

Technical manual, Novembre 2003

Vivak[®] and Axp[®] Solid Sheets

Forming

1. Cold forming

Cold bending

All Vivak[®] and Axp[®] sheets can be subjected to cold bending with a minimum radius of 150 times sheet thickness.

Minimum radius = 150 x sheet thickness

Thermoforming is recommended for smaller radii.

Cold brake

Vivak[®] and Axp[®] sheets can be cold formed. The best results are achieved with a rotating bending machine. Cavity folding is possible up to a thickness of 2 mm.

The relaxation immediately following the cold folding process means that the sheet has to be overstretched by approximately 25°. The internal and external stress levels take a few days to become balanced with the parts only then taking on their final shape.

The sheet should be folded parallel to the extrusion direction marked on the masking.

Bear in mind that cold brake forming places high stresses on the edge areas of the material. Avoid the use of aggressive chemicals, particularly with cold brake formed and cold bent parts.

The use of cold folding should be restricted to thin Vivak[®] and Axp[®] sheets.

2. Thermoforming

Protective Masking

Vivak[®] and Axp[®] sheets are provided with a PE masking film to protect the smooth surfaces from damage during transport and fabrication.

Please leave the film on the sheet during machining. Solar radiation and weathering may influence the properties of the film and make it very difficult to remove later on (possible formation of adhesive residues).

Our standard protective masking film is not suitable for exposure to thermal loads, and does not allow thermoforming with good results. The film should therefore be removed from the sheets before processes such as drying, hot line bending and/or thermoforming.

We have specially manufactured, unprinted grades of film that allow the sheets to be fabricated with the protective masking left on.

Vivak[®] sheets can be thermoformed even at low temperatures (120 to 180 °C).

However, at temperatures the Axp[®] sheets tend to crystallize resulting in whitening. It is therefore important to ensure short heating times and rapid cooling of the molded part to preserve the transparency of the material. We recommend conduction trials first.



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Pre-drying

Vivak sheets do not need to be predried.

Hot line bending

Hot folding is a relatively easy forming process for the production of uniaxially formed parts. The Vivak[®] and Axp[®] sheet simply requires local heating to approx. 100 °C.

The Vivak[®] and Axp[®] sheet IR-Heizstab + Reflektor heaters or heating elements in a linear manner (see Fig. 1). As soon as the ideal temperature is reached, the sheet is removed from the heating element, folded, placed in the mold and clamped into position. The desired shape should be fixed until the material rigidifies.

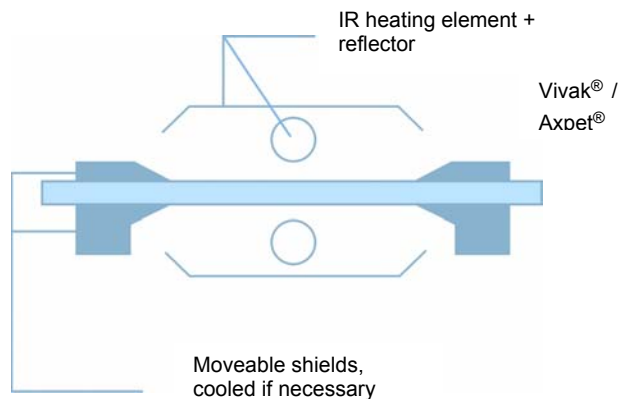


Fig. 1: Hot line bending

If using one-sided heating, the Vivak[®] sheet must be turned over several times to guarantee even heating on both sides. With sheet thicknesses of 2 mm or more and when producing large numbers of units, we recommend simultaneous heating of both sides using a sandwich heating appliance. By adjusting the heating width using the shields (see Fig. 2), various different bending radii can be achieved, although a minimum bending radius of 3 times the sheet thickness should not be undershot.

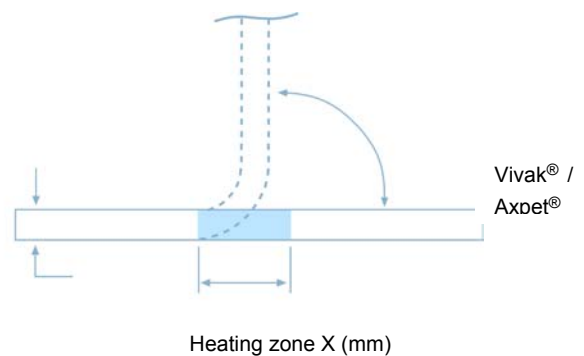


Fig. 2: Adjustment of heating zone

Please note that excessively high temperatures can lead to whitening in the heated area. Local heating creates stresses in the finished part. Care should be taken when using chemicals with bent formed parts.

