FOAMALITE

APET lite

PETG lite

General Technical Information

Polyester Sheet Range

the choice is clear

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1.0 Sawing / Cutting

APETlite and PETGlite can be sawn and cut in many different ways such as sawn by manual saw, band saw and Circular saw and also cut using Laser, Punching and die cutting. Details on all these processes are shown below.

1.1. General Guidelines

- Do not remove the surface protection film from the APETlite and PETGlite sheets before cutting; after finishing, blow or vacuum away any resulting shavings.
- The blade design plays an important part in sawing plastics. It is preferable to use a saw blade with wide set teeth as the gaps help to remove swarf.
- To prevent the plastic from melting or cracking the blade must be very sharp and the fence should be placed very near the cut to reduce any vibration.
- Tool speeds should be such that the plastic sheet does not melt from frictional heat.
- Since plastics are poor heat conductors, the heat generated by machining operations must be absorbed by the tool or carried away by coolant.
- In general, the highest speed at which overheating of the tool or plastic does not occur will give best results.
- Hard, wear-resistant tools with greater cutting clearances than those used for cutting metal are suggested.
- High-speed or carbon-tipped tools are efficient for long runs and provide accuracy and uniformity of finish.
- A jet of air directed on the cutting edge aids in cooling the tool and in removing chips. Plain water or soapy water is sometimes used for cooling unless the trim scrap is to be reused.

Suggested Sawing Tools and Specification for Various Cut Types

Type of Cut	Sawing Tool	Blade Type	Blade Parameters	Blade Speed
Straight	Band Saw	12.7mm	3 to 6 teeth per 25 mm	610 m/min
Straight	Saber Saw or Jigsaw	Finish Cutting Blade	7 teeth per 25mm	
Straight	Handsaw Crosscut	Crosscut	8 or 10 pt.	
Curved	Band Saw	12.7mm	3 to 6 teeth per 25 mm	610 m/min

1.2 Manual Sawing

When sawing APETlite and PETGlite sheets by hand, it is best to use a fine bladed saw. It is essential to ensure the sheet is well secured to prevent vibration and that the saw teeth are sharp. Test the sawing process on a scrap piece of material to ensure the finish is acceptable.

1.3 Knife Cutting

When using a knife cutting process, score the sheet several times until the desired depth is reached (minimum half the thickness), applying even pressure. The sheet should be well secured to prevent slippage. Then place it on a flat surface and apply gentle pressure until it snaps. Sandpaper may be used to remove any rough edges.

1.4 Circular Saw and Band Saw Cutting

APETlite and PETGlite can be sawn by using most traditional wood and metal working machines. Generally, circular and band saws produce better edges and can be used for almost all cutting operations. The cutting process with a circular saw generally causes less heat build up during sawing compared to a bandsaw, so a circular saw is advisable were heat build up is an issue.

Types of Saw Teeth:

Alternate or Combined Straight and Trapezoidal Teeth

- Sheet must be well secured to prevent them from cracking due to vibration during circular saw cutting.
- Cutting speed must be as uniform as possible.
- Saw blades should be sharpened regularly.

Flat-Trapezoid: Less Vibration

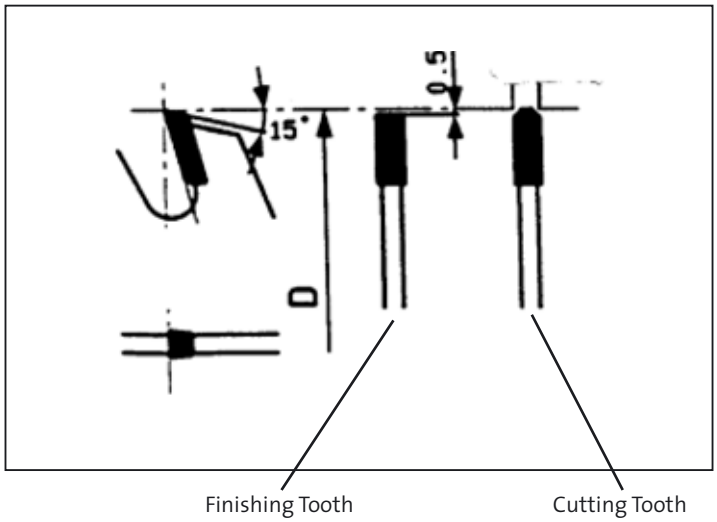
- The trapezoid tooth, is the cutting tooth. It has a bigger diameter than flat tooth.
- The flat teeth give a good quality finishing.

Alternate: Lower Heating

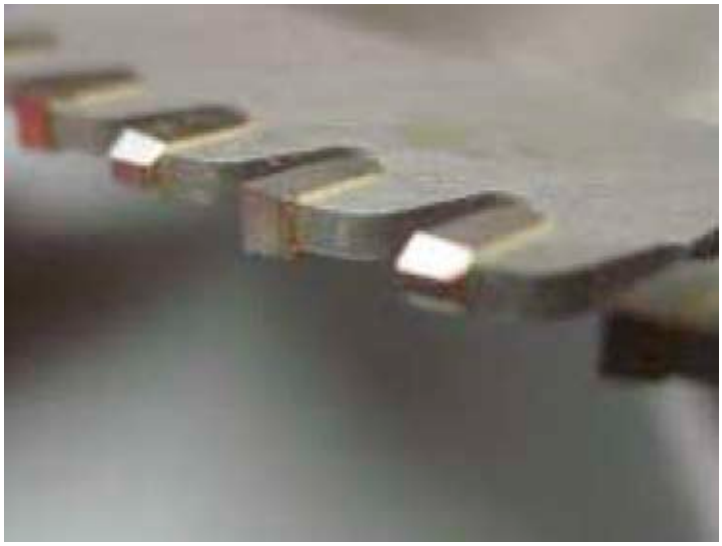
- Each tooth cuts in different direction, and the heat it is easily dispersed.

