Technical information

ACRYLITE® extruded sheet (FF)

#2 Cutting with Circular Saws

This brief gives advice for:

- **Equipment**
- **Operation**
- **Trouble Shooting**

Equipment

ACRYLITE® sheet is generally cut with overhead panel saws, beam type panel saws, and table saws. The saws should have minimal vibration and be powerful enough to make the required cuts.

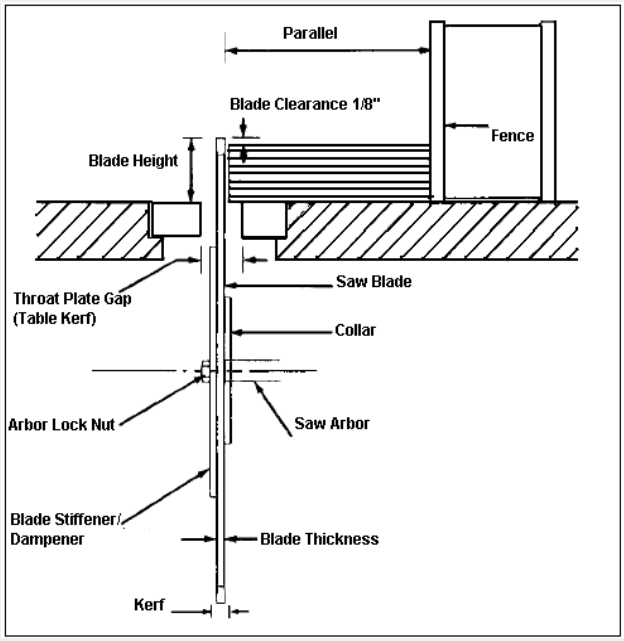
Table saws with arbor sizes from 5/8" to 1" in diameter driven by motors ranging from 3-10 hp are recommended. Direct drive or belt drive systems can be used. Most table saws provide a saw blade rotation speed of 3,450 rpm.

Panel saws vary greatly in size from small vertical panel saws for general purpose cutting to large CNC controlled horizontal panel saws capable of high volume, tight tolerance cutting. Their drive motors should range in power from 10 to 30 hp. Saw blade rotation speeds are typically between 2,000 and 8,000 rpm. Panel saws with adjustable saw blade speed are available and provide greater flexibility for achieving an optimum saw cut. In selecting a beam type table panel saw for cutting acrylic sheet, the following three considerations are critical.

1. Be sure the saw offers the ability to easily adjust blade clearance (or height). This will ensure the necessary flexibility for cutting different thicknesses or quantities of sheet.

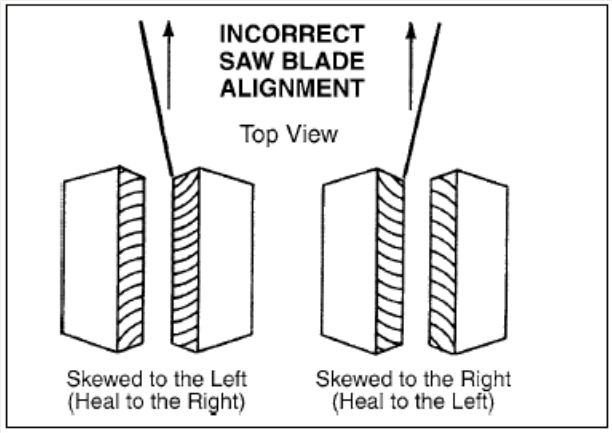
2. When selecting a panel saw, also be sure that it provides full and close support under the sheet while the saw blade is making the saw cut. Some designs of computer controlled panel saws do not provide continuous material support. This results in sheet vibration during cutting and will cause chipping on the bottom of the sheet, especially with thinner gauge material. A narrow gap between the saw blade and the supporting structure is also important for minimizing vibration.

