

NACHI



High Performance Tools for
Aerospace Applications



Nachi Products for Aircraft Manufacturing

Industry– adding value through innovative tooling solutions:

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INTRODUCTION TO NACHI:

Nachi — Your full service tooling Partner:

Nachi offers a complete tooling program for machining aerospace metals and composites. As the choice of tools is always based on a cost-benefit assessment, the solution often includes standard as well as customized tools. This allows the customer to get the best solution from one source, thus reducing your supplier bases and overall cost of material procurement .

High Performance tooling solutions:

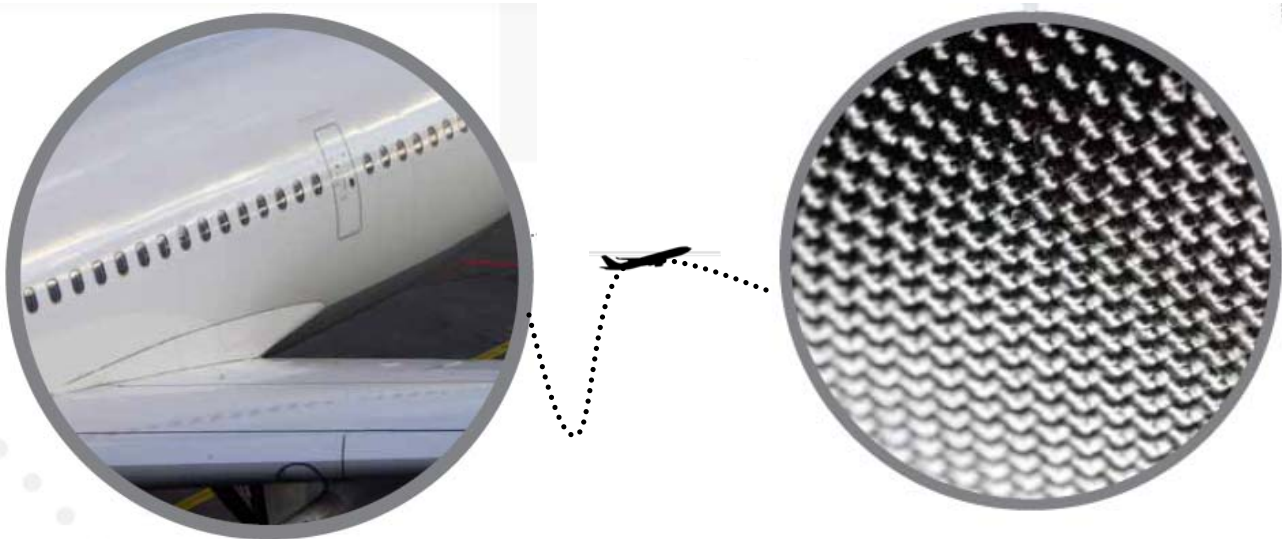
Obtaining lowest possible costs, involves a combination of machinery, machining parameters and high performance tooling solutions. We at Nachi analyze all aspects of the production process involving cutting tools and systematically optimize them. Due to wide range of requirements for machining aerospace components, Nachi works in partnership with each customer to ensure that every tooling solution offered is optimized for each individual application. The optimized tooling solution often includes unique geometries developed by Nachi built to ensure extreme accuracy and tight tolerances.

Research & Development:

Nachi has established a state of art testing and development facility at our Toyama facility in Japan. The R&D center helps Nachi stay ahead of the field by testing and re-testing our tools in various materials. For instance, tools are tested for function, tool life, wear under severe test conditions to establish and provide the optimum machining parameters for our customers. Hence, our major aerospace customers repeatedly rely on Nachi's extensively compiled test data obtained through testing on various materials.

Nachi — Your partner in manufacturing:

Today's competitive market demands a serious and permanent co-operation between both customer and manufacturer to improve productivity. Nachi today is in a unique position as manufacturer of both cutting tools and machining equipment to provide solutions that work to our customers advantage. That is why Nachi is the preferred tooling partner for the aerospace industry.