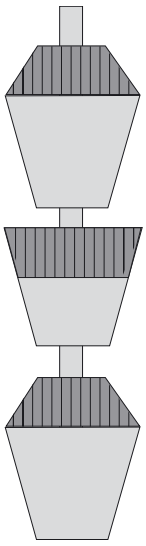
1.4.1 Types of Teeth for Circular Saw

Flat Trapezoid Type

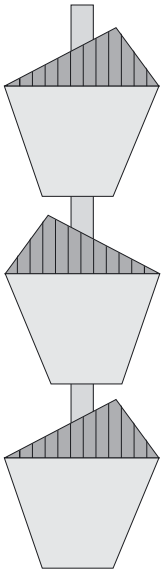


Flat Trapezoid Disk



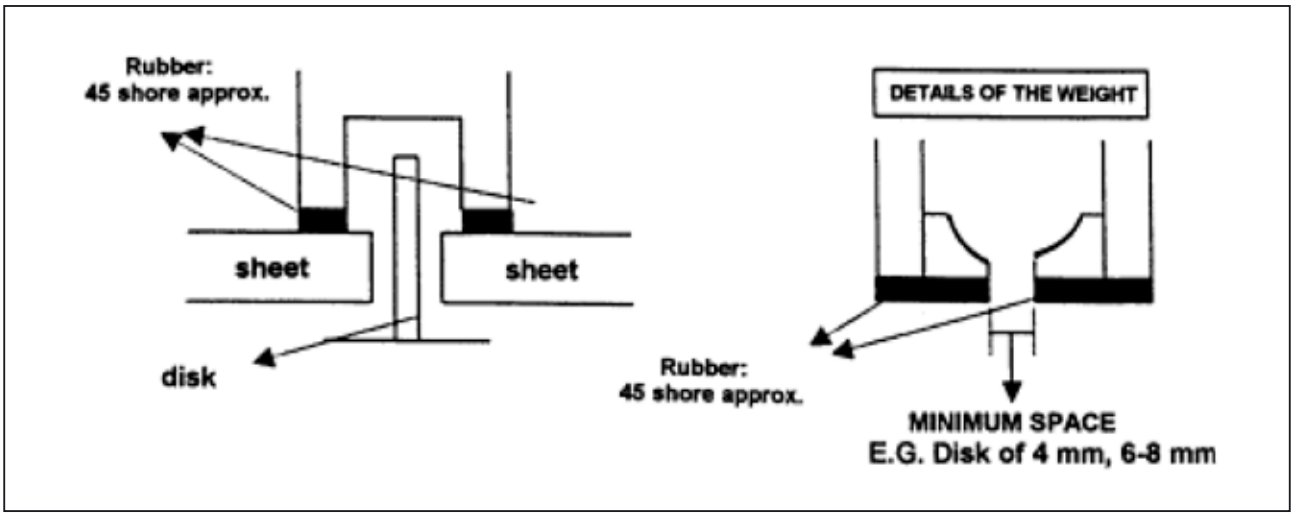


Alternate Disk



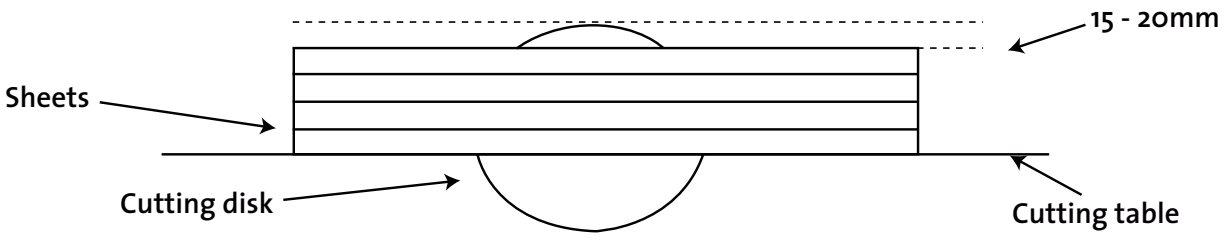
1.4.2 Circular Saw Clamping

It is very important that the sheets to be cut are correctly clamped so that they do not lift as the disk passes. We recommend using a **double weight with a rubber or similar base** to absorb the vibrations produced by the disk. See example below:



1.4.3 Circular Saw Disk Position

The cutting disk should project between 15 and 20 mm above the upper part of the sheets that are being cut.



1.4.4 Cutting Speed and Feed Rate

As with all cutting and fabrication processes it is recommended that a trial process is completed to ensure satisfactory results are achieved.

General Conditions for Industrial Circular Sawing

Material	PET	PETG
Diameter disc	350 - 500mm	350 - 500mm
Teeth number	72 - 96	72 - 96
Speed (rpm)	2000 - 3500	1800 - 3000
Advance speed (m/mm)	6 - 10	6 - 10

Example of Suitable Design of Disc

- Diameter: 430mm
- Thickness of teeth: 4.4mm
- Thickness of disc: 3.2mm
- Number of Teeth: 72
- Type of teeth: Alternate

1.4.5 Recommendations

- The cutting table should have the opening adjusted as close as possible to the width of the disk.

  For example, for a disk of 4 mm, the ideal opening is 6 - 8 mm.

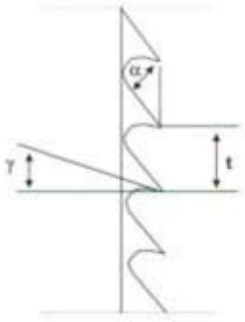
- The cutting table should be as flat as possible. If the saw has clamps, the grooves/guides should be of minimum depth to prevent excessive vibration.

- When cutting stacks of several sheets at the same time, with a total thickness of more than 10-15mm, it is advisable to cool the disk using compressed air.

- The breakage of corners can be prevented by using a pre-forming disk. This disk prevents the corners from breaking because of the advance rate when extracting the cutting disk.

1.4.6 Band Saw Cutting

Below are our suggested blade tooth profiles for a band saw. Ensure to test a sample piece of material to ensure satisfactory results are obtained.



Advised lip clearance - α	30° - 40°
Cutting clearance - γ	0° - 5°
Saw Speed	1200 m/min - 2000 m/min
Teeth Distance - t	2mm - 3mm

1.4.7 Trouble Shooting

Suggestions for APETlite and PETGlite Materials:

- **Cracking or Chipping**
  - Reduce the advance speed.
  - Decrease the tooth size.
  - Increase the clamping pressure.
- **If Sheet Sticking or burrs appear because of friction heating**
  - Progressively increase the advance speed by a maximum of 2m/min.
  - If the advance rate is to fast, the cut is not correct and it leaves a jagged, grooved edge.
  - If they continue to appear at the maximum advance speed progressively reduce. the saw blade speed by 250 rpm.
  - If it is not enough, cool the disc with air.
- **PET: Burr Appearance**
  - Decrease number teeth in saw blade. (for example reduce from 72 to 60).
- **PETG: Lines on the Edge**
  - Increase the saw blade rpm.
  - Reduce the advance speed.

1.5 Laser Cutting

All APETlite and PETGlite Sheets up to 2mm can be cut with an industrial laser. The main problems are burning edges, crystallisation and toxic gases. Due to the varying capabilities of different manufacturers we recommend you contact your machine supplier for assistance. Always try a sample piece of material first to ensure a desired result is achieved.

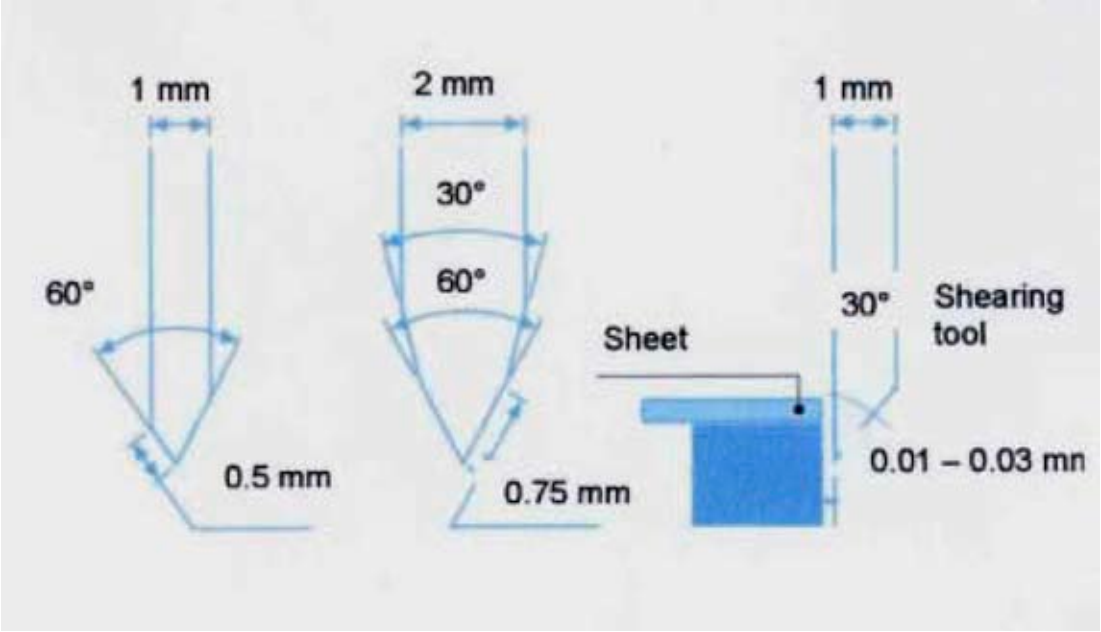
1.6 Guillotining and Punching

- Guillotine and punching are suitable methods for cutting all sheets up to 1mm, and for PET, PETG and PC sheets up to 2.5mm
- A guillotine will produce a straight-edged cut whereas a punch can produce holes of almost any desired shape.
- Power guillotines can cut PETg sheet in thicknesses up to approximately 2.5mm. For thicker sheet, saw cutting is preferable.
- It is important to maintain a blade-to-bed knife clearance of approximately 0.0254 mm (0.001 in.) for a smooth cut.
- Punches may be used when a fairly rough edge is acceptable.
- Cracking and chipping can sometimes be reduced by warming the sheet, however, some allowance for hole shrinkage due to cooling may be necessary.
- Sawing, drilling, and routing are preferable to punching when the thickness is greater than our recommendations.