3. A solid hold-down system that clamps the material firmly in place during the cutting operation is also a necessity. It will help to reduce vibration of the sheet and improve cutting results. Most panel saws employ a single rigid hold-down bar with pressure cylinders at each end for clamping force. Additional pressure cylinders positioned across the length of the hold-down bar will provide improved clamping pressure. Some systems utilize several independent hold-down bars. These have the advantage of being able to conform to thickness variations in the material being cut; however, the gap between bars must be small to prevent material vibration.



If using a table saw, be sure it comes equipped with all the necessary safety devices. Most table saws come complete with a blade guard, splitter and anti-kick back device. Many anti-kick back devices do not work well with plastics. It may be necessary to consult the equipment manufacturer for help in selecting a suitable device. Kick-plate switches and electronic motor brakes should also be considered for additional safety. As well, a heavy-duty fence will provide greater stability when cutting and will last longer.

With any saw, blade alignment is critical for achieving good results. The saw arbor, the saw table and the table fence must be properly aligned to prevent “back” or “double” cutting. Improper alignment can cause crowding of the material against the back of the saw blade. This will lead to chipping and melting of the material and on table saws can result in dangerous “kick-back”. On table saws, the blade should be set perfectly parallel to the miter gauge slots in the saw table. The fence should also be set parallel to the miter gauge slots or open slightly at the back (1/32” to 1/64”). On panel saws, the saw blade carriage should be aligned to produce a square cut and the saw blade rotation must run parallel to the direction of carriage travel to ensure proper tracking. Incorrect saw blade alignment can often be identified by observing the machining marks in the saw cut edge. For table panel saws, the machining marks should curve downwards in the direction of the blade travel. If the machining marks on one side of the cut curve upward in the direction of the blade travel, it indicates that the saw blade is healing to that side. See the diagram below.



Run-out (or wobble) of the saw arbor and blade collar should be essentially zero. Total run out, including the saw blade, should be less than 0.002”. A simple dial indicator to measure the run-out can be purchased from industrial hardware suppliers.

The width of the throat plate gap (table kerf) should be kept to a minimum. This will minimize material vibration (especially with thin gauge sheet) helping to reduce chipping. Zero-clearance throat inserts are available for many table saws and should be used whenever possible. On panel saws, a “false” tabletop can sometimes be fastened to the panel saw surface to provide a narrower throat gap.

Saw Blades

There are several saw blades on the market that can effectively cut ACRYLITE® sheet. Sharp teeth are essential for achieving good results. Carbide tipped saw blades are recommended for superior cuts and longer life of the cutting edge. It is also important to dedicate saw blades for only cutting acrylic.

Cutting other materials on saw blades intended for acrylic will dull or damage the blade and lead to poor cutting performance when the blade is used again to cut acrylic.

The optimum number of teeth per blade can vary depending on the blade size, blade rotation speed and application, such as gang or single sheet cutting. Common blade diameters and tooth selections used for cutting acrylic sheet include:

- **10" diameter, 60 and 80 tooth**
- **12" diameter, 60, 80, and 100 tooth**
- **14" diameter 60, 80, and 100 tooth**

Proper selection of the saw blade size can be guided by considering the surface feet/minute (SFM) of the blade in the saw. The SFM of the blade is the actual speed at which the teeth are moving. For acrylic, it should be between 6,000-14,000 ft/min. To determine the SFM of the blade use the following formula:

SFM = diameter (inches) x RPM x 0.262

Example: 10" diameter blade rotating at 3450 RPM
SFM = 10 x 3,450 x 0.263
= 9,000

The 10" blade size is suitable because the SFM is between 6,000 and 14,000.