BROACHING

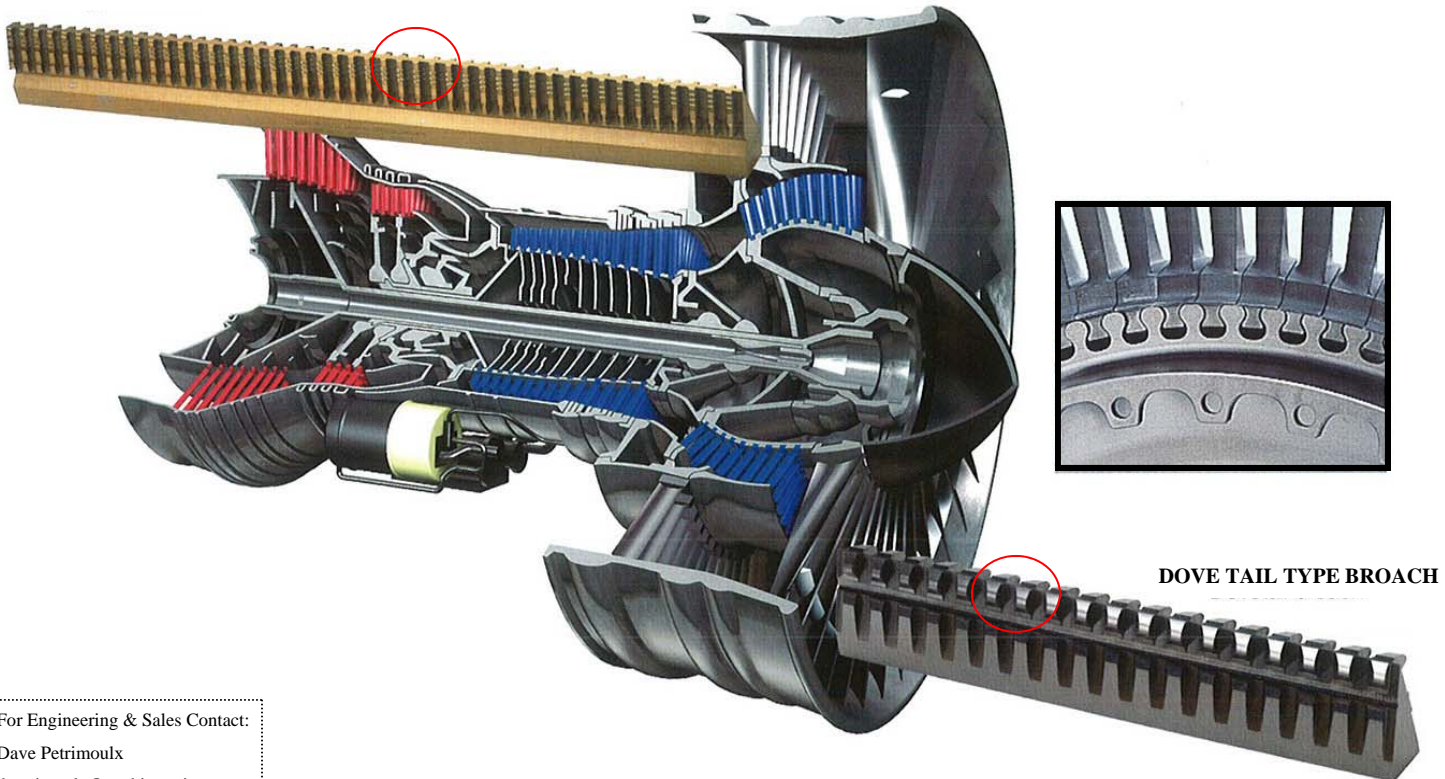


FIR TREE BROACHES FOR TURBINE DISKS FOR JET ENGINES

Jet engines intake air, compress it with compressor disks, then combustible gas is compressed to drive the turbine disks. The grooves that are used to mate the blade to the disk are produced using a dovetail broach to create a dovetail shaped groove in the compressor disk. Fir tree broaches are used to cut fir tree shaped grooves in the turbine disk. The fir tree shape, with its superior stress distribution particularly in very hot high pressure environments, not only fills demands for shape accuracy, but also responds to the stringent demands for work surface characteristics such as surface roughness, and changes in the quality and ductility of the work surface layer. This has made Nachi the leading provider of Fir Tree broaches to companies like GE Turbines, Pratt & Whitney , Rolls Royce. Nachi Fujikoshi has developed broaches and broaching machines that support production of the heart of jet engines with sets of cutting tool and machining equipment.



FIR TREE TYPE BROACH



DOVE TAIL TYPE BROACH

For Engineering & Sales Contact:
Dave Petrimoulx
dpetrimoulx@nachi-america.com
Ph: (586)-764-2263



FIR TREE BROACH DESIGN & MANUFACTURING PROCESS

To produce a dovetail or fir tree shaped grooves, a set of more than 10 broaches each with different cutting shapes are used. The best design involves taking into account the material to be cut, the length and shape of the cut as well as the specifications of the broaching machine to be used. Nachi designers and tool engineers work hand in hand with customers like GE Turbine, Pratt & Whitney, Rolls Royce to name a few to produce the best design and form. Broaches are made from Nachi's own ultra-fine Powder metal HSS that has superior wear-resistance characteristics. Broaches are manufactured at our state of art broach manufacturing plant in Toyama, Japan to the stringiest aerospace quality standards. Nachi thus can control all aspects of manufacturing from raw material to finished product.