1.7 Die Cutting

- APETlite and PETGlite sheets can be satisfactorily cut using a die with steel blades.
- The key to die cutting is the die board and steel rule die. A steel rule die is a cutting tool similar in form and function to a cookie cutter.
- Sharpened steel blades are bent and formed to the pattern to be cut. The blades are held in position with either high density wood or steel braces. The die and material to be cut are placed in a press and the final shape is stamped out.
- Conventional steel rule dies attain the highest accuracies and can represent the most complex forms.
- Fold lines, scores, and perforation cuts can all be made.
- It is also possible to partially cut through a material.
- The blade should be changed or sharpened frequently.
- The press for die cutting should be adjusted so that the stroke completely slices through the plastic sheet.

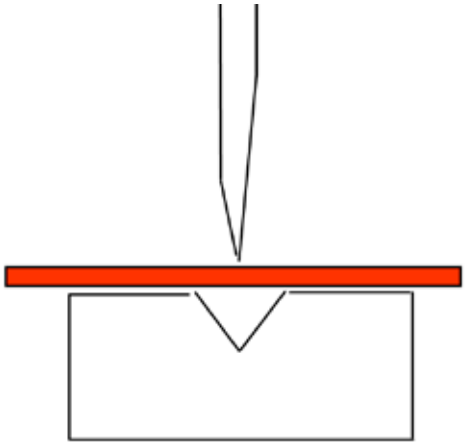
1.7.1 Angles for Die Cutting & Shearing



2.0 Bending

2.1 Cold Line Bending

Cold Line bending is suitable for both APET and PETG.

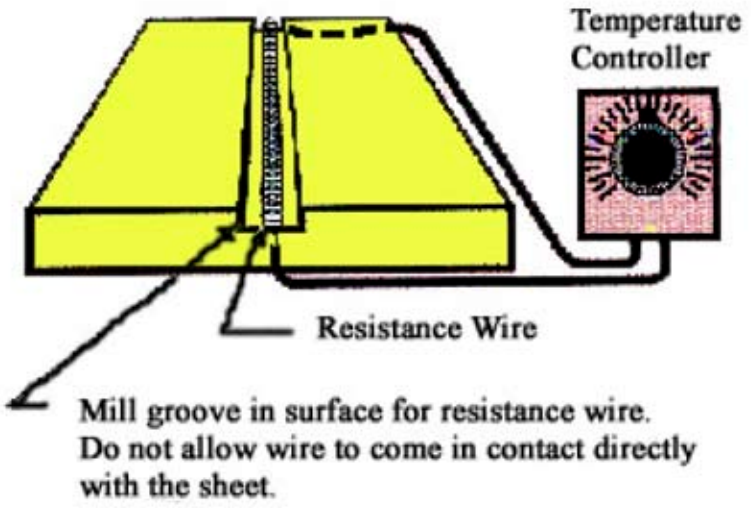


2.1.1 Recommendations

- Over bending of 20 to 25% is in the most of cases required in order to compensate for relaxation after bending.
- The internal and external stress cause by bending, can take up to 48 hours to relax, this will depend to the thickness, the angle and the material.
- Do not force the bend angle during installation.
- Impact strength can decrease in the bend zone because of residual stress.
- Coloured sheets can change colour tone in the bend zone.
- The material is more sensitive to chemicals in the bend zone.
- In general maximum thickness recommended 2.5mm
- Minimum radius:
  - APET is equal to 150 times the thickness
  - PETG is equal to 150 times the thickness
- The greater the thickness, the more internal stress is introduced during cold bending.

2.2 Hot Bending

- All APETlite and PETGlite products can be hot line bent into a small radius
- The process consists of preheating the material on one or both sides, using an electrical resistance along the line to be bent.
- Depending on the polymer and the angle required this may be done with or without protection film, in the cases where it is required to remove this film, we recommend to only remove the film from the heat affected area as this will help to protect the sheets general surface.
- Care should be taken with thicker sheets as the film may be trapped inthe fold or melted onto the surface due to overstretching on theprotection film.
- Preheat the sheet to the temperatures indicated below, these are guidetemperatures only as the optimum depends on heating time and thickness.
  - PETlite: 100°C - 110°C (Heat and cool quickly to avoid crystallinity)
  - PETGlite: 100°C - 110°C
- The best temperature can be recognized when there is only slightresistance to bending.
- Quickly bend the part along the heated line and hold or clamp this position until it cools.



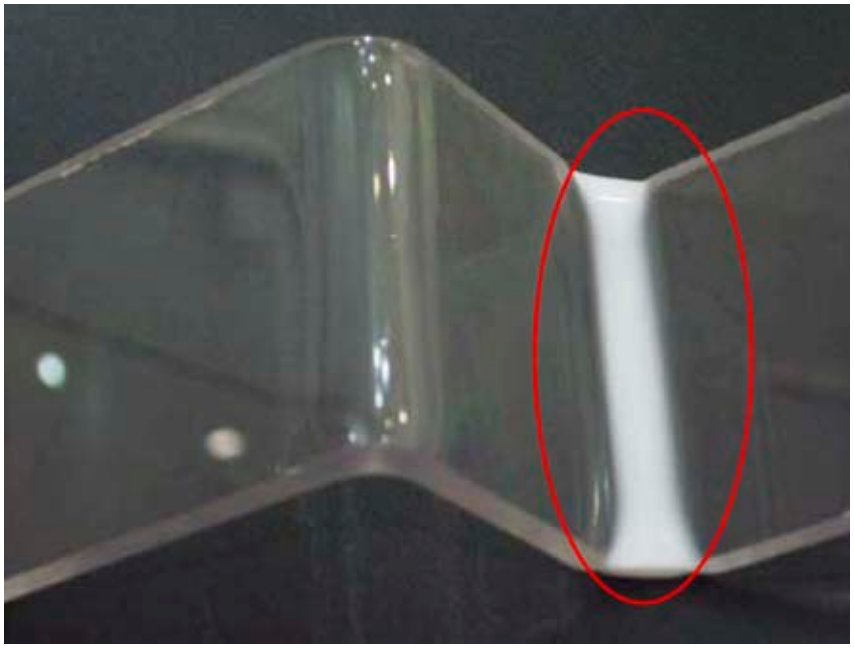
Single Side Hot Bending

The sheet can be heated on one or both sides, depending on the thickness and angle required.

- Overheating can cause bubbles and crystallinity
- Under heating causes stress which will result in more brittle parts and reduced chemical resistance.
- As heating is only done in a line and not in the entered sheet, the expansion in this line can cause concave effect on wide sheets. It begins in 3mm sheets above 1m.
- In order to avoid this distortion, we recommend to cool the sheets in the bent position.
- Thermal expansion table shown below, these are typical values and Foamalite recommend you test the product in your desired application to ensure allowances for thermal expansion are adequate.

	Density (g/cm3)	Elastic Modulus	Lineal Thermal Expansion °C
PET	1.33	2420	6 x 10-5
PETG	1.27	2200	6.8 x 10-5

1.7.2 Trouble Shooting



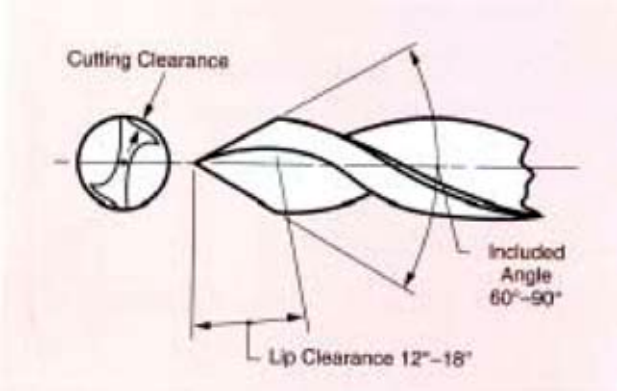
PET can crystallise; to avoid this, temperature should be controlled accurately.

Low power heat, and increase heating time gives the best results.
If necessary extra air cooling could be used.