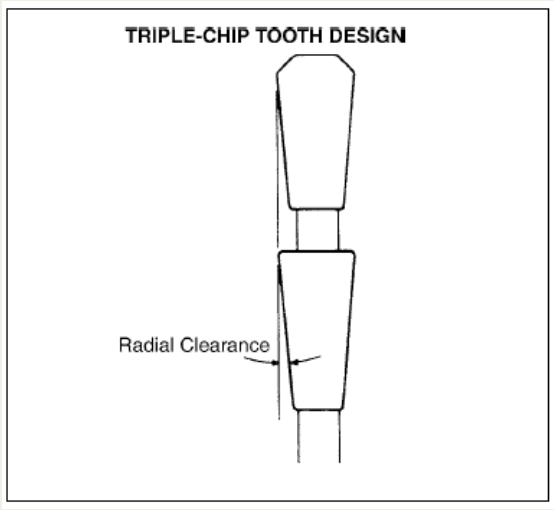
The number of teeth on the saw blade should be selected to give proper tooth engagement. Between 2-6 teeth should be engaged with the material during cutting. Engagement of three teeth is considered to be optimum (one tooth entering the material, one tooth fully engaged, one tooth leaving the material). A 10-inch diameter, 80-tooth blade is recommended for all-purpose cutting on a table saw. For recommended saw blade size and tooth selections, see Table 1.

Table 1:
Recommendations for Saw Blade Size, Tooth Selection and Operating Clearance When Cutting Acrylic Sheet.

Acrylic Sheet Thickness (inches)	Blade Diameter (inches)	Number of Teeth	Blade Clearance* (inches above material)
1/16 – 1/8	10 12 14	80 100 100	1/8 1/8 1/8
1/8 – 1/2	10 12 14	80 80, 100 80, 100	1/4 1/4 1/4
1/2 – 1	10 12 14	60 60 60	1/4 1/2 1/2
1 – 2	12 14	60 60	1/2 1/2

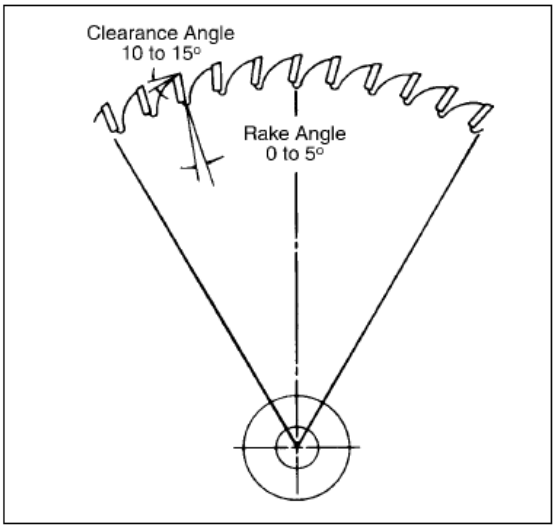
* Table saws or beam type panel saws only.

For cutting acrylic, the teeth of the saw blade should have the triple-chip design, where the cutting edge of every other tooth is beveled. The beveled tooth, or crown tooth, removes the material in the center of the cut while the flat-top raker tooth follows behind, removing material from the edges of the cut. This results in the production of three separate "chips" - center, left side and right side - and hence, the term triple-chip design. On some designs, the flat-top raker tooth also has very slight bevels along the top side-edges of the tooth. This helps to reduce chipping by reducing the notching affect caused by a square cutting edge.



Best results are achieved when the teeth have a clearance angle (top clearance) of 10° to 15°. This minimizes contact between the teeth and the

material – reducing friction and resulting in less melting. The proper rake or "hook" angle, 0° to 5° positive, ensures the teeth do not strike the material too aggressively. Higher angles can lead to chipping due to poor blade stability and poor control of material feed rates.



For gang cutting of stacked sheets, a saw blade whose teeth have increased radial clearance is recommended. This clearance will reduce carbide/plastic contact on the sides of the teeth and, therefore, reduce heat generated by friction. When gang cutting, use ACRYLITE® sheet masked with polyethylene masking because it acts as a lubricant.

