HIGH PERFORMANCE PLASTICS

MACHINING GUIDE

The general machining techniques used for plastics are similar to those for metals. In fact, ordinary metal and, in some cases, wood machining tools are used. However, compared to other materials, there are significant differences in the behaviour of plastic materials undergoing machining. To compensate for these differences, the cutting tool settings, speed and movement must be altered. The techniques and tool angles are provided for use as a general guide.

THE DIFFERENCE BETWEEN METAL AND PLASTIC

The main difference between metals and all plastic materials is in the behaviour of plastics during machining due to thermal expansion. Plastics are thermal insulators and do not evacuate the heat produced in the machining zone. If the heat is not dissipated, thereby increasing the temperature, the material expands and increases friction with the tool, further increasing the thermal production levels. This deteriorates measurement accuracy during the operation. These alterations are difficult to calculate or forecast in terms of tolerances because the material suffers partial annealing caused by the heat and does not return to its initial size after cooling. This is why machining must be carried out in two steps ; firstly rough machining to approach final tolerances, and then slow and accurate machining for the finish.

High speed operations and the removal of large quantities of material at the same time generate stress and high temperatures in the material which result in the worked part being misshapen and warped. The temperature must be kept low using a cooling liquid or, if this is not possible, by using slow machining speeds to remove small quantities of material.

Large size bars that require major machining suffer specific problems because significant stress is generated during machining, causing the deformation or movement of the parts when they are machined. It is imperative to eliminate these stresses. To guarantee the stability of the end product during use, the machined part must be annealed a first time before cutting and then again after finishing.

COOLING LIQUID

It is essential to minimise the heat produced using a cooling liquid. It is preferable to use a soluble oil type cooling liquid. During high speed operations, the cooling liquid must be used to dissipate the heat and remove the shavings.

CUTTING TOOLS

They must always be correctly sharpened. They must have sufficient clearance for the cutting edges to be the only area in contact with the material. This allows the elastic overlap and prevents friction which deteriorates the final tolerances. Generally, high speed or tungsten cutting tools are suitable.
For all materials that have a material charge, we recommend "diamond" cutting tools. These tools make it possible to reduce tool wear and to obtain a better surface condition on the part.

It is essential to correctly hold the part during machining to avoid bending.

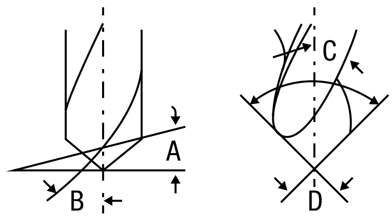
DRILLING

Drilling rate: **2 m/sec**
Progression: **0,127 mm - 0.254 mm per rotation**

For holes that completely cross the part, progress must be slowed down near the end of the hole to prevent the drill bit from causing ripping with chips or shavings on the other side. To drill deep holes, regularly withdraw the drill bit to encourage the cooling process and to clear the shavings from the drill flutes. To drill large diameter holes, a starter hole is recommended.

Drilling geometry:

Orthogonal cutting angle B:	0°
Sharpening angle A:	10-15°
Helical angle C:	30°
Tip angle D:	118°



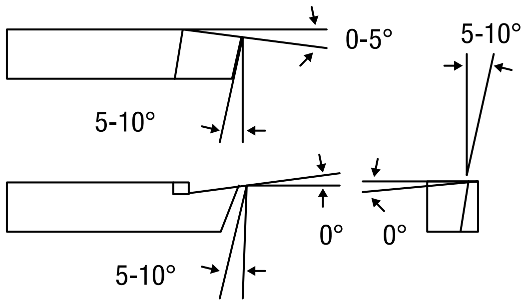
Drilling plastic material parts is the machining operation that has the highest risk of issues caused by the generation of heat. Even if an experienced and careful operator can machine without fluid, it is recommended to use a water-based cooling liquid when drilling. An unusual skin effect has been found on extruded strings that can cause cracking issues when drilling or cutting with a saw. We recommend the removal of remove about 0.020"/0.03" of surface material from the external diameter before drilling (annealing can also help). Furthermore, it is recommended to grind the drill bit tip with an offset of 0.005" from the axis to reduce the friction caused by the drill bit faces. Furthermore, if the cutting edges are ground to obtain an orthogonal cutting angle of zero for a flat width of 0.127 mm - 0.381 mm, the drill bit will tend to have less "bite".