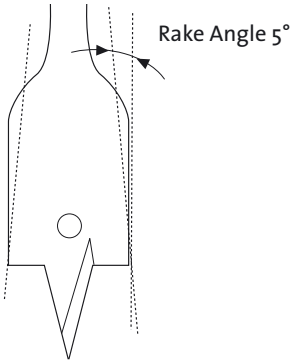
3.0 Drilling

3.1. Overview

- Drills designed especially for plastics are available for all APETlite and PETGlite sheets, and their use is recommended. Standard twist drills for wood or metal can be used; however, they require slower speeds and feed rates to produce a clean, non gummed hole.
- Acceptable holes with minimal shavings can be produced on a 5-speed drill press operating at speeds from 500 to 2500 rpm.
- Twist drills for plastics should have 2 flutes, a point with an; included angle of 60° to 90°, and a lip clearance of 12° to 18°, as shown following figure.
- This reduces the heat by allowing the cuttings to escape easily.



Two flute taps for standard plastics sheets.



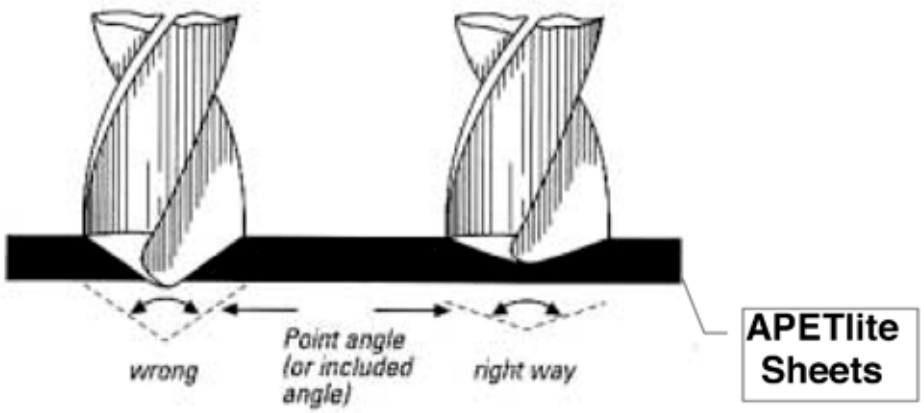
Drill for large holes: PET & PETG

3.2 Drilling Parameters

The table below are the suggested parameters for drilling various hole sizes in PET and PETG sheets. Use a hole diameter 1.5 times larger than the screw diameter to account for sheet expansion.

	PET & PETG	
Hold Diameter (mm)	2-6mm	8-20mm
Clearance Angle	12-18	12-18
Rake Angle	0-5	0-5
Included Tip Angle	45-160	45-160
Cutting Speed r.p.m	1000-2500	350-1000

3.3 Drilling Thick Sheets v Thin Sheets



For Best Results

Thinner sheets should have an included angle (90°),

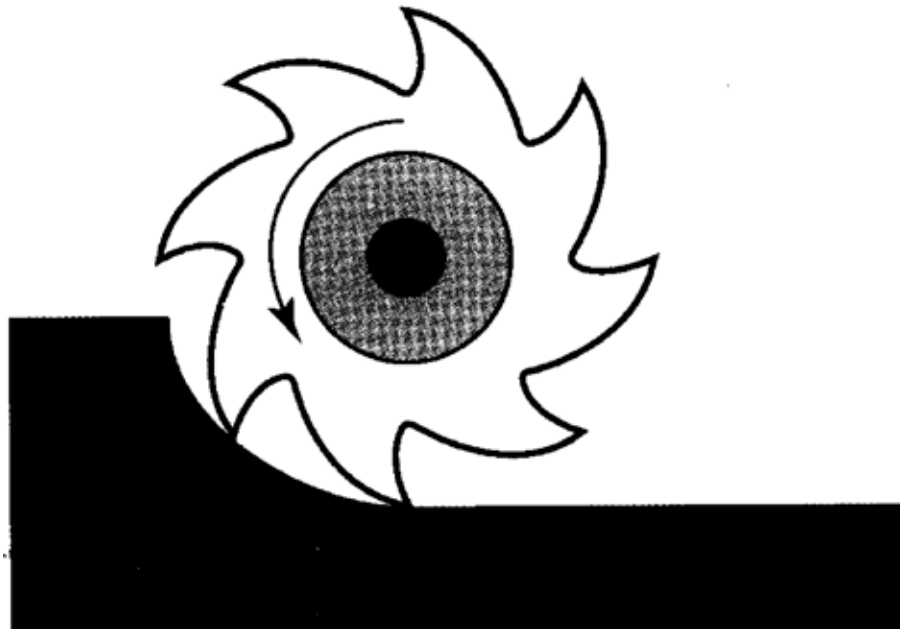
Thicker sheets should have a pointed angle of (60°).

3.4 Recommendations

- Reduce the drill bit rpm for larger diameters.
- Use a hole diameter 1.5 times larger than the screw diameter to account for sheet expansion.
- The sheet should be well secured to prevent chipping and cracking.
- A pointed object may be used to start the drilling.
- Use water or air to cool the sheet.
- Drills should be backed out often to free chips, especially when drilling deep holes.
- Use compressed air to prevent overheating, especially if sheet is more than 5mm thick.

4.0 Milling

4.1 Milling



4.2 Recommendations

- All APETlite and PETGlite Sheets can be machined with standard highspeed milling cutters for metal.
- Climb cutting is a milling operation that gives a good machined finish on plastics. In climb milling, the work moves in the same direction as the rotating cutter.
- It is very important to clear away the swarf while working, and to cool the part and the tool with suitable non aggressive liquid depending on the polymer.
- Satisfactory results can be achieved using:
  - Diameter bit : 6 to 15mm
  - Spindle Speed: 10.000 – to 20.000rpm
  - Advance speed: 1.5m per minute.
- Milling plastics always requires lubrication.
- For best results we recommend diamond tipped tools.

5.0 Tapping / Threading

5.1 Overview

- Cutting edges should be 85° from the centreline, giving a negative rake of 5° on the front face of the lands so that the tap will not bind in the hole when it is backed out. It is desirable to have some relief on the sides of threads.
- Sharp V-threads should be avoided. Since plastics are notch sensitive
- Conventional 4-flute taps can be used for cutting internal threads in plastic sheet when a close fit is required. Such taps, however, have a tendency to generate considerable heat during the tapping operation.
- A thread with a rounded root, such as a British Standard series (Whitworth Thread) or American Standard Unified Thread form with rounded root is recommended.
- For tapping holes, high speed oversize taps, such as H-3 oversize for small diameters, up to H-5 for larger diameters are suggested.
- For deep holes (over 3:1), four flute taps are recommended for greater chip clearance.
- Taps for all thermoplastics should have maximum back clearance unless a tight fit is required.
- Taps should be nitrated or chrome-plated, and all new taps should be honed to remove burrs.
- After tapping, a chamfering operation is sometimes necessary to remove burrs.
- Chips from tapping can be removed from the bottom of the tapped hole by re-drilling with the tap drill.
- For maximum strength and dimensional stability, all tapped parts should be annealed to relieve the stresses of the tapping procedure.

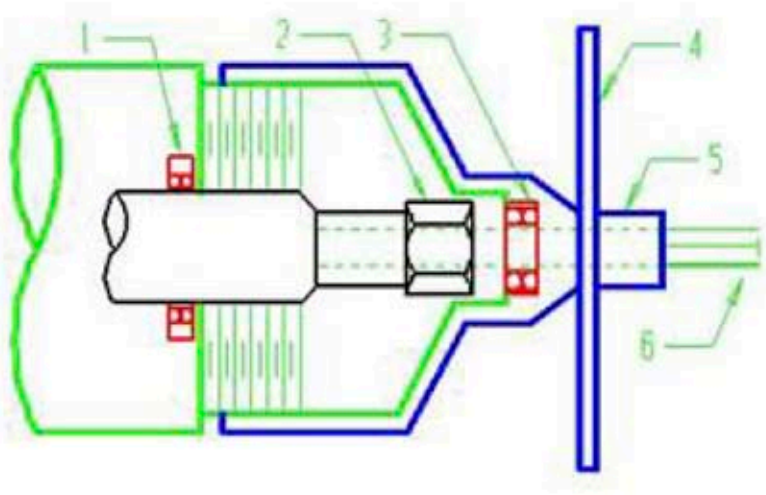
6.0 Routing

6.1 Overview

- Machines include: air and electric routers, pin routers, and CNC machinery.
- Hand fed machines are heavily influenced by the skill of the individual operators.

