diameter	D2=22 mm (0.866 inch)
Neck length, step 1 + 2	L1=150 mm + L2=240 mm
Insert, back draft	BD-32-N Exalon™ MILLSTAR
Strategy	Spiral-type removing of material
Cutting Depth	0 - 50 mm (2.0 inch)
Stock remaining	0.2 mm (0.008 inch)
Feed down / spiral, ap	< 0.18 degree (ap ~ 0.32mm per pass)
Feed	1000 mm/min (39.37 inch/min.)
Spindle speed	1600 RPM (min/1)
Machining time	15 minutes

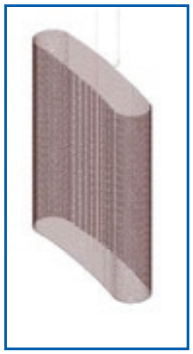


Fig. 3

Machining of the Front-Side (0 degree - side)

Finishing	
Strategy	Z-LEVEL machining
Cutting Depth	0 - 25 mm (0 - 1.0 inch)
Feed	800 mm/min (31.5 inch/min.)
Speed	1200 RPM (min/1)
Machining time	25 minutes
Step down / pass, ap	0.2 mm (0.008 inch)

Extrusion Die for Aluminum (cont'd)

Summary

Prior to this test many different competitive tools were tested without success.

The first roughing process was performed with the BD-20-N (CBN-tipped) tool. It did not fail initially, but due to vibration and poor geometrical cutting conditions this test was stopped.

Second we tried the TO-32 toroid bull nose inserts. Cutting in the first few levels was very smooth but when the tool was in full nose radius contact, the cut resulted in bad vibration. The large nose radius R= 8mm of these inserts created radial forces which are too heavy for a tool extension and a length-to-diameter relation of almost 10 to 1.

The tools that performed best under these difficult conditions were the BD-32-N inserts with an insert nose radius R = 2.6 mm. Cutting was strong but smooth. Over the cutting time of about 30 minutes per hole (115 mm depth) the color of the chips changed from yellow/gold into light blue. After roughing the part, the tool showed slight wear but was still good for additional finishing operations.

Conclusion

The customer was very satisfied with the test results. He has purchased the first Makino machine and Millstar tooling. The combination of the machining-technology of MAKINO and the tooling-technology from MILLSTAR once again proved a superior combination.