The quality of construction of the saw blade significantly affects how well it will cut. Quality considerations when evaluating a saw blade include:

- Run out should be less than 0.002".
- Teeth height needs to be nearly constant. Any variations must be gradual and not abrupt – the blade should have good concentricity.
- Teeth positioning must all be in the same radial plane, i.e. one tooth cannot extend to one side more than the others or chipping will result.
- Blade plate quality should be tempered to a hardness of C42 – C46 giving it greater rigidity and resulting in reduced vibration during operation.
- Number of blade expansion slots from 4–5 for a 10" diameter blade minimize warping when the blade heats up.
- Size of carbide tips, the larger tips mean the blade can be sharpened more often. Tips will vary in size from 5/32" – 13/32" long and 1/16" – 3/32" wide.
- Brazing method is used to attach the carbide tips to the plate and carbide tips may be brazed to the plate by hand or by "machine induction". Generally, "machine induction" provides more consistent and reliable performance.
- Grinding quality or surface finish of the teeth will determine their sharpness and the quality of the resulting saw cut. Finer grinding will result in a smoother finish, leaving less machining marks on the teeth (visible under magnification) and cleaner, straighter tooth edges.

Saw blades should be handled carefully with cut resistant gloves. Avoid impact shocks such as dropping or hitting the saw blades, as the carbide tips are brittle and can chip easily. Also, impact shock can bend a blade, creating melting and chipping as it moves through a cut. When not in use, blades should be stored on a properly designed wooden fixture that will protect the blade from accidental impacts and prevent accidental contact with its sharp tips.

Saw blades have a maximum rating for rotation speed. Be sure to verify that the saw being used will not exceed the limitations of the saw blade that has been selected. Carbide tipped saw blades should never be operated in excess of 18,000 SFM.

Saw Blade Dampeners/Stiffeners

Saw blade dampeners or stiffeners can greatly reduce saw blade vibration during saw operation. They are highly recommended for use when cutting acrylic sheet because they will usually result in improved saw cut quality and reduced noise during saw operation. (Note: Some high quality panel saws

are built with large blade collars and may not benefit from the use of a blade stiffener.) When installing a stiffener, be sure to remove all foreign material from the saw blade and mounting washers. Any bumps or scratch-burrs on the saw blade surface should be stoned flat to ensure even metal-to-metal contact between the stiffener and the saw blade. Best results are normally obtained by selecting a stiffener 1/2 to 2/3 the diameter of the saw blade.

Cooling

The use of a saw blade cooling system can yield a much cleaner, smoother saw cut edge and greatly increase the life of the saw blade. These systems remove heat from the blade and the plastic as it is being cut. Two types of systems are commonly used. Compressed air or vortex tube cooled compressed air systems are preferred. These systems are cleaner to operate and require little maintenance. Mist systems, which apply water soluble oil with rust inhibitor, also work well providing blade lubrication as well as cooling. However, these systems will require more maintenance and the material may need cleaning afterwards to remove residual oil. It is also important to ensure that the lubricating solution is compatible with acrylic. When using a saw blade cooling system, the air or mist stream should be lightly sprayed on the teeth of the saw blade just before they enter the material.

Operation

For table type saws or panel saws with the blade mounted underneath, the blade should protrude approximately 1/8" to 1/2" above the work pieces. The optimum setting will vary with sheet thickness (see Table 1). On overhead blade-mounted panel saws, the blade should protrude 1/32" through the material. These settings should yield a smooth cut and minimize edge chipping by providing a favorable cutting angle for the cutting edge of the saw blade teeth. In general, larger blade clearances will reduce tooth engagement slightly resulting in less heat generation and, in some situations, reduced melting. Smaller blade clearances provide better cutting and chip control resulting in less chance of chipping on the bottom of the cut. Excessively low blade clearances, often in combination with a dull blade, can cause chipping at the top of the cut.

Feed the material evenly through the saw. Uneven feed rates will produce melted spots or chipping on the plastic. Typical feed rates for ACRYLITE® sheet are 100" to 300" per minute. However, with some specially designed saw blades, feed rates as high as 600" per minute can be used with success.