Examples of the layout of a Router

Assembly Diagram



1. Spindle Bearing
2. Collect
3. Nose Bearing
4. Guard
5. Guide Bushing
6. Cutting Tool

Examples of the Flute of a Router

Single Edge Spiral "O" Flute

Double Edge "V" Flute

Three Edge Finisher

- PET and PETG are flexible materials that will vibrate when machined if not held properly.
- All PET and PETg can be gummy and require an O flute router bit.
- Do not use V or Z flute cutting tools with PET because all grades are subject to crack propagation.
- Routing these products on a CNC router is best accomplished with solid carbide single edge “O” flute router bits.
- If a curved edge is required then a solid carbide O flute edge rounding bit.
- Solid carbide O flute bits are also a good choice for air routers when cutting all thicknesses of PET.
- Entry into the cut should be a ramping and not plunging action.
- The tooling material of choice should be high speed steel or carbide tipped with a steel shank.
- These tool materials are more forgiving in a hand fed application, and less likely to fail.
- Regardless of the type of machinery utilized, the ability to properly hold the part is critical.
- Router tools for plastic cutting are application and material specific. In almost all cases, one cutting tool cannot be utilized across a variety of plastic material.
- The use of “O” flute tools in straight and spiral configuration with high rake angles and low clearance will aid in eliminating the knife marks associated with soft plastic.
- Hard plastic is best routed with double edge “V” flutes, spiral “O” flutes with hard plastic geometry, or two and three edge finishers.
- These tools along with the proper chip load produce a crater free finish.
- Cratering in hard plastic occurs when the shear strength of the material is exceeded in the routing process.
- Thick materials (over 6mm), particularly small parts cut from sheet, can best be machined in two passes.
- Excessive spindle speeds will typically melt the plastic or cause a wiping or smearing action on the finished edge that reduces the quality of the surface finish.
- Depths of cut are critical to ensuring consistent edge finishes and nonbroken tooling.
- A good rule of thumb is a maximum of twice the cutter diameter per depth of cut.
- Four factors in the routing operation typically will affect the quality of the cut edge: Tooling, Programming, Machine Condition, and Fixturing.
- If any one of these factors is not optimised, it will be extremely difficult to maintain a consistent, high quality edge finish.
- Common request for tooling diameters to be in the 3mm to 6mm range, designing the parts, fixtures, and programs for 10mm to 12mm tooling can dramatically improve surface finishes and consistency from job to job.
- There is typically only a marginal benefit when increasing cutting edge diameters over 12mm.
- Typically low helix multi-fluted tools will yield the best results.

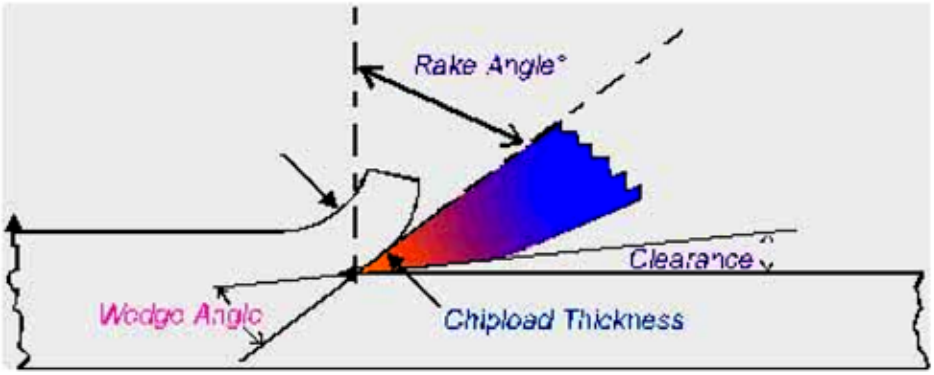
- Another important programming feature is the choice of tool or feed direction.
- In machining, there is climb cutting (clockwise direction) and conventional cutting (counter-clockwise direction).
- In most cases, conventional cutting provides a better part.
- The fabricator should always compare the finish of the scrap to the finished part to identify which edge is better.
- If the scrap is better, reverse the cut direction.

6.2 The Routing Process

As a general rule, the following feed rates are good starting points for an good edge finish, a constant spindle speed of 18,000RPM and a depth of cut equal to the cutter diameter is required:

- 3mm Diameter Tooling: 1.9-2.5 mpm
- 6mm Diameter Tooling: 2.5-5 mpm
- 10mm Diameter Tooling: 3.2-6.4 mpm
- 12mm Diameter Tooling: 3.8-7.6 mpm

Most of these feed rates can be increased by simply increasing the spindle RPM. With the newer generation spindles typically having maximum speeds of 21,000 to 24,000 RPM.



If you have a high rake angle in a cutting tool it is very aggressive on the plastic and wants to "run" and can sometimes rip the router from your grasp. The solution for this aggressiveness is to change both the angle and type of clearance. This can be achieved by using a low angle relief grind on the clearance angle.

Routing of APETlite and PETGlite Sheets on a CNC router is best accomplished with solid carbide single edge O flute router bits, such as the one shown in Figure 1. If a curved edge is required then a solid carbide O flute edge rounding bit as shown in Figure 2 is the best choice. Both tools are also available in a two flute configuration which can be tested if finish is a problem with the single flute tool.

Figure 1

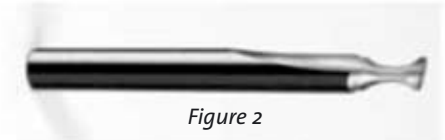


Figure 2

If air routers are being used to route or trim unreinforced APETlite and PETGlite then high speed steel O flute router bits may be the most cost effective choice. The high speed O flute bit is shown in Figure 3. Solid carbide O flute bits are also a good choice for air routers when cutting all types of PET.

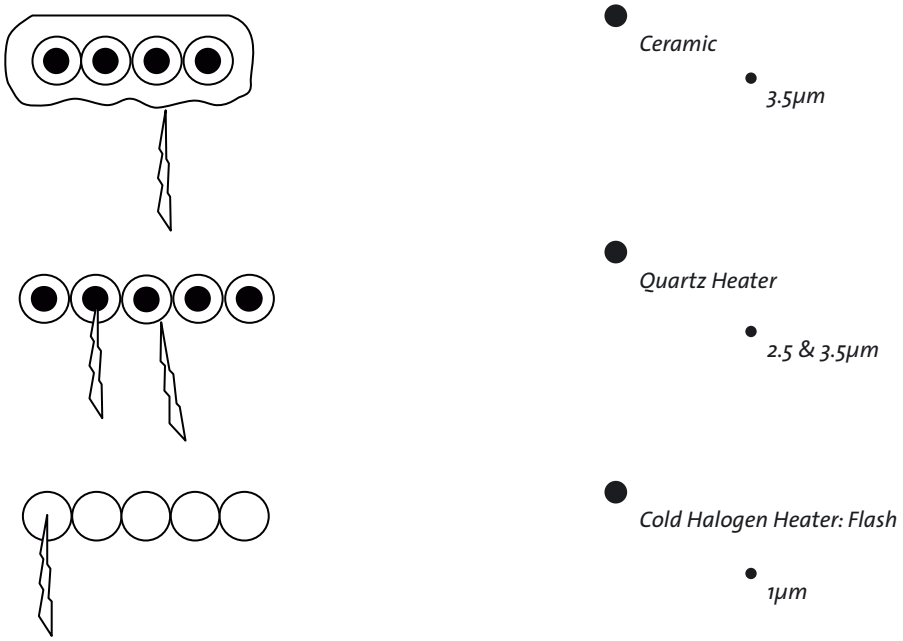
Figure 3

When programming a CNC router for cutting APETlite and PETGlite, there area few considerations that will dramatically affect production, scrap and finish. Entry into the cut should be a ramping and not plunging action. Outside or perimeter sharp corners should be programmed as a loop or exit ramp movement to prevent tool stops or dwells which can cause crack propagation, heat or burning. Spindle speed should be set at 18,000 RPM and feed rates between 200 to 350 inches per minute for ¼ inch and below diameter tools. APETlite and PETGlite should be cut as fast as possible with a one pass cut. There is reasonably little experimenting to be done other than finding the fastest speed rate when routing APETlite and PETGlite materials once the right cutting tool has been selected and proper programming techniques have been employed.

