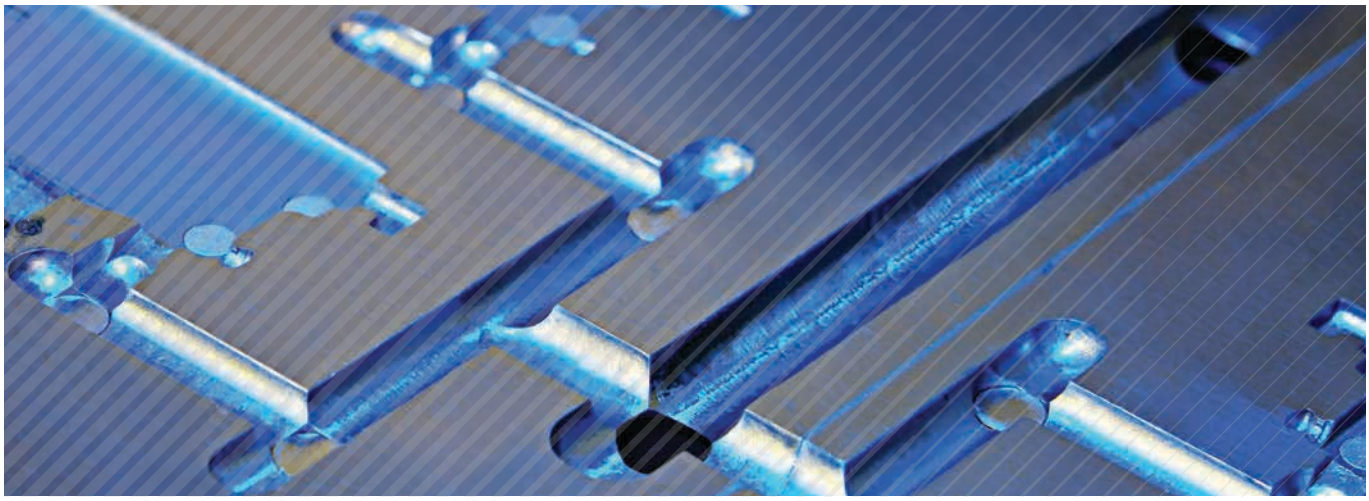

DISTORTION OF POLYETHYLENE MOULDING

Uneven shrinkage due to poor mould design or processing conditions can lead to distortion or warping in moulding.

The explanation of this warping is mainly due to polymer orientation and differential crystallisation across the moulding (see Figure 1 below).

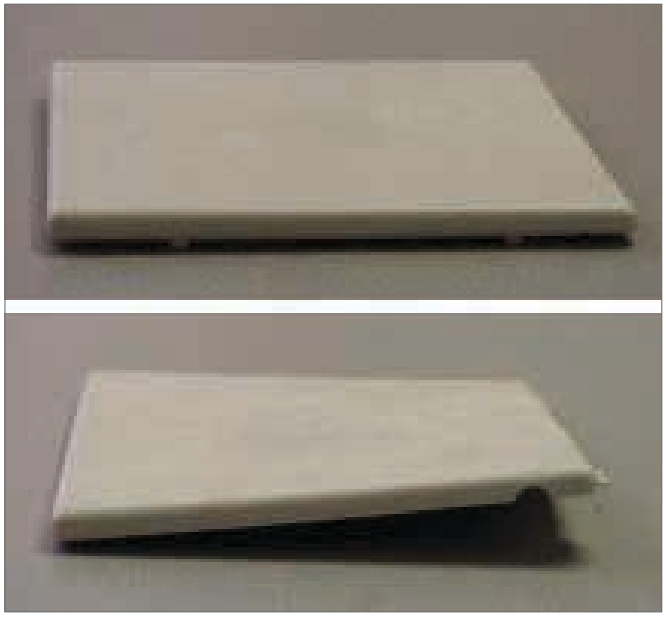

Figure 1: Processing Conditions Causing Polymer Orientation which Leads to Warping

When the mould is first filled, a hot moulding will be made. As the mould fills, the long thread-like polyethylene molecules would tend to be oriented in the direction of flow i.e. radially outwards, but as the moulding cools a radial shrinkage will occur which is greater than the shrinkage at right angles to the radius. Thus when the moulding is cold it will inevitably warp due to the difference in the stresses generated in the part. All methods of preventing the distortion of flat articles without rims or walls depend, in essence, on reducing this difference.

MOULD DESIGN

To reduce the warping in articles, multiple pin gates must be used. This system relies on reducing the length of each radial flow path and inter-mingling the melt streams, and is often adequate for low and medium density polyethylenes (see Figure 2 on the next page).

For rectangular shapes the ideal gating arrangement is a fan gate (see Figure 2) all along one edge so that flow takes place mainly along the major axis. The moulding will still shrink to a greater extent in the direction of flow, causing the major axis to be proportionately shorter than the minor axis when the moulding is cold, but it will not distort. To position a gate at the end of a rectangular article is relatively easy on small mouldings to be made on multi-impression tools, but it is not so easy on large single-impression moulds. Some machine manufacturers can arrange for off-set injection points by altering the nozzle position from the usual central point and this is a very useful feature if large flat articles are to be made from high or low density polyethylene.

Figure 2: Photos Illustrating Multiple Pin Gating and Fan Gating

> THE BEST COMPROMISE IN MOULDING CONDITIONS HAS BEEN FOUND TO CONSIST OF A VERY HIGH MELT TEMPERATURE AND A VERY COLD MOULD

CHOICE OF POLYMER

The likelihood of warping increases rapidly with increasing density of the polyethylene used: high density polyethylene mouldings warp more than those of medium density, which in turn warp more than those of low density polyethylene. If flexibility in the moulding can be tolerated, a polyethylene of low density (e.g. 0.916 g/cm^3) will give the least distortion.
If the mouldings are not to be stressed and physical strength is not important, e.g. sink trays and many box lids, the best results are obtained from a low density polymer of high MFI (22-70 g/10 min, according to the lack of strength which can be tolerated).

MOULDING CONDITIONS

Obviously the ideal moulding conditions would be those which give no orientation in the moulding and thus no warping. In practice such conditions can never be achieved. It has been found that long injection dwell times and high pressures, because they reduce the overall level of shrinkage, can often reduce warpage, but these conditions give rise to packing stresses and may cause the mouldings to split across the sprue. The best compromise in moulding conditions has been found to consist of a very high melt temperature (i.e. 50°C higher than that normally used for a given polyethylene) and a very cold mould (i.e. as cold as can be achieved).

TROUBLESHOOTING GUIDE – DISTORTION

Causes	Potential Solutions/Actions
Moulded in stress/ orientation	Increase melt temperature. Use increased melt flow index grade of PE
Ribs too thick	Employ more, but thinner ribs to impart stiffness
Variation in thickness	Use ribs for varying thickness rather than solid walls
Variation in mould cooling	Increase cooling channels in difficult to cool areas
Sink marks	Increase second stage pressure and or time
Gate freezing off too quickly	Increase gate size

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