# PLASTICS & PLASTIC PARTS: Getting a Handle on Gas-Assist

*by mark howards*
*Posted: August 1, 2005*

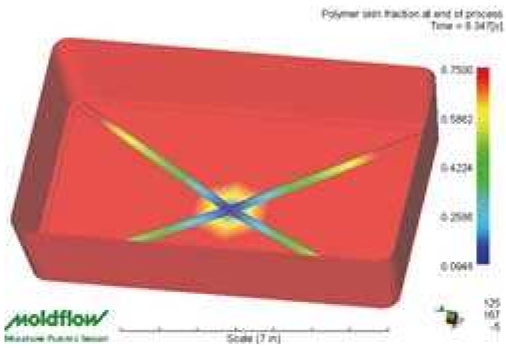


*Fig. 1.*

Most design engineers think of gas-assisted injection molding in terms of handles and other thick and chunky parts. In the appliance industry, the thermoset versus thermoplastic gas-assist “battle for the handles” has been going on for a long time and the truth is, they probably are both good solutions. But what about other applications for thermoplastic gas-assist?

Too often gas-assist is thought of as merely the answer to the question how to make a part hollow. In fact, for most hollow parts, except handles, gas-assist is really not the most suitable application. Think of gas-assist as appropriate for parts that have long flow lengths, areas which are difficult to pack or parts susceptible to warping.

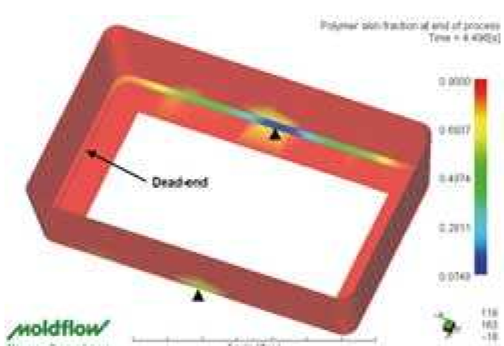


*Fig. 2.*

There are a myriad of uses for gas-assist that do not include handles. Aside from automotive applications which have also been predominately thicker parts, such as door handles and sideview mirrors, another early application was for television housings. TV screen sizes that were considered innovative 10 years ago have become commonplace, as new technology is pushing the envelope for larger TV screen sizes, and, subsequently, for the plastic cabinets that must house them.

There are also many other applications featuring large, injection molded housing parts that are good candidates for utilizing gas assist methods. Such applications might include water softeners, fitness equipment, medical equipment, business machines and vending machines. Many structural foam applications are relatively simple to convert to a gas-assist process. Even some thermoformed parts may also may be suitable for conversion to gas assisted injection molding.

Gas-assist is a great way to break conventional design rules and get away with it. For example, it is possible to design bosses and ribs at nominal wall thickness or greater while still avoiding sink marks. Several benefits of gas-assist also reduce part costs by reducing cycle time. Gas-assist should not be thought of as a process different from injection molding, but rather as a method that extends the capabilities of injection molding much the same way that overmolding creates new possibilities.

**Simulation**

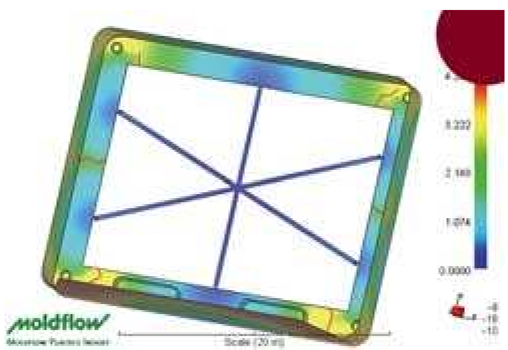



*Fig. 3.*

Plastics analysis tools, such as Moldflow software, can be valuable in assessing the feasibility of a gas-assist application. This may be as simple as evaluating the fill pattern and cooling rates of a part. Unlike conventional molding where following basic design rules generally leads to a good part, the use of gas-assist requires the part designer to be more in tune with the manufacturing process.

A basic rule of gas-assisted molding is that the gas will find the path of least resistance inside the mold. Often this will be through the thickest or hottest section between the gate and the last location to fill. A common mistake is to create a thick section in the part and expect the gas to hollow it out. But without considering the gate location and filling pattern, the designer may not achieve what was intended.

Fig. 1 shows what happens when this concept is not properly understood. This engineer wanted to strengthen the structure of this center-gated part by adding gas channels. While the X pattern is a good idea, the channels around the inside of wall intersections will not work. The flow of the gas would have to be perpendicular to the flow of the plastic. This design will result in solid channels and not achieve the desired result.


*Fig. 4.*

Another common problem in plastic part design is the "dead end," as shown in Fig. 2. Dead ends are created when the flow of two advancing gas fronts meet. In such cases, the resin between the advancing gas fronts has nowhere to go, so the situation creates a solid slug of plastic. While the concept is easy to visualize on this sample part, it is much more difficult to envision in a part design has complex geometry and requires multiple gas inlets. It is precisely in those more challenging cases that a molding analysis can be useful.