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Heating during thermoforming

To achieve compliant formed parts, the Vivak[®] and Axpet[®] sheets should be heated evenly as part of a controlled process to a temperature of 100 to 160 °C. The best forming precision of the parts is achieved at the upper end of the forming temperature range.

Vivak[®] and Axpet[®] sheets cool quickly, so that we recommend that the sheets be heated directly on the forming machine and not – as is frequently done with other thermoplastics – in separate air circulating ovens.

For heating the Vivak[®] and Axpet[®] sheets we recommend IR heating systems, if possible two-sided, which can be heated up relatively quickly. The advantage of two-sided heating lies in the more even and quicker heating of the material. This enables shorter cycle times and is more economical.

This reduces the risk of crystallization by Axpet[®].

Cooling the finished part

It is very important that Vivak[®] and Axpet[®] material is cooled quickly. It should be cooled using compressed air or – where possible – water fog mist until the parts are completely cooled. It is very important that Axpet[®] material is cooled quickly.

Vivak[®] and Axpet[®] shrinks by 0.4 % upon cooling.

Male forming

You can stretch simple, uniaxially curved mouldings with large bending radii. The Vivak[®] and Axpet[®] sheets are heated to the correct temperature in an air-circulation oven and rapidly conveyed to a mould heated to approx. 55 °C.

The inherent weight of the sheet or the exertion of slight pressure using gloves or fabric is sufficient to shape the sheet over the male mould.

Afterwards, the sheets must be subjected to air cooling. Caution: draughts may cause warping and internal stress.

We advise you to remove the masking film before heating the sheet in an oven.

Thermoforming

Depending on the size of the production series and desired surface quality, tools made from different materials can be used. Please note that the material selected will influence cooling time and surface properties. The mold should be sufficiently rounded.

Vivak[®] sheets effectively reproduce details.

We recommend not polishing the surface of the mold but slightly matting it to avoid impressions on the formed part.

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We recommend not polishing the surface of the mold but slightly matting it to avoid impressions on the formed part. When constructing forming molds, allowance should be made for shrinkage of 0.4 %. Special materials are available for producing porous forming tools without vents.

Male and female tools

The decision on whether to use a male or female tool depends on the application. To achieve a better surface quality on the outer side of the finished part, use of a female tool is recommended to attain greater detail.

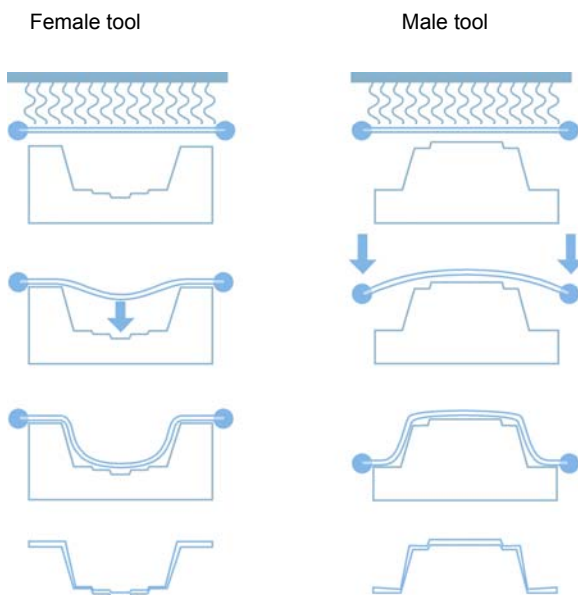


Fig. 3

Free blowing or free drawing

This technique is used to form domes. Blowing without a countermold involves working with air pressure, whilst the thermoforming process without a countermold is carried out in a vacuum.

To produce perfect moldings, the sheets should be evenly heated. At a sheet temperature of approx. 80 °C, the part retains its desired shape and can be removed.

	Molding temperature
Vivak [®]	120 – 140°
Vivak HT [®]	140 – 180°
Axp [®]	100 – 140°

For the risk of crystallization is the male forming of Axp[®] sheets not recommended.