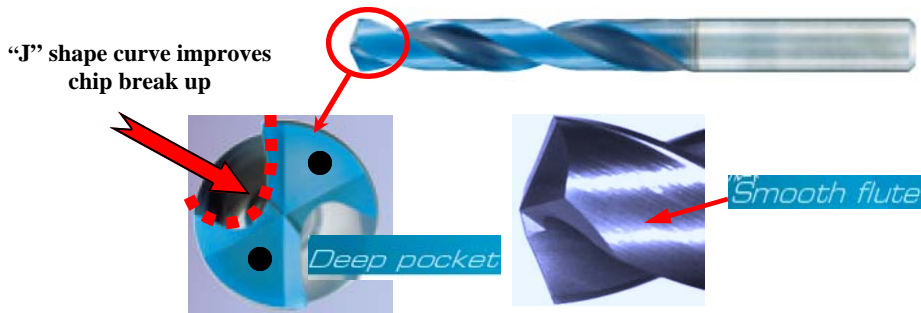
Solid Carbide Drills for Heat resistance Hi-temp alloys for Engine Components

The current set of materials used in the manufacture of aircraft engines can differ greatly according to their location within the engine. Due to the extreme forces and temperatures incurred during service, the materials involved are normally high strength and high temperature resistance alloys such as Inconel, Waspalloy and Titanium.

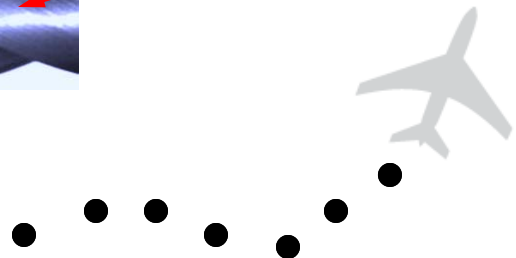
Due to the complex composition of these materials, it can be very difficult to machine with conventional tooling, calling for special tool geometries and specific machining techniques. Nachi has developed the *AQUA EX* solid carbide drill series with proprietary geometries and coatings to machine aerospace materials such as Inconel, Waspalloy and Titanium.

Nachi Aqua EX Series Features

- The AQUA EX Drills are made with Ultra fine micro grain carbide and coated with Nachi's proprietary Aqua Ex coating (TiALN + AlTiCR based)
- Improved heat and wear resistance than regular TiALN coating. The Aqua Ex coating can withstand higher service temperatures up to 1200° C as compared to 900° for TiALN coating.
- A perfectly adapted TiALN based coating ensures excellent adhesion and affords great mechanical strength.
- The Nano crystalline Al-Ti-Cr based offers excellent hot hardness, resistance to oxidation and thermal insulation properties.
- Specially designed point angle and web thickness for drilling into Hi-temp alloys like Inconel, Titanium.
- "J" shape curve improves chip break up and smooth polished flutes offer excellent chip evacuation.



For Engineering & Sales Contact:
 Chandan Shiroy
 cshiroy@nachiamerica.com
 Ph: (586)-610-0968





CASE STORY: DRILLING TURBINE ENGINE COMPONENT

NACHI answered the call of an aerospace customer whose requirement was to eliminate breakage of drills when drilling into a turbine engine component made out of Inconel 718 hi-temp alloy.

The current process of drilling **60** holes involved changing carbide drills after every **30** holes to avoid breakage of the drills and scrapping the part. This involved constant monitoring by operators and reduced efficiency and productivity.

Nachi optimized the process by introducing the Aqua Ex Coolant thru 3xD carbide drill to the customer. The Aqua Ex drill was able to complete **240 holes (4-Parts)** consistently without breakage. The result is significant reduction in cycle time, tooling cost, improved surface finish, hole size and most importantly consistently tool life for the customer.



Actual picture of Customer Part—Turbine Engine Component

OLD METHOD



NEW METHOD

CUTTING CONDITONS:

Competitor Drill

Drill Diameter: Ø 4.1mm (3xD)

Material: Inconel 718

Type: Carbide Coolant thru Drill

Hole Depth: .250" or 6.35mm

SFM=50 (V=15 m/min)

RPM=1180

*FEED : 100 mm/min (.003 IPR/
4.0 IPM)*

NO. OF HOLES : 30 holes

RESULT: DRILL WORN OUT

CUTTING CONDITONS:

NACHI AQUA EX SERIES

Drill Diameter: Ø 4.1mm (3xD)