TURNING

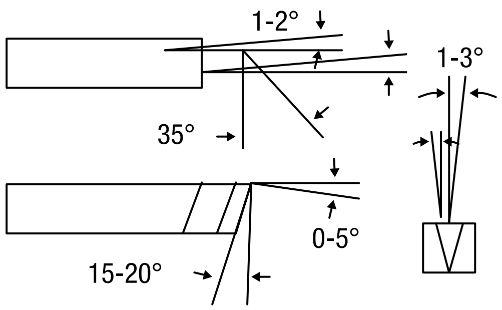
Cutting speed: 2 to 3 m/sec
Progress: 0.127mm / 0.28 mm per rotation

Here again, a sufficient quantity of cooling liquid must be provided to keep the part being worked on at a low temperature. Cutting speed must be low to reduce stress.

The recommended geometry of single cutting edge tools and grooving tools is shown below:



Outil tranchant



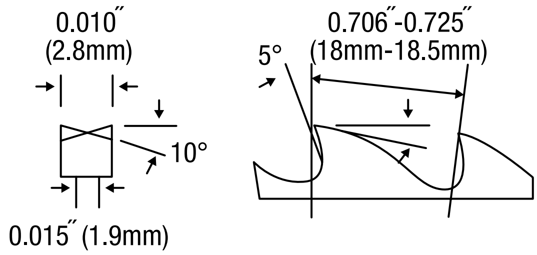
Outil à saigner

SAWING

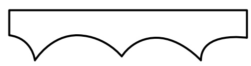
Circular saws are not suitable to cut large cross sections greater than 25 mm. we recommend a band saw for all sizes.

Hand sawing is possible using a fine toothed saw. However, frame saws risk producing a lot more heat ; band saws are more suitable because the band length dissipates the heat that is generated. Band saws can be used for irregular or curved borders as well as for straight cuts. American saw teeth with 10 to 12 teeth per inch (25 mm) give the best results. Plastics tend to close up behind band saw or frame saw cutting edges if there is not enough space. Twin-metal blades reduce friction and improve the finish. Circular saws of a diameter between 225 to 300 mm can be used. These blades must have enough space to reduce the friction between the saw and the part being cut. See the diagram below.

See the diagram below:



Scie circulaire



Scie à ruban

The teeth must be of the reinforced type, spaced from 10 to 12 teeth per inch (25 mm). Cutting lubricants and cooling liquids are recommended, preferably using water-soap solutions. To make the work easier, shavings and waste can be removed using blown air or suction. The cutting speed is high, but only experience can dictate the correct cutting speeds for the material being worked, the shape, the saw being used and the type of teeth. Avoid forcing the progression of the blade as this causes it to heat, to rub the material, creates an excessive load on the saw blade, a bad cut and accelerated saw wear.

MILLING

Cutting speed: 2.5 to 3.5 m/sec
Ascending milling is preferable because it eliminates burrs.

Conventional mills are suitable for milling extruded materials without an added charge. Sprayed air/oil cooling liquid is recommended for all milling operations, it being agreed, however, that a water based cooling liquid is more suitable when milling deep holes or pockets. The part being worked on must be solidly fixed and supported during milling to prevent it from collapsing under the pressure of the milling tool.

Using conventional mills, slow progress will make it possible to achieve relatively smooth surfaces. However, when the surface finish is critical, the use of single tooth mills is recommended.

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