7.0 Thermoforming

7.1 Heater Radiation

- **Ceramic:** Indirect heat, the heat only arrives to the surface of the sheet.
- **Quartz:** Direct heat. Part of the direct heat arrives to the surface; and also some of the directed penetrates the surface of the sheet.
- **Flash:** Direct heat. All of the heat penetrates into the sheet. If it is enough thin, it can pass completely throw the sheet. Then, the heat is dispersed more equally throughout the thickness of the entered sheet with flash direct heat.



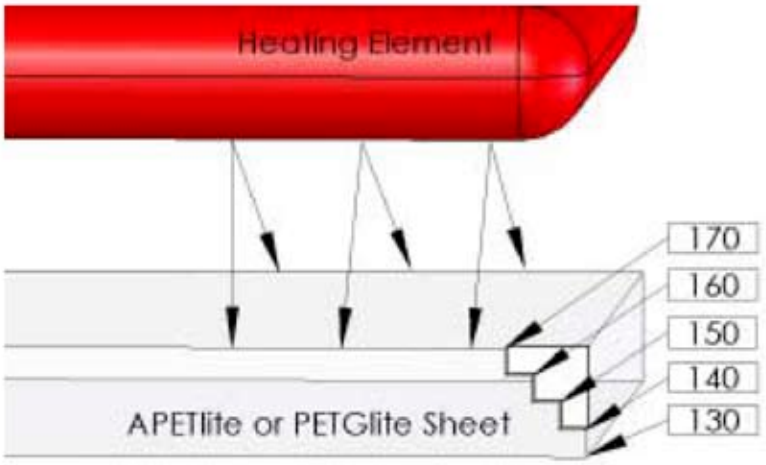
Plastics in general can absorb radiation with a wavelength equal to or lower than 3.5µ

7.2 Heater Efficiency

- The flash direct heat can reduce up to 50% of the heating time when compared to the quartz direct heat.
- The flash heaters are recommended especially when the sheet is printed, because the heat arrives to the mass of the sheet.
- Ceramic & Quartz heaters, which heat from the surfaces, the surfaceabsorbs heat with different intensities depending on the colour.

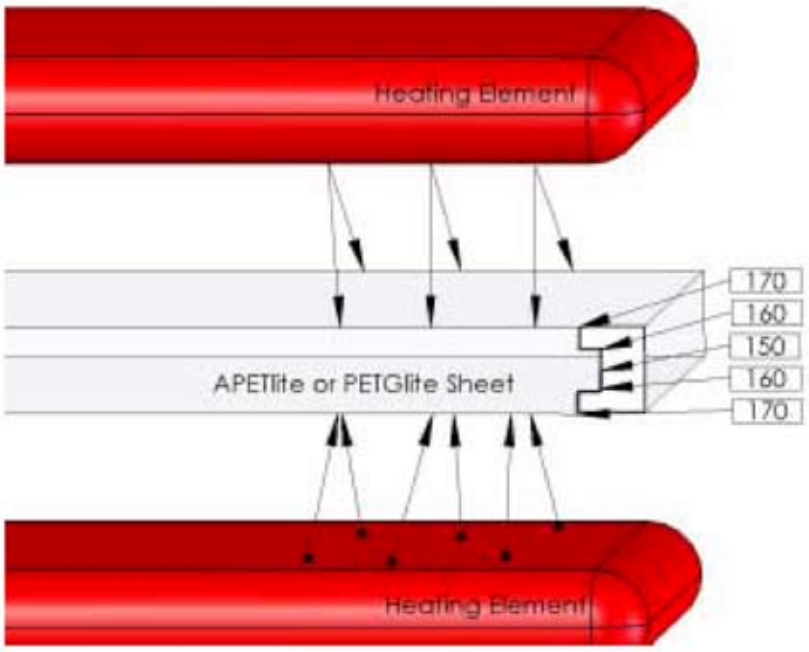
7.3 One Side v Two Sided Heating

Ceramic or Quartz Heating Elements



One Sided Heating (above) causes a greater heat variation through the thickness of the sheet. To get a more uniform heat distribution, two sided heating can be used.

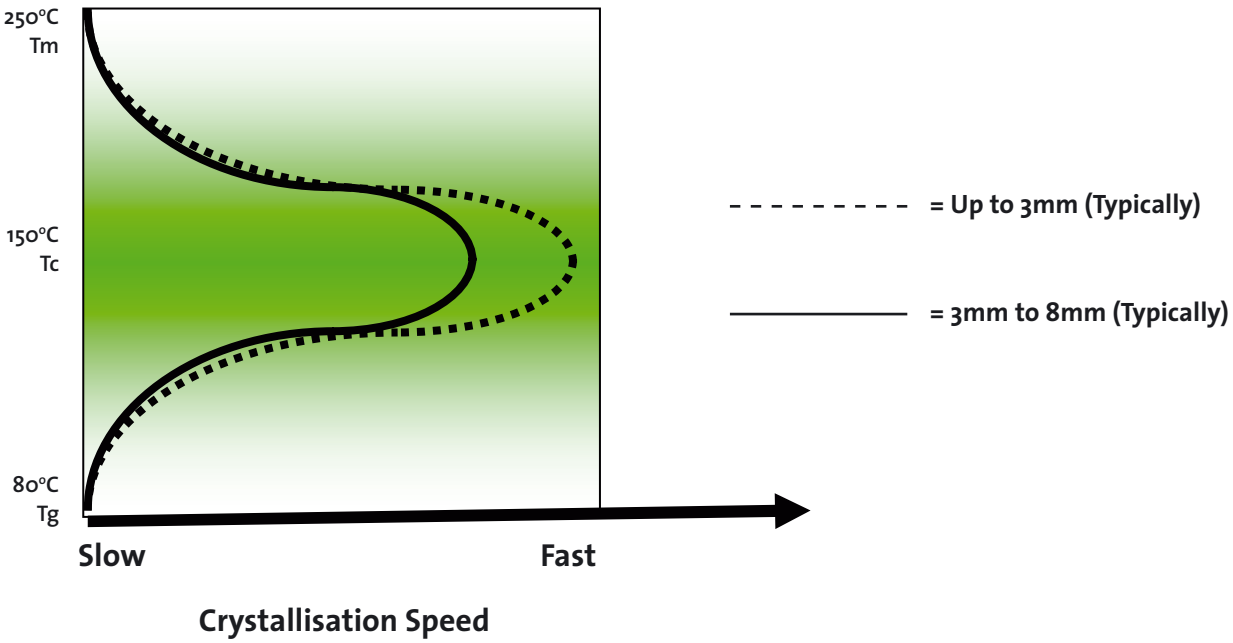
Note: Figures used in diagrams are just for display purposes and not actual temperatures.



7.4 The Mold

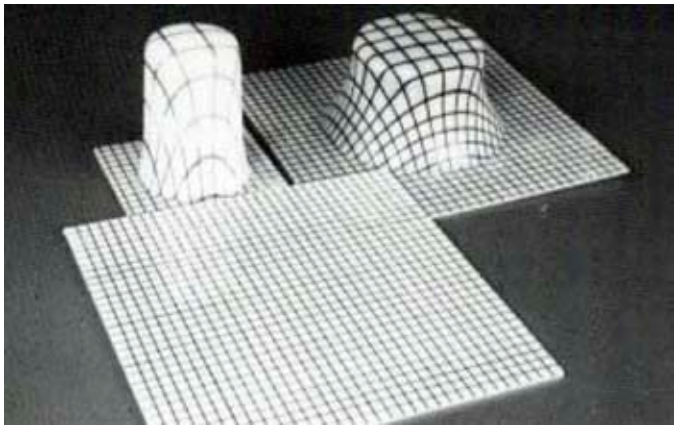
- The best material is aluminium. If a high quality is needed, it is recommended that the entire mold is made with aluminium and without painting.
- If it is necessary to control the mold temperature up to 95°C, it can be controlled by water. If it is needed up to 130-140°C it can be controlled by electrical heaters.
- The most common mold temperature it is around 60° for PET.

