Machining Thermosets

AtlasFibre

Best Practices for Fabricating Advanced Engineering Plastics

Best Practices for CNC Machining Thermoset Composite Materials

In the craft of CNC machining, the unique properties of thermoset composite materials require specialized techniques and equipment. Discover some of the essential best practices that Atlas Fibre uses to optimize efficiency, precision, and tool longevity when working with these advanced materials and the integrity of critical components.

What's Inside?

+ Use High-Speed Spindles with Low Torque
+ Select Appropriate Cutting Tools
+ Ensure Proper Tool Holder Selection
+ Optimize Cutting Parameters
+ Implement Effective Dust Collection
+ Choose Appropriate Cooling Methods
+ Consider Material Composition
+ Ensure Machine Rigidity
+ Monitor Tool Wear
+ Optimize the Work Envelope

Use High-Speed Spindles with Low Torque

For efficient machining of composites, high-speed spindles operating at 18,000-24,000 RPM are recommended.

This range balances the need for speed while minimizing the risk of damaging the material due to excessive force.

Failing to follow this guidance may increase the risk of **delamination**, especially at the edges of the workpiece or in thin sections.

STAY SHARP

Keeping cutting tools sharp is vital to prevent delamination and hanging fibers, particularly during trimming operations. Regular tool maintenance is essential for maintaining high-quality finishes.

Select the Appropriate Cutting Tool

Diamond or diamond-coated cutting tools are ideal for composite materials.

These tools are designed to handle the abrasiveness of composites, ensuring clean cuts and prolonged tool life.

Improper tooling can result in broken fibers or leave some fibers uncut, affecting the structural properties of the composite material.

ALTERNATIVE TOOLING

If diamond or diamond-coated tooling is out of budget, or if shorter runs of parts are required, full carbide is a suitable replacement (but will dull quickly).

Ensure Proper Tool Holder Selection

Utilize hydraulic chucks to minimize run-out and prevent tool pullout, especially at high spindle speeds.

This ensures stability and precision during the machining process.

Tool holders with high runout (deviation from perfect rotation) can result in less precise cuts and poorer dimensional accuracy of the machined parts.

BETTER BALANCING

Ideally, tools should be balanced to at least G2.5 using a tool balancer. This balance quality grade, defined in ISO standard 1940/1, indicates high precision suitable for high-speed machining.

Optimize Cutting Parameters

Adjust cutting speeds and feeds to avoid melting the resin in composite materials.

Target cutting speeds of 550-760 meters (about 2493 ft) per minute and feed rates of 0.076 mm per tooth for a 6.3 mm (about 0.25 in) two-flute cutter for optimal results.

Using suboptimal cutting parameters can necessitate slower cutting speeds and more frequent tool changes, decreasing overall machining efficiency.

INITIAL FEED RATE

A standard starting point for feed rate is around 0.076 millimeters per tooth for a 6.3-millimeter two-flute cutter, translating to approximately 4,570 millimeters per minute at 30,000 RPM.

Implement Effective Dust Collection

An appropriately sized dust collection system is crucial to capture composite dust and debris, maintaining a clean working environment and protecting both equipment and operators.

The abrasive nature of composite dust can accelerate wear on cutting tools and machine components if not effectively removed from the work area.

Safety & Compliance

Use high-efficiency dust collectors and optimized airflow and ventilation systems to ensure compliance with safety standards.

Choose Appropriate Cooling Methods

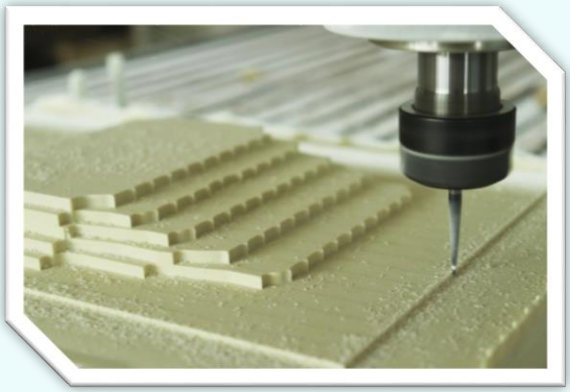
Cold air guns or cryogenic cooling systems are typically preferred over traditional coolants but can be cost prohibitive.

These methods can prevent the cutting-edge from building up a film of glass, dulling the tool before the expected life.

For Optimal Cooling

In the experience of Atlas Fibre, cryogenic cooling is the most efficient cooling method, and leads to the best tool life, machining speed and surface finish.

Consider Material Composition



Understanding the specific constituents of the composite material being machined helps in optimizing cutting strategies.

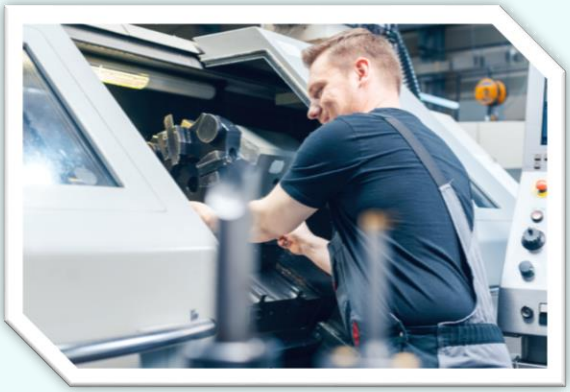
Different composites may require tailored approaches to achieve the best results.

Consult a materials specialist to identify the appropriate thermoset composite material for your component or set of parts for a broader project.

Material Comparison

Atlas Fibre's comparative data sheet offers up an easy way to determine how different materials compare in terms of properties including tensile, flexural and bond strength, flammability rating and more.

Ensure Machine Rigidity



A CNC machine with reinforced structural integrity reduces vibrations and tool deflection, improving machining precision and extending tool life.

Machine rigidity is a key factor in achieving consistent results.

A lack of rigidity would result in greater deflection of machine components under cutting forces, compromising the precision and dimensional accuracy of machined parts.

Monitor Tool Wear

Regular inspection of cutting tools for wear patterns allows for timely adjustments to tool paths, ensuring consistent performance and avoiding unexpected downtime.

As tools wear, they become less effective at cutting accurately, leading to poor surface finishes, dimensional inaccuracies, and potentially out-of-spec parts.

Checking each tool with a tool breakage detector or a tool setter will ensure that there are no surprises and that tolerances remain tight through the life of the tool.

Tool Life Monitoring

Many modern CNC machines are equipped with tool life monitoring systems that track the number of cutting hours or cycles a tool has completed. The system can alert machinists when a tool is approaching the end of its expected life, allowing for preventive replacement.

Optimize Work Envelope

Selecting a machine with an appropriate work envelope for the size of parts being machined is crucial.

Options like pendulum processing can increase efficiency by allowing continuous operation.

The benefit is that once a machine finishes working on one side, it automatically switches to the other side to continue processing, allowing for uninterrupted operation and reduced downtime.

5-Axis Machining

An effective way to optimize the work envelope is to utilize five-axis machining, where the cutting tool moves along five different axes simultaneously, allowing for more complex shapes and features to be machined in a single setup.

By adhering to these best practices and many others gained from over 60 years of experience in advanced plastics machining, Atlas Fibre significantly enhances the efficiency and quality of its CNC machining operations for thermoset composite materials, ensuring superior outcomes and reduced operational costs for companies that rely on the integrity of critical components.

Need Additional Information on CNC Machining of Thermoset Composites?

Consult an Atlas Fibre material specialist and explore the possibilities in machined components from advanced engineering plastics.