Material: Inconel 718

Type: Carbide Coolant thru Drill

Hole Depth: .250" or 6.35mm

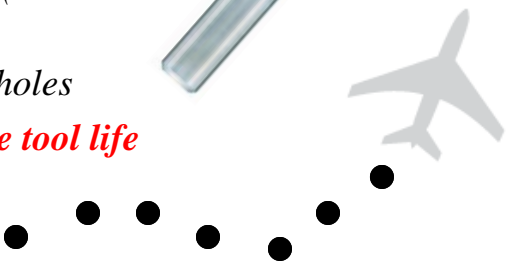
SFM=70 (V=21 m/min)

RPM=1650

*FEED : 100 mm/min (.003 IPR/
4.0 IPM)*

NO. OF HOLES : 240 holes

RESULT: 8-times more tool life



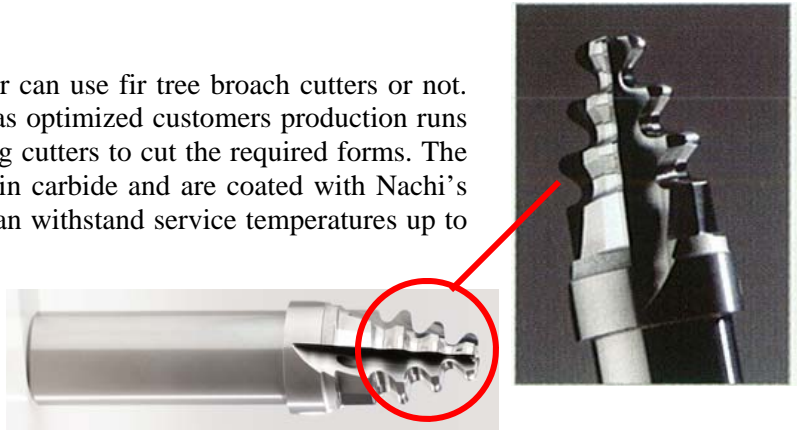
End mills



Solid Carbide End mills for Heat Resistance Alloys & Turbine Engine Components

Solid Carbide Fir tree form cutters

Cost as well as part production dictates if a customer can use fir tree broach cutters or not. Where cost and part piece becomes a factor Nachi has optimized customers production runs by designing customized Fir tree solid carbide milling cutters to cut the required forms. The fir tree cutters are manufactured from sub-micro grain carbide and are coated with Nachi's very own GSX coating (TiAIN + AlTiCR), which can withstand service temperatures up to 1200° C.

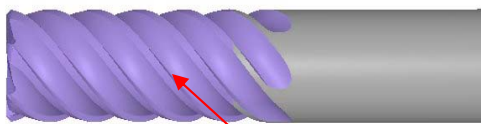


Solid Carbide End mills for Heat Resistant Alloys

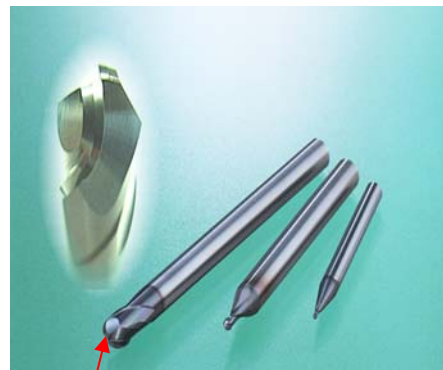
Titanium (Ti-6Al-4V) alloy commonly used in turbine disks, blades and landing gear is 1/2 the weight of steel and has comparatively superior hardness and high-temperature strength. One top of that, it is corrosion resistant and non-magnetic. Because of the great affinity between the material and cutting tool during cut, the end mills are prone to vibration and chipping during machining.

Nachi understands the need for designing end mills with special geometries, cutting edges and coatings. By using sub-micro grain carbide, superior coatings & special cutting edges that are heat resistant and have lubricity, these end mills can handle machining of Titanium alloys.

Features of Geometry



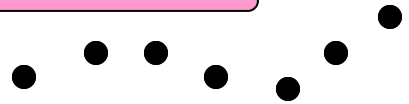
* Variable Helix & Variable index for anti-vibration
 * GSX Coating (TiAIN + AlTiCR) with lubrication film



Ball nose End mills for Titanium and Hi-temp alloys

Variable Helix—Variable Index end mill with Corner radius

Component Examples



For Aerospace Aluminum



Solid Carbide Drills / End mills / Taps for Aluminum Components

The structural materials used for air frames, ribs & spars are comparatively lightweight aluminum alloys. However, high-performance cutting is necessary because more than 80% of the material is cut away and ejected as chips. Also, this works demand high quality surface finish as most of the work pieces have thin walls.