7.5 Crystallinity



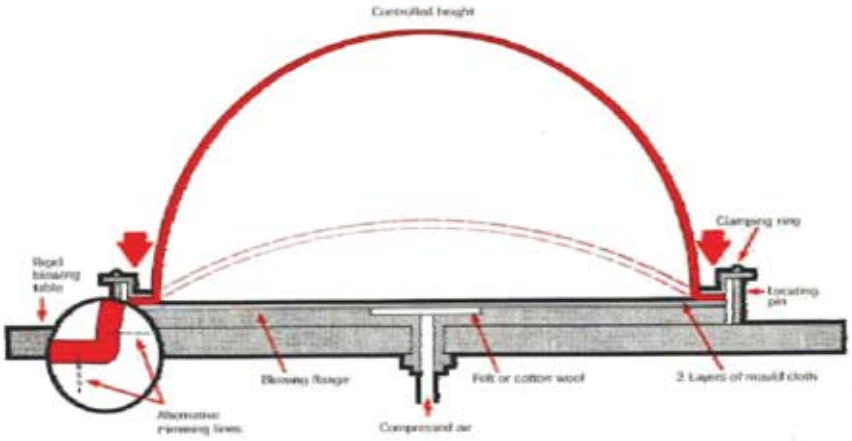
7.6 Sheet Heating

- It is very important to have very good control of the temperature of the sheet. This is because to obtain optimum detail of the mold it is better to have temperature control in as many different areas of the sheet as possible.
- Different mold shapes require different distribution of temperatures.



7.7 Free Blow Molding

An example of a free blow molding process is shown below.



7.8 Trouble shooting

APETlite or PETGlite do not require drying which is a major cause of bubbles in other plastics during blow molding.

a) Reduce or incomplete details

Causes	Solutions
Insufficient vacuum	Check for lack or tightness or add vents
Sheet temperature too low	Increase heating

b) Badly Formed Parts

Causes	Solutions
Sheet too hot	Reduce heating
Tool too cold	Raise tool temperature
Part no released soon enough	Shorten cooling cycle
Vacuum too fast	Limit vacuum
Sharp edges	Round off edges
Sheet surface too small	Use larger sheets

c) Sheets Stick to Mold

Causes	Solutions
Tool too hot	Reduce tool temperature
Part not released soon enough	Release sooner
Release angle too small	Release angle >4 to 6°

d) White Marks

Causes	Solutions
Partial Crystallisation (only PET)	Reduce time and temperatures
Sheet too cold	Increase temperature Increase forming speed

e) Impressions

Causes	Solutions
Mold surface too smooth	Slightly matt tool
Sheet temperature too high	Reduce heating time
Vents badly positioned	Re-evaluate vent positioning

f) Surface Defects

Causes	Solutions
Dust on sheet or mold	Clean with ionized compressed air
Vents badly positioned	Re- evaluate vent positioning

g) Uneven Finished Parts

Causes	Solutions
Tool / clamp too cold	Increase pre-heating
Heating / cooling	Check heating distribution Check for broken heaters Check for draught
Release too late	Release sooner

8.0 Bonding

8.1 Bonding with Solvents

- Machines include: air and electric routers, pin routers, and CNC machinery

  PET - Not Possible

  PETG - Good Results

- Solvents work by dissolving the surface of the sheet, in this way they get a better join between both surfaces.
- Curing occurs as the solvent evaporates.
- Solvent adhesives are commonly used throughout the plastic sheet fabrication industry. These consist of two types; those which are solvents only (solvent type) and those consisting of another polymer dissolved in a solvent blend (dope type).
- During bonding some bubbles can appear:
  - Care should be taken to make sure that the solvent is applied evenly throughout the joint and that no air bubbles are present.
  - It is better to apply this with syringe.
  - You should always do a trial: Leave the solvent to rest for some time before gluing (wait until there are no bubbles before assembly the joins).
  - Generally the better polished the edge, the less bubbles will appear.
  - All the following can influence in the appearance of bubbles.
    - The surface quality, too rough.
    - If solvent has been applied by a brush.
    - If the cleaning preparations were not made properly.
    - If the solvent is too thick.

Solvents to bond to APET

- Because of the outstanding chemical resistance of PET sheet solvent type adhesives are unsuitable.
- MEK (methyl ethyl ketone).
- Cyclohexanone
- Perchloroethylene
- MC (Methylene Chloride)
- THF (Tetrahydrofuran)
- Trichloroethylene
- In order to thicken the adhesive, we recommend dissolving 10% PETG into the solvent.

8.2 Commercial Adhesives

- In the case that solvents bonding is unsuitable and adhesives are required the same preparations as used for solvent bonding should be done.
- Adhesive bonding offers some of the most efficient, effective and economical methods of bonding plastics to themselves and other materials.
- Some adhesives form a flexible bond, others form a rigid bond and some are used for filling gaps.
- It is extremely important to select the correct adhesive witch should depend on your various materials and requirements.
- Depending on the type of application and the surface to be bonded, commercial adhesives are available for use with APETlite and PETGlite Sheets.

For PET

- Two part reaction adhesives based on epoxy or polyurethane
- “Instant” cyanoacrylate
- UV curing adhesives, etc.

For PETG

- Cyanoacrylates
- Two part acrylics
- Two part polyurethane’s
- Two parts epoxies

Foamalite recommend that you contact your adhesive supplier, to identify the most suitable adhesive for your application and the product been used (APET or PETG).

Some potential suitable adhesive suppliers are shown on the table below:

Company
Engineering Chemicals
Ciba Geigy Plastics
Dymax Europe
Evode
Datac
Henkel Chemicals
Agomer
Evode
3M Company
Sailoc

8.3 Preparation

- Joined surfaces must fit well without forcing and have no visible gaps.
- The surfaces to be joined must be clean. A slight film of oil, water, polishing compound, or some other contaminant can cause poor bonding.
- Before bonding, the surfaces to be bonded should be cleaned with a soft cloth with the following liquid to remove dirt and grease.
- PET, PETG: Mixture 1/1 Isopropyl alcohol / water
- Good results can also be obtained by cleaning with a detergent solution.
- The surfaces to be bonded should be smooth but no polished.
- if possible, the surfaces should be slightly roughened in order to provide a better bond surface.
- According to the instructions given by the adhesive manufacturer, coat the sheet surface with the appropriate primer where necessary.
- Some adhesives with a volatile component may shrink while curing. To compensate for this, cut the joint on an angle, providing space for the joint to be slightly overfilled.
- Subsequent finishing operations must be delayed until the adhesive has cured.

8.4 Bonding - Techniques

- According to the instructions given by the adhesive manufacturer, coat the sheet surface with the appropriate primer where necessary.
- Some adhesives with a volatile component may shrink while curing. To compensate for this, cut the joint on an angle, providing space for the joint to be slightly overfilled.
- Subsequent finishing operations must be delayed until the adhesive has cured.
- Apply the adhesive or solvent according to the instructions given by the manufacturer.
- The surfaces should be accurately aligned and have no visible gaps.
- After the adhesive has been correctly applied, place the sheet substrates in contact and secure them firmly until the adhesive has cured.
- For larger articles, the preferred method of bonding is to coat the adhesive onto the surfaces to be joined and then to clamp or otherwise hold them in position until the bond is set.
- Pressure must be applied until the cement joint has set sufficiently to prevent any movement when the pressure is released.
- Clamping may cause the adhesive or cement to protrude at the joint. This protrusion can usually be removed by suitable machining operations followed by polishing.
- This should only be done, however, after the pieces have stood for the curing time recommended by the adhesive supplier. If a high finish is desired, it may be necessary to flame the surface at the joint after it has been machined and before it is polished.

