









Machining & Processing Guide For Laminate, Tube and Rod.

In general, Bakelacque laminate sheets may be machined using normal machine tools, though some modification and adjustment may be necessary to give the best results.

The thermal conductivity of plastics is lower than that of metals. Heat generated during machining operations cannot dissipate as readily as it does when cutting metals. Heat build up can lead to dimensional inaccuracy and in severe cases can even lead to scorching damage to the product. Cutting procedures are similar to those used for brass.

The following general guidelines are useful:

-  As a general rule, machining and cutting operations are carried out dry. Coolants can affect the properties of thermosetting plastics, particularly where subsequently used as an electrical insulator. Cold air jet onto the cutter can aid cooling and assist in moving dust and swarf into local extraction.
-  Ensure that tools are sharp so as to ensure minimal heat generation during cutting and best possible finished surface.
-  All operations that generate dust are potentially hazardous unless appropriate precautions are taken. Always ensure that adequate dust extraction at source and / or appropriate personal protection is used when cutting / machining in order to minimise exposure to dust and to ensure that statutory requirements are met. Separate Health and Safety data sheets are available for our range of products.
-  As a general rule grind cutting tools to an increased clearance. A relatively high cutting speed and low feed rate give better results, particularly for harder (glass based) grades.
-  High speed steel tools can be used for small runs and when machining non-glass based products. For extensive machining operations, tungsten carbide is preferable. TC tips are suitable for small scale machining of glass-based composites, but for extensive machining operations, diamond-tipped tools give extended life and better finish.
-  Avoid swarf build up when drilling and tapping. Clogged tools rapidly generate heat.
-  Where necessary a backing board or support should be used to prevent breakout or chipping of the back face of the work piece.
-  Following data on speeds and feeds are given for guidance and provide a starting point. These will vary in practice depending upon operation / material / tooling / equipment.

Drilling & Tapping

Tungsten carbide tips are preferable. Use pecking action to ensure swarf is effectively cleared from the hole during drilling.

When drilling thinner sheets, either stack and clamp a number of items together on a backing board, or reduce the included angle of the drill tip so as to ensure that the full diameter of the drill has entered the hole before the point breaks through.

Positive rake may be removed to prevent lifting the laminations and the land removed to improve the flow of swarf.

Typical speeds for machining glass based materials:

DIAMETER	SPEED	Feed Rate
3 – 6mm diameter	1000 / 2000 rpm	200 - 300 mm / minute
6 - 12mm diameter	800 / 1500 rpm	200 mm / minute

Drilling & tapping continued

Large holes in sheet may be cut using a wing or fly cutter. Trepanning can be carried out using standard wing trepanning cutters. Holes can be tapped by hand or by machine and should be drilled slightly oversize as they tend to close in slightly when the drill is withdrawn. Chamfers at the open ends assist starting and reduce breakout of the tap. With blind holes, it is necessary to remove all swarf before tapping.

Standard TC taps can be used. The use of starter / taper taps is not normally necessary. Tapping speeds typically 200 - 400 rpm with a clearing tap speed of 700 rpm.

Punching.

Most grades of Bakelaque laminates can be punched on hand or power presses in thickness up to 3mm. Paper based materials; particularly the better electrical grades such as B1 and B3, are easier to punch warm or hot. Most other grades can be punched cold up to about 1mm thick, but for thicker materials and when punching delicate components or complicated shapes, heating of the materials is recommended.

Pre-heating of the strip to between 80°C and 100°C is recommended for all grades. Higher temperatures are possible but take care not to damage the material using excessive heat.

Extended heating or frequent re-heating of the product may cause brittleness.

Some edge cavitation is possible, particularly when thicker materials are punched. The punch should be set to enter the die not more than 0.15mm at the end of its stroke. The die must also be smooth with a typical clearance between punch and die not exceeding 0.05mm. Allow a clearance of between 0.25mm and 0.4mm between the strip and the stripper plate.

Typically, for holes, the punch should be oversize by 0.004mm per cm of diameter and for blanks; punches and dies need to be slightly smaller than the finished size. Tools must be kept clean and free of swarf or dust.

Milling.

Milling of Bakelaque laminates can be carried out on plain or universal millers. Spindle moulders can be used particularly when removing small amounts of material. Cutters with straight or spiral teeth can be used for milling, spiral teeth giving a smoother finish. Diamond cut solid carbide cutters are recommended when cutting glass based products (supplied by Ritz of Germany).

Typically, when using tooth cutters, a depth of cut of about 1.5mm and cutter surface speed of 1200 – 1800 m/min may be used.

For glass based materials when using diamond cut solid carbide cutters 6 or 12mm diameter is suitable for roughing out using a cutter speed of about 2000 - 3000 rpm and a feed rate of 500mm / minute. Finish contour using 3 flute cutters (3000 rpm / 500 mm / minute).

Routing.

Bakelaque laminates can be routed using double edge cutters at speeds between 18000 and 24000 rpm. Tungsten carbide tipped cutters are advisable when routing paper and phenolic cotton grades whilst diamond-cut burrs are recommended for glass grades.

For deep profiles and internal routing, the cut should be taken in stages by lowering the cutter head.

Grinding.

Centreless grinders are suitable for grinding glass bases tube or rod sections. Use an average diameter reduction of 0.010" (0.25mm) per pass using water as a coolant.

Grinding wheels must be kept from clogging and true by periodic dressing of the wheel.

Guillotining.

Bakelaque laminated sheet can be cut on a power guillotine up to a maximum of about 1.6mm. Blade slope of 20mm per metre is typical.

The cutting edges of blades must be kept clean.

Gear Cutting.

Gear teeth can be cut on a milling machine or gear shaper with normal cutters and tools. Speeds and feeds vary with the shape and size of teeth, but typically 40 m/min is a good average peripheral speed when using a high-speed milling cutter.

Sheet material must be used for producing gears. Rods or tubes are not normally suitable due to the direction of lamination.

Sawing.

Circular saws, band saws, jigsaws and fretsaws may all be used.

Circular Saws: For Paper and cotton based laminates use carbide tipped blades with a tooth pitch of 10mm to 12mm and a set of 0.7mm each side.

Recommended peripheral speed of saw from 1200 m to 3000 m per min. Glass based materials are best cut using a diamond edged cutting discs.

Peripheral speed 2000 – 3000 m per minute. – Typical feed rate 1.5 – 2 m per minute.

Turning.

Generally, tipped tools at high speeds with light finishing cuts give good results. Using a feed of 0.1 - 0.15mm per rev with a peripheral speed of 180 m/min will give a good result. For general work a tool with no top rake but with side and front clearances of 10° to 15° is satisfactory.

Diamond tipped tools may be used and give extended life on long production runs, particularly when machining glass based products.

For heavy cuts, high-speed tools with a positive rake of 0° to 20° may be used.

Further Information.

For further information, please contact a member of our technical sales team on 01772 258245, or email info@attwater.co.uk.

For further details on our products, including technical & health & safety datasheets please visit www.attwater.co.uk.