Nachi has developed DLC line up of solid Carbide Drills & End mills for machining Aluminum alloys.

Nachi has also developed DLC thread forming taps for Aluminum alloys.

Features of DLC Drills / End mills/ Taps:

- DLC Coating has a low friction co-efficient that reduces adhesion to aluminum, which has extreme surface smoothness.
- Special designed flute shape and cutting edges keep the cutting edges sharp and increase chip ejection to make high-performance cutting possible.
- DLC thread forming taps designed for stronger and cleaner threads. Roll form taps eliminate chip clogging and promote stronger threads



DLC Drills

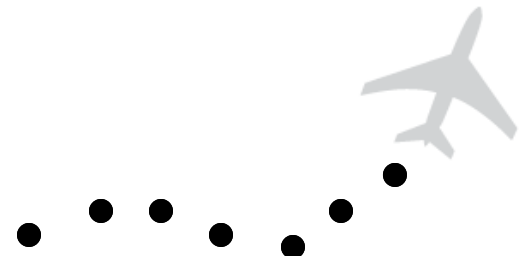


DLC End mills



DLC Taps

For Engineering & Sales Contact:
Chandan Shiroy
cshiroy@nachi-america.com
Ph: (586)-610-0968



For Composite Components



Diamond Coated Carbide Drills for CFRP Material

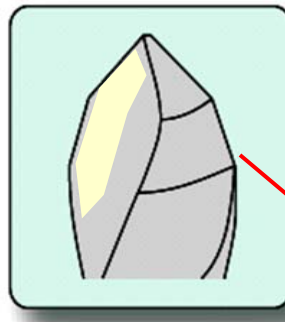
CFRP materials due to their very high strength to weight ratio are rapidly becoming very popular in aircraft industry. Due to their structure and machining properties, they are very difficult to process in terms of drilling and profile milling.

To avoid delamination of the layers and splintering drills & end mills with special geometries have to be designed to machine them efficiently. To add to that CFRP materials are very abrasive and can have a big impact on tool life.

Nachi's tailor-made tooling solutions in Diamond Coated Carbide drills & End mills can provide excellent tool life, allow increased speeds and feeds, no to minimum delamination thereby reducing downtime and increased productivity.

Features of Diamond Coated Double Angle Drills for CFRP:

- Optimal geometry for CFRP material
- Made from K10 grade carbide with 6% of less cobalt content for optimal diamond adhesion
- Nachi's very own Crystal Diamond coating for optimum tool life in Composite materials
- Double point angle sharp cutting geometry cuts the carbon fiber with low cutting resistance, resulting in no to minimum delamination.

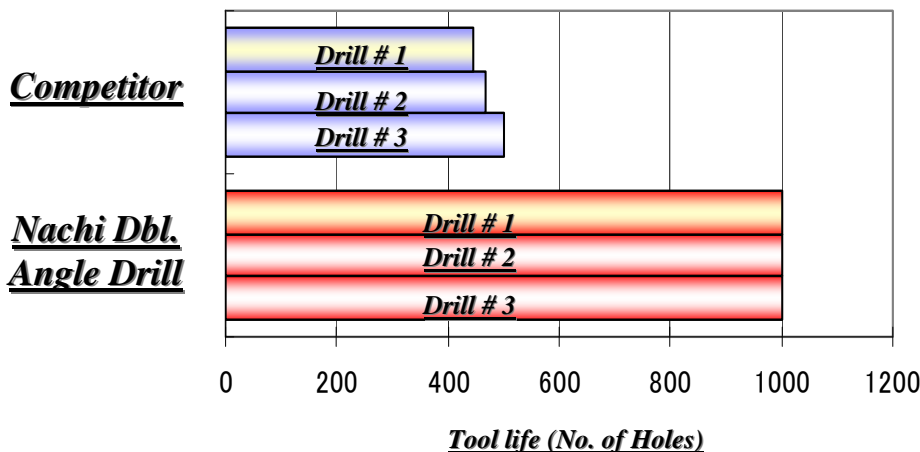


Diamond coated
Double Point Angle



Performance:

Consistent Tool & No-delamination or burrs



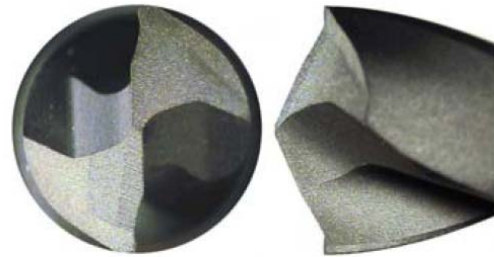
Drills For Component Assemblies



Diamond Coated Drills for CFRP + Aluminum Stack Material

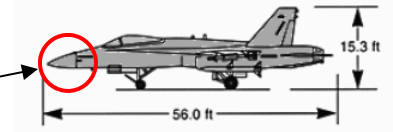
Features of Diamond Coated “ Fish Tail” Drill for CFRP + Aluminum Stack:

- For Stack Drilling of CFRP & Aluminum
- Made from K10 grade carbide with 6% of less cobalt content for optimal diamond adhesion
- Nachi’s very own Crystal Diamond coating for optimum tool life in Composite materials
- Specially designed point and flute geometry keep the exit burr in aluminum down to .005” or less
- Eliminate costly deburring operations



NACHI FISH TAIL POINT CONFIGURATION

CASE STORY: CFRP + Aluminum Stack (Aircraft Nose Barrel)



OLD METHOD:



CARBIDE UNCOATED DRILL

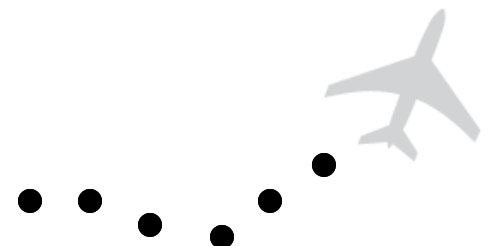
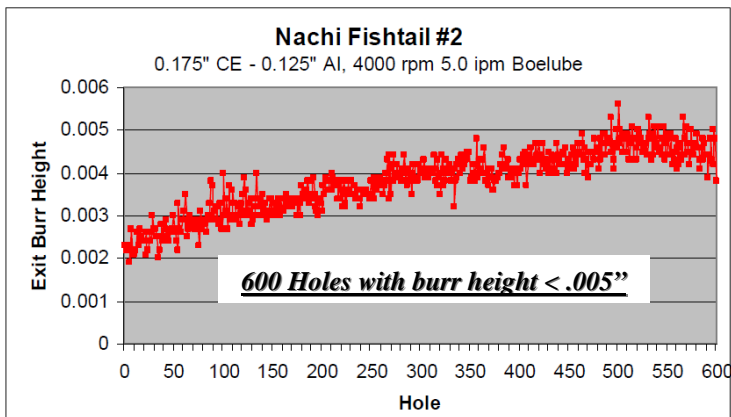
- Hand Drilling & De-burring before Installing fasteners
- No. of Holes: 1200
- No. of Drills used: 17 (70 holes per drill)
- Total Time: 4 Hrs (3-hrs Drilling + 1-Hr De-burring)

NEW METHOD:

NACHI “FISH TAIL DRILL”

Success Criteria: 400+ Holes with exit burr height less than .005”

- Automatic Flex Track 5-axis drilling machine using Nachi “Fish Tail Drill”
- No. of Holes: 1200
- No. of Drills used: 2 (600 Holes per drill with burr height less than .005”)
- Total Time: 2 Hrs (2-hrs Drilling— De-burring eliminated)
- **50% Cycle time reduction**
- **55% Reduction in tooling Cost**



For Composite Components

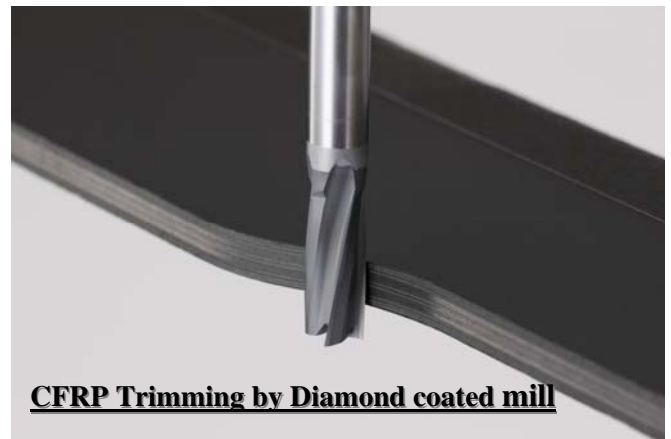


Diamond Coated Carbide End mills for CFRP Material

CFRP materials pose the same problems when milling them. CFRP materials are harder on the cutting edges due to their abrasive nature. Standard End mills wear out faster and cause delamination. Nachi has developed end mills with special geometries and Diamond coating for trimming of CFRP Material edges.

Features of Diamond Coated Roughing & Finishing End mills for CFRP Trimming applications:

- Optimal geometry for CFRP material
- Made from K10 grade carbide with 6% of less cobalt content for optimal diamond adhesion
- Nachi's very own Crystal Diamond coating for optimum tool life in Composite materials
- Lower helix angle to prevent cutter flex.
- Sharp cutting edges for even trimming operations.
- Extended tool life due to Diamond Coating.