9.0 Printing & Painting

9.1 Overview

- APETlite and PETGlite can be easily printed with most conventional printing techniques such as silk screen or tampo printing.
- It is also possible to print the flat sheet prior to the forming process because of the low thermoforming temperature of APETlite and PETGlite.
- Methyl ethyl ketone, acetone, benzene, or similar solvents should be avoided with APETlite and PETGlite.
- Bi component polyurethanes and epoxy based inks are recommended.
- Recommended ink systems and their thinners should be employed.
- APETlite and PETGlite sheets can be easily printed, lacquered and painted with a wide range of products.
- Sheets can be decorated by silk-screen printing or lithographic printing, vacuum metallising.
- It is essential to ensure that any solvent contained in the lacquer or varnish will not attack the sheet and therefore it is advisable to consult the paint manufacturers regarding their products.
- Remove the printed film before printing to avoid print transfer onto the new printing surface.
- To remove any dirt or particles without scratching the surface, only soft cloths or damp leather cloths should be used.
- Each application may require a different type of ink and therefore the ink manufacturers generally prefer to consider each application separately to determine the best ink for the purpose.
- A preliminary test with the inks to confirm the results should be performed.
- Ink systems should not be mixed.

9.2 Preparation

- All surfaces to be printed must be clean. A slight film of oil, water, polishing compound, or some other contaminant can cause poor printing results.
- Before printing, the surfaces to be printed should be cleaned with a soft cloth and with the following liquid to remove dirt and grease.
  - APETlite and PETGlite: Mixture 1/1 Isopropyl alcohol / water
- Good results can also be obtained by cleaning with a detergent solution.
- Subsequent finishing operations must be delayed until the ink has cured.

9.3 Inks

Foamalite recommend that you contact your adhesive supplier, to identify the most suitable ink for your application and the product been used (APET or PETG).

Some potential suitable ink suppliers are shown on the table below.

Company
Marabu Werke Gmbh
Sericol Limited
Visprox B.V.
Datac
Unico N.V.
Coates Screen
Ernst Diegel Gmbh
Arets
Zeller+Gmelin Gmbh

10.0 Surface Finishing

10.1 Sanding

- All APETlite and PETGlite sheets can be sanded.
- APETlite and PETGlite sheets are best sanded wet.
- To avoid chemicals problems, we suggest always use water.
- Start by rough sanding with 80-grit silicone carbide.
- Progressively reduce the roughness, for example 200-grit follow by 350 and so on.
- The final sanding can be done with sandpaper up to 2400 grit.
- If a smoother finish is required, a final two wheel buffing system maybe used:
  - First wheel with fine paste compound to remove abrasions.
  - Second buffing wheel will give the final gloss finish.

10.2 Planing

- Standard wood working electrical plains can be used on all sheets.
- Blades must be carbide or high speed steel type.
- Trying to remove too much material with each pass of the plain, will cause in cracking and chipping of the sheet.
- If a smoother finish is required wet sanding with a very fine sandpaper or polishing using a two wheel system can be made.
- Particular caution to ensure that the rotation speed of the blade is low to prevent melting of the surface.

10.3 Diamond Knife Planing

- Standard cut edges can be smoothed and polished in one step by diamond knife planing.
- With this type of industrial planing, high quality bevelled or plane edges can be obtained.
- In order to achieve these high quality surfaces, the material has to securely mounted and precisely guided to prevent vibration.
- Sometimes vibrations in thinner sheets can not be avoided.
- This process yields a highly transparent and glossy surface with very good optical properties.

10.4 Polishing

- The sheet edges must first be smoothed to remove the marks left by sawing.
- The following may be used:
  - Rigid fabric rotary discs with cleaning paste followed by soft fabric discs with cleaning paste for the final finish.
  - The polishing operation requires a balance between the rotating speed and the applied pressure.

An example of polishing cloth rings and paste is shown below.

10.5 Hot Air Gun Polishing

- Following milling or planing, PETGlite edges can be polished quickly and easily using a hot-air gun.
- The protective film should be peeled off to free about 1.5 - 2 cm from the edge.
- The gun should be moved along the edge, maintaining a constant speed and distance between the nozzle and the edge.
- The result depends on the temperature and the distance of the gun from the edge of the sheet.
- In the case of PET, over temperature can cause crystallisation problems and therefore we do not recommend this process for PET.
    - If necessary and the edge turns white, you should increase the distance of the gun, or lower the temperature, or a combination of both.
- The thickness of the nozzle should correspond to the thickness of the sheet.

10.6 Gas Torch Polishing

- As in the case of hot air polishing, We do not recommend this gas torch polishing for PET.
- Gas torch polishing is similar to polishing with a hot-air gun.
- The film should be removed 1 or 2 cm.
- A standard butane torch with a small tip can be used.
- Since the temperature of the gas torch is higher than the temperature of the hot-air gun, the burner should be moved along the edge at a greater speed.
- High temperature H2 or acetylene torches are not recommended.
- The speed selected should be such that the surface melts slightly and produces a glossy edge.
- Care should be taken not to burn the edge of the sheets.

10.7 Solvent Polishing

- Polishing Polyester (APET)
  - Because of the outstanding chemical resistance of PET sheet edge polishing is not possible.
- Polishing Polyester (APET)
  - Because of the outstanding chemical resistance of PET sheet edge polishing is not possible.
- Remember that solvent polishing can not totally eliminate, sawing or sandpaper marks from the edge of the sheet.
- To prevent humidity blushing from solvent drying, It maybe necessary to add slow dry additives to the solvent for example diacetone alcohol or glacial acetic acid.

10.8 Diamond Polishing

- Generally 100 mm radius diamond edge tooling will produce the best results.
- Set diamond tools for 0,4 -0,5 mm material removal.
- Lower setting may not clean off all of the saw-cut edge.
- Higher setting will cause premature wear of the tool.
- Always use a vacuum system during the machining operation.
- Use a cotton swab dampened with alcohol to clean diamond inserts.
- At approximately 1/10 the cost of carbide to diamond tooling (both new and re-sharpening costs), it is very important to save the diamond tool for those edges that will remain exposed
- Never touch the diamond insert with fingers or a measuring instrument as Diamond is one of the hardest substances but one of the most brittle.

11.0 Sterilising

11.1 Overview

APETlite and PETGlite can be used for medical /chemical and food industry applications because of the fact that it can be sterilised.

The two most common method of sterilisation are:

- Gamma Radiation
- Ethylene Oxide Fluid

12.0 Recycling

12.1 Environmental

APETlite and PETGlite does not contain heavy metals, chlorine or plastericisers. It complies with the compositional requirements of the US Food and Drug Administration and also complies with the European Union Directives for plastic used in food contact applications.

12.2 Toxicology

APETlite and PETGlite does not release any toxic fumes when burnt. APETlite and PETGlite does not contain any class 1 and class 2 ozone deflecting substances.

13.0 Weathering

13.1 UV Rays

Sunlight affects all materials, to varying amounts, due to UV radiation and also the raising of surface temperatures. APETlite and PETGlite, like all plastics, is affected by UV light. A colour will change according to its colourfastness and the quantity of radiation absorbed.

The rate and level of discolouration of a sheet is variable by the actual shade and colour.

By tailoring the formula of APETlite and PETGlite to include strong light stabilisers; the weatherability of the product can be further enhanced. It is advisable to state whether the product is to be used for exterior applications since the factors that determine the performance of the materials are multi-fold and are often interdependent. Our technical staff can advise on the appropriate grade required.

14.0 Storage and Handling

14.1 Storage

APETlite and PETGlite sheets should be stored on flat pallets that are at least equal to the sheet dimensions.

APETlite and PETGlite sheets must be stored indoors. The sheet or protection film must not be exposed to sun or rain.

14.2 Handling

APETlite and PETGlite sheets to be handled with care. When removing a sheet from a pile of sheets, ensure that two people are used and the sheet is lifted directly up and does not slide on the sheet below. (Any sliding of one sheet on another may cause scratching on the sheet).