If initial analysis confirms the feasibility of gas-assisted approach, the next step is then a more detailed analysis that evaluates the gas-assist phase. This provides valuable insight into gas channel sizing and placement. Analysis can be used first for basic process setup, then next, the gas channels can be fine-tuned by resizing them, shortening them or tapering them where necessary. This fine-tuning can improve the aesthetics of the final molded part.

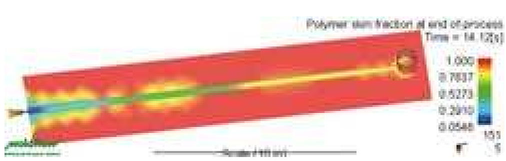


*Fig. 5, includes the two diagrams below.*

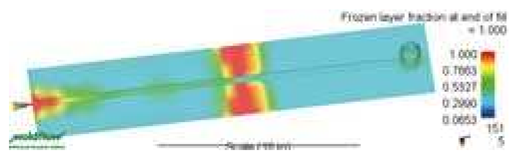
From the analysis standpoint, new capabilities exist that allow analysis with 3D tetrahedral elements as well as traditional 2.5D (mid-plane) and beam elements. While 3D is most useful on thick geometry, it can be also be used effectively on parts with complex louver geometry or thick-to-thin transitions. Moldflow software can be used to analyze virtually all gas-assist equipment, as well as both short-shot and spillover techniques.

What are the advantages of gas-assist on a large part such as a TV bezel? Using conventional molding methods on such a part would require multiple gates which would then result in multiple weld lines (Fig. 3). To mount the heavy CRT screen in the bezel would require the designer to selectively add ribbing and increase thicknesses to enable the bezel to support the heavy load. Using conventional methods will create a part whose surfaces require significant secondary operations to achieve a high quality appearance. With gas-assist it is possible to fill the part with only two gates. And the gas-assisted packing pressure on the boss and rib areas will eliminate sink marks. (Fig. 4)

It is always better to start off with undersized gas channels rather than oversized, because it will be less expensive and faster to increase their size than decrease them when making tooling adjustments.

Except for conversions of structural foam parts, engineers must design a part for gas assist. In addition to performing an analysis, seeking recommendations from applications specialists with the equipment suppliers will also help with the part's design.

## The process




As the gas-assist process has become more widely accepted, gas-assist equipment has become available at many more molders. More recently, it has become a relatively simple and inexpensive add-on to existing molding machines. Therefore, OEMs should have many sourcing options available.

For those not yet familiar with the process, the terminology relating to gas assist can be a little confusing, as there are multiple terms that appear to describe the same thing. Gas-assist designs may include overflow wells, spillover or overspill. A weak design could lead to fingering or permeation, which are undesirable effects. This shouldn't be confused with gas penetration, which is often referred to as the gas bubble, which is the result of a good design. A gas channel is often called an in-part runner.

In the past, licensing issues have often scared people away from developing new applications for gas assist, however, licensing issues are mostly non-existent if the designs don't involve spillover. With proper design, many parts, including handles, can be molded without spillover. For certain applications spillover may be required. In those cases the benefits derived from solving problems with gas assist will probably outweigh the licensing fees.

Spillover allows material from the part cavity to be pushed to a small cavity or overflow area upon injection of the gas. This overflow area can resemble a small runner segment or a larger puck of plastic. This method can be used to direct the gas where it might not otherwise tend to go, to help stabilize the process, or to help avoid hesitation lines on the part. Techniques that don't use spillover are commonly referred to as short-shot, gas-assist or local packing via gas pins.

Visual imperfections create another potential concern with gas-assist, but it is no reason to shy away from it. This may especially be the case with filled resins or certain colors. Often a quick test conversion on an old tool or input from the equipment suppliers can be a good resource for dealing with these issues. Virtually all resins can be used for gas-assist.

Gas can be injected into the part through the nozzle or through multiple, individual gas pins located throughout the part. Gas can be used with hot manifold systems and multi-cavity tools, although valve gates are usually required to keep the gas out for the hot portion of the tool. One should also remember that each gas inlet will result in a small hole on the part, which is one more reason a part designer should understand the manufacturing process.

Usually gas channels can blend into existing features. For example, they are often placed at intersecting walls or along the base of ribs. Hollow gas channels are typically around 2.5 times the thickness of the nominal wall. As the channels become smaller, they will have less of a tendency to become hollow, even though they can still be effective transmitters of packing pressure.

One of the simplest and most interesting aspects of gas-assist is the "manifold effect." When trying to pack a part's feature far from the gate with conventional methods, the pressure must be transmitted through the part walls, which results in a pressure gradient. This approach may require multiple gates, not only to successfully fill the part, but also to