CASE STORY: Trimming by Diamond Coated End mill

OLD METHOD:

CARBIDE TiAlN Coated End mill

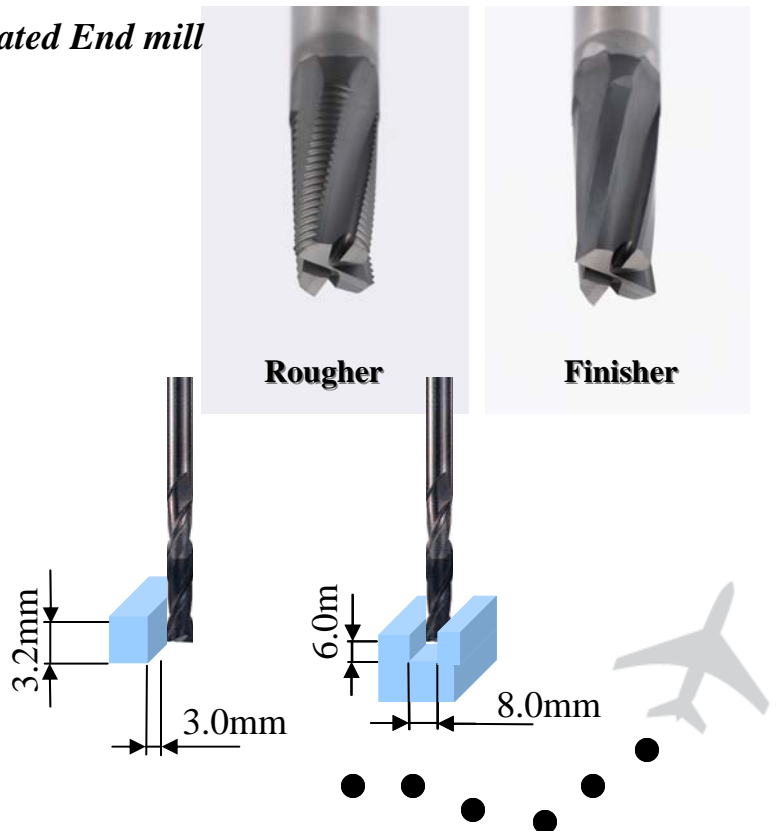
- Grooving Tool life: 2.6 meters
- Trimming Tool life: 1.4 meters



NEW METHOD:

Nachi Carbide Diamond Coated End mill

- Grooving Tool life: 29.2 meters
- Trimming Tool life: 32 meters
- ***15% more tool life than Carbide TiAlN Coated End mill***



NACHI-FUJIKOSHI CORP.

We have a history of Seventy five years as a world-famous integrated manufacturers with the renowned brand "NACHI". With the continuous production system, from high class special steels to finished products, our well-coordinated technics stand high in public estimation.



Head Office—Toyama Plant



Higashi-Toyama, Steel Plant



NACHI AMERICA INC.



Namerikawa Plant



Brazil Plant

JAPAN MAIN OFFICE

Shiodome Sumitomo Bldg. 17F, 1-9-2 Higashi-Shinbashi,
Minato-ku, Tokyo JAPAN, 105-0021
Phone: (03)5568-5111
Fax: (03)5568-5206

Overseas Subsidiary Companies

NACHI AMERICA INC. HEADQUARTERS

713 Pushville Road, Greenwood, Indiana 46143, U.S.A.
Phone: (317)530-1001 Fax: (317)530-1011

NACHI CANADA INC.

89 Courtland Ave., Unit No. 2, Concord, Ontario L4K 3T4, CANADA
Phone: (905)660-0088 Fax: (905)660-1146

NACHI MEXICANA, S.A. DE C.V.

Urbina No.54, Parque Industrial Naucalpan, Naucalpan de Juarez,
Estado de Mexico C.P. 53370, MEXICO
Phone: +52-55-3604-0832/0842/0081 Fax: +52-55-3604-0882

NACHI EUROPE GmbH

Bischofstrasse 99, 47809, Krefeld, GERMANY
Phone: (02151)65046-0 Fax: (02151)65046-90

NACHI TECHNOLOGY (THAILAND) CO., LTD.

5/5 M, 2, Rojana Industrial Estate Nongbua,
Ban Khal, Rayong, 21120, THAILAND
Phone: (38)961-682 Fax: (66)38-961-683

NACHI SINGAPORE PTE. LTD.

No. 2 Joo Koon Way, Jurong Town, Singapore
628943, SINGAPORE
Phone: 65587393 Fax: 65587371

NACHI (SHANGHAI) CO., LTD.

