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SWITCHING ON TO BIOPLASTICS

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MATERIALS HANDLING UPDATE

MOULDING THIN WALL PARTS

Weld lines have a negative impact on part quality but their presence can be predicted using flow analysis tools as part of the DFM process. **André Eichhorn** explains how

Plan to manage weld lines

Aside from part deflection and distortion, there is another critical factor that has a huge impact on the quality of an injection moulded component – weld lines. Weld lines do not only affect the visual quality of a part, they are also a major cause of mechanical weakness in the product and this can give rise to costly failures during assembly or in service.

All of those that have spent time working in the plastics industry will have experienced parts that always tend to break in the same position. One of the major reasons for such failures is poor weld line quality. When such problems emerge in parts in production, it is sometimes possible to improve the situation by applying a structured injection moulding process optimisation routine and adjusting process parameters such as injection speeds, melt and mould temperatures to achieve the best mechanical performance.

While modifications to the moulding process can resolve weld line issues, or at least minimise their impact, processing around design issues is rarely a good use of process engineering time. Far better that we avoid weld line issues in the first place by giving them due consideration in our DFM procedures.

With the tools available to design engineers today, it is quite easy to predict where weld lines will appear. But let us first consider the basics. Weld lines are formed where two melt flow fronts meet and can be caused by a number of factors, including the use of multiple gate points or by mould features that interrupt and divides the path of the flow front.

A typical example is often seen where the melt is divided in the mould cavity to flow around a 'hole'. The main image above shows a weld line which has formed where the divided melt flow fronts meet again after encountering such a mould feature. This specific example resulted in visual issues, as well as considerably reducing the strength of the part. The result was that the moulding broke very easily and failed the required drop tests on almost every occasion.

In this case, optimising the injection moulding process did not resolve the problems so the component design was analysed in a further DFM loop. Significant changes were made to the tooling design, involving costly relocation of the gate points and other tooling

Main image: The visible weld line on this part shows the typical characteristics of inconsistent melt flow front temperatures

Figure 1: Weld line location can easily be predicted in the part design process using flow analysis software

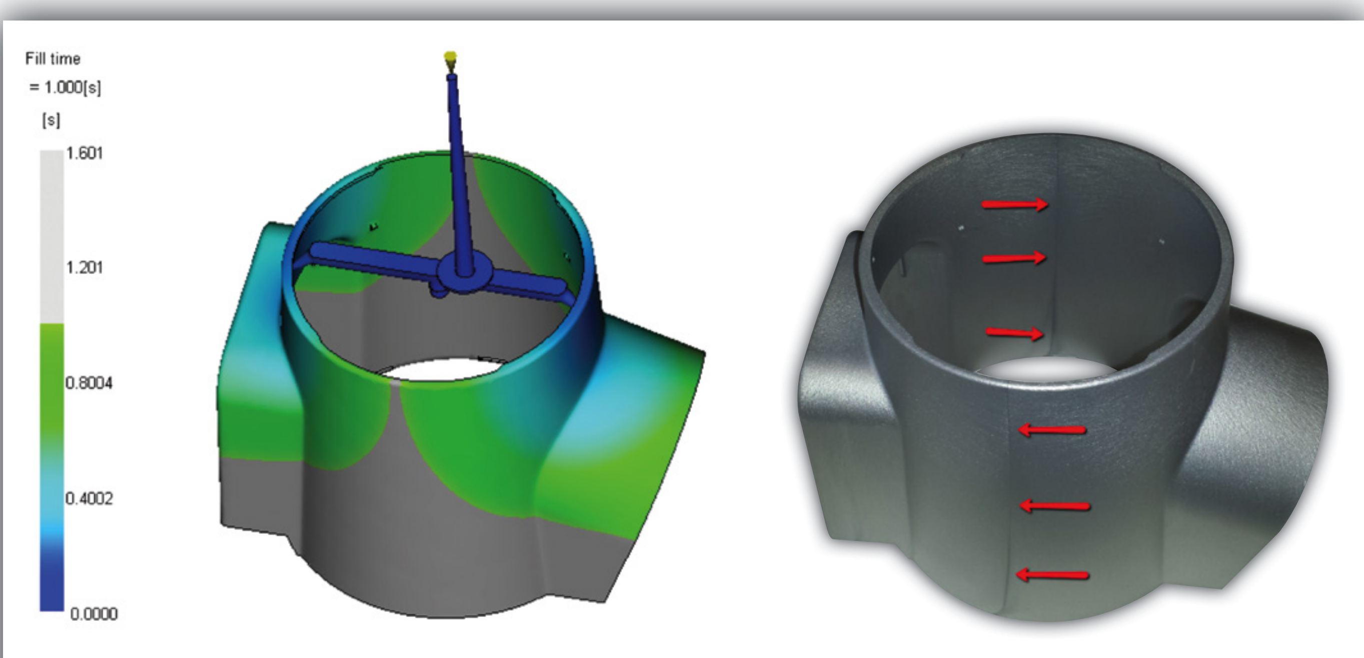

Figure 2: Metallic pigment flakes in this ABS component highlight the weldline, as predicted in flow analysis studies.

modifications. If this analysis had been carried out in the first place, the additional costs and delays on the ramp up of the complete device could have been avoided.

So, what can be done to minimise weld line issues during the DFM process? First of all, consideration should be given to the material to be moulded. For reinforced materials such as glass fibre reinforced PA it is a big disadvantage in any case to have weld lines as the resulting fibre orientation will show up in both visual and mechanical terms.

It is also important to minimise the number of gate points onto the component. This becomes even more important where there are thin wall thicknesses on the flow path as high injection speeds generally result in poor weld line strength (this was the case for the component mentioned earlier).

The positioning of the gate points is also an important factor. It is very important that all weld lines meet at the same time during the mould filling cycle. This is because of the switchover from filling to packing pressure, which can only ideally be done once the cavity is fully filled. If some weld lines meet early in the mould filling cycle then the flow fronts may start to freeze off early and, as a result, will not receive the full amount of packing pressure required to obtain optimal mechanical properties.

This latter point may sound like a processing issue rather than design consideration, but this understanding of the moulding process is very important if weld lines are to be considered properly during DFM.

Modern flow analysis software provides the essential tools required to check how weld line behavior is effected by injection speed, flow-front temperature, cooling time, final point of fill, and freeze off of the gate. Some applications also offer a module allowing fibre orientation at the weld line to be modelled. By knowing where weld lines will be formed, information can also be passed on to the toolmaker to help in deciding where to place venting features.

The following list highlights some of the key points that need to be considered when looking at weld lines as part of a flow study of any component and gating system design:

- Limit the number of gate points and calculate the right gate and runner size;
- Place all weld lines on the last point of fill so that sufficient packing pressure can be applied to each;
- Maintain a maximum 10°C temperature difference between flow fronts;
- Avoid fast filling speeds (especially on thin wall thicknesses as high shear rates have a negative impact on the mechanical properties of weld line);
- Consider the presence of fillers and pigments in the material which may cause highly visible cosmetic issues (Figure 2).

About the author:

André Eichhorn is general manager of Germany-based AST Technology. This is the latest instalment in a series of articles in which he discusses how product manufacturing problems can be overcome at the start of a project by the application of Design for Manufacturing techniques. You can read the most recent articles in this series **here**, **here**, and **here**.