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Thermoforming Tips

Problems	Possible causes	Solution	Hot bending	Thermo-forming	Free blowing/free drawing
Badly formed parts	Sheets too hot	Reduce heating	•	•	•
	Production cycle too long	Shorten cooling period		•	•
	Vacuum speed too fast	Limit vacuum		•	
	Sharp edges	Round off edges		•	
Thin edges	Sheets too small	Use larger sheets		•	
Wave formation	Uneven heating	Check heating surface		•	
	Too small a distance between molds	Increase min. distance between parts		•	•
	Vacuum too fast	Limit vacuum		•	
	Sheet surface too large	Distance between clamp and tool < 50 mm		•	
Reduced details	Insufficient vacuum or compressed air	Increase vacuum or compressed air or check for lack of tightness		•	•
	Sheet temperature too low	Increase heating		•	
Molding sticks to mold	Mold too hot	Reduce mold temperature		•	
	Release angle too small	Release angle > 4°		•	
Impressions	Mold surface too smooth	Slightly matt tool		•	
	Sheet temperature too high	Reduce heating/heating time		•	
Surface defects	Dust on sheet or mold	Clean with ionized compressed air		•	•
Uneven finished Parts	Heating/cooling	Check for draughts; check heating		•	•
	Release too fast	Sufficient cooling of part		•	
Tears or cracks	Excessive stress	Slow heating, heat large surface area	•	•	•
Crystallization (by Axp [®])	Sheets too hot	Reduce heating	•	•	•
	Production cycle too long	Shorten cooling period		•	•



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3. Finishing

Polishing

Flame Polishing

Propane, butane or other types of gas burner may be used for flame polishing. This technique can produce excellent results but requires experience and ongoing practice. Make sure that the material does not crystallize. Cracks may appear in the polished area in the long term.

Buffing

Medium-density reiter polishing wheels with a peripheral velocity of 20 to 30 m/s can be used to polish Vivak[®] and Axp[®] sheets with alkali-free polishing pastes. A clean polishing wheel without polishing paste is then used to complete the polishing process. Large-surface polishing should be avoided.

Decorating

Before treating Vivak[®] and Axp[®] sheets - e.g. by coating, screen printing or thermoforming - we recommend removing any loose particles of dirt or dust adhering to the surface using ionized. The matt side of NR is not suitable for printing.

Transfer printing

Vivak[®] and Axp[®] sheets and finished parts can be printed using transfer printing.

Screen printing

Vivak[®] and Axp[®] may be printed with standard screen printing equipment and inks suitable for thermoplastic polyesters (PET). The ink manufacturer's recommendations should be followed.

Vivak[®] and Axp[®] sheets can be printed with Uvcured inks. The short-term UV radiation has no impact on the physical properties. The maximum application temperature of 65 °C should not be exceeded during the drying process.

Coating

After prior cleaning, Vivak[®] and Axp[®] may be coated without being pre-treated. The coatings must be suitable for use with Vivak[®] or Axp[®].



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4. Cleaning

Vivak[®] and Axp[®] has a pore-free surface to which it is difficult for dirt to adhere. Dusty parts can be wiped with water, a soft cloth or a sponge but should **never be rubbed when dry!**

For thorough cleaning, we recommend a non-abrasive detergent. Razor blades or other sharp tools, abrasive or strongly alkaline detergents, solvents, leaded benzene and carbon tetrachloride should not be used.

The only way to achieve effective cleaning without streaks is to use a microfiber cloth that is simply dampened with water. In the case of a greater build-up of dirt or greasy stains in particular, benzene-free pure petroleum spirit (cleaner's naphtha or light gasoline) may be applied.

Splashes of dye, grease or residual sealing putting etc. may be removed using a soft cloth soaked in ethyl alcohol, isopropyl alcohol or petroleum ether (boiling point 65 °C) and gentle rubbing prior to curing. Rust marks can be removed with a 10 % solution of oxalic acid.

Vivak[®] and Axp[®] has good electrical insulation properties resulting in electrostatic charging and the attraction of dust particles.

Before treating Vivak[®] and Axp[®] sheets we recommend removing any loose particles of dirt or dust on the surface by blowing with ionized air. The particles cannot be removed using a normal compressed air gun or a cloth but will generally just be moved around

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