Yitong Industry Zone 258, Fengmao Rd. Malu Town,
Jiading, Shanghai 201801, CHINA
Phone: +86-(0)21-6915-2200 Fax: +86-(0)21-6915-5427

NACHI (AUSTRALIA) PTY. LTD.

(SYDNEY HEAD OFFICE)
Unit 1, 23-29 South Street, Rydalmere, N.S.W. 2116, AUSTRALIA
Phone: (02)9898-1511 Fax: (02)9898-1678

FUJIKOSHI-NACHI (MALAYSIA) SDN. BHD.

No. 17, Jalan USJ 21/3, 47630 UEP Subang
Jaya, Selangor Darul Ehsan, MALAYSIA
Phone: 03-80247900 Fax: 03-80235884

Overseas Plants

NACHI TECHNOLOGY INC.

713 Pushville Road, Greenwood, Indiana 46143, U.S.A.
Phone: (317)535-5000 Fax: (317)535-9484

NACHI TOOL AMERICA INC.

713 Pushville Road, Greenwood, Indiana 46143, U.S.A.
Phone: (317)535-0320 Fax: (317)535-0983

NACHI BRASIL LTDA.

Avenida João XXIII, No. 2330, Jardim São Pedro,
Mogi das Cruzes, S.P., BRASIL, CEP 08830-000 Caixa Postal 2505
Phone: (011)4793-8800 Fax: (011)4793-8870

NACHI INDUSTRIES PTE. LTD.

No. 2 Joo Koon Way, Jurong Town, Singapore 628943, SINGAPORE
Phone: 6861-3944 Fax: 6861-1153

NACHI PILIPINAS INDUSTRIES, INC.

1ST Avenue, Manalac Compound, Sta. Maria
Industrial Estate, Bagumbayan, Taguig Metro Manila, PHILIPPINES
Phone: (02) 838-3620 Fax: (02) 838-3623

NACHI



CUTTING TOOL PRODUCTS

NACHI AMERICA INC.

HEADQUARTERS AND MAIN WAREHOUSE

715 Pushville Road, Greenwood, Indiana, 46143, U.S.A.

Phone: 317-530-1003 Toll Free Phone: 1-888-340-8665

Fax: 317-530-1013 Toll Free Fax: 1-888-383-8665

Web Site URL : <http://www.nachiamerica.com>

WEST COAST BRANCH

12652 E. Alondra Blvd. Cerritos, California, 90703, U.S.A

Phone: 562-802-0055 Toll Free Phone: 1-800-548-3903

Fax: 562-802-2455

NACHI CANADA INC.

TORONTO HEADQUARTERS

89 Courtland Ave., Unit No.2, Concord, Ontario L4K 3T4, CANADA

Phone: 905-660-0088 Toll Free Phone: 1-800-387-9188

Fax: 905-660-1146

MONTREAL BRANCH

9730 Trans-Canada Hwy., St. Laurent, Quebec H4S 1V9, CANADA

Phone: 514-856-2200 Toll Free Phone: 1-888-622-4411

Fax: 514-856-9144

NACHI MEXICANA, S.A. DE C.V.

Urbina No.54, Parque Industrial Naucalpan, Naucalpan de Juarez, Estado de Mexico C.P. 53370, MEXICO

Phone: +52-55-3604-0832/0842/0081

Fax: +52-55-3604-0882

NACHI'S OTHER QUALITY PRODUCTS

BROACH/GEAR TOOLS

Phone: 317-530-1004

Fax: 317-530-1014

MACHINERY

Phone: 317-530-1007

Fax: 317-530-1015

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Phone: 317-530-1002

Fax: 317-530-1012

Toll Free Phone: 1-888-340-2747

Toll Free Fax: 1-888-734-1206

HYDRAULICS

Phone: 317-530-1005

Fax: 317-530-1015

Toll Free Phone: 1-800-622-4410

MATERIALS

Phone: 317-530-1006

Fax: 317-530-1015

Toll Free Phone: 1-800-626-6281

ROBOTICS

Phone: 248-305-6545

Fax: 248-305-6542

NACHI-FUJIKOSHI CORP.

Tokyo Head Office

Shiodome Sumitomo Bldg. 17F, 1-9-2 Higashi-Shinbashi, Minato-ku, Tokyo, JAPAN

Phone: +81-3-5568-5240 Fax: +81-3-5568-5236

Web Site URL <http://www.nachi-fujikoshi.co.jp/>

Toyama Head Office

1-1-1 Fujikoshi-Honmachi, Toyama, JAPAN

Phone: +81-76-423-5111 Fax: +81-76-493-5211

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NACHI