When cutting on a table saw, care must be taken to ensure the operator's safety. Always follow the precautions outlined in the manual provided by the saw manufacturer and consult the saw blade supplier for recommendations on the proper use of their saw blades.

Safety precautions should also include (but are not limited to) the following:

- Always wear protective safety glasses with shields.
- Ensure all guards are in place and operational.
- Do not wear loose fitting clothing or jewelry and tie back long hair.
- Ensure work area is clean and free of slip hazards.
- Ensure the correct saw blade is mounted for the material being cut.
- Ensure saw blade is in good condition, is properly mounted, rotates in the correct direction, is correctly aligned, and is set at the proper height.
- Never place hands within four (4) inches of the rotating saw blade. If small pieces must be cut that could require the hands to be closer, then consider alternate methods of cutting, feeding or fixturing the material for safer handling.
- Never force-feed material into the blade. If the motor slows down, the material begins to "ride-

up" or if excessive vibration is encountered, discontinue cutting and turn off the power.
- Never position your body directly behind the saw blade during operation and be sure no one else is working in the area behind the blade.
- Never utilize the fence for sizing cuts less than 2.0 times the length of exposed saw blade. For shorter cuts use a miter gauge to guide the material.
- Never use the miter gauge and fence together.
- Never draw the material backwards during cutting.
- Always hold the material firmly while feeding.
- Stop the saw frequently to clean up cutoffs and sawdust. Be sure the saw blade has stopped completely before cleaning. Do not attempt to remove waste while the saw is running.

Trouble Shooting

Problem	Cause	Solution
Chipping	Sheet vibration	On table saws, hold stacked sheet firmly while feeding. If gang cutting, hold sheets tightly together by clamping or taping them together. On panel saws, ensure sheet is fully supported underneath and that the sheet is being firmly held down across the entire cut.
	Chipping at bottom of cut: the clearance of the blade above the material is too large	Reduce Clearance
	Chipping at top of cut: the clearance of the blade above the material is too small	Increase Clearance
	Incorrect blade style	Use carbide tipped, triple chip design, saw blade
	Incorrect blade size or number of teeth	Use recommended blade size and tooth selection
	Rake angle too high	Rake should be 0° to + 15°
	Excessive width of throat plate gap	Replace throat plate
	Blade vibration or wobble	Clean collar and measure blade run out. Employ a blade stiffener. Replace blade with stiffener, higher quality blade.
	Defective teeth (broken or out of alignment)	Replace blade
	SFM of blade is too low	Increase RPM of blade size
	Misalignment of blade or fence	Verify that saw blade and fence are properly aligned
Melting	Blade clearance too small	Adjust clearance
	Feed rate too slow	Increase feed rate
	Incorrect blade style	Use carbide tipped, triple chip design, saw blade
	Insufficient clearance behind cutting edge of blade teeth (top clearance)	Use blade with increased radial clearance on teeth
	Dull blade	Replace blade
	Incorrect blade size or number of teeth	Use recommended blade size and tooth selection
	SFM of blade too high	Reduce RPM or blade size
	Misalignment of blade or fence	Verify that saw blade and fence are properly aligned

Fire Precautions

ACRYLITE® sheet is a combustible thermoplastic. Precautions should be taken to protect this material from flames and high heat sources. ACRYLITE® sheet usually burns rapidly to completion if not extinguished. The products of combustion, if sufficient air is present, are carbon dioxide and water. However, in many fires sufficient air will not be available and toxic carbon monoxide will be formed, as it will when other common combustible materials are burned. We urge good judgement in the use of this versatile material and recommend that building codes be followed carefully to assure it is used properly.

Compatibility

Like other plastic materials, ACRYLITE® sheet is subject to crazing, cracking or discoloration if brought into contact with incompatible materials. These materials may include cleaners, polishes, adhesives, sealants, gasketing or packaging materials, cutting emulsions, etc. See the Tech Briefs in this series for more information, or contact your ACRYLITE® sheet Distributor for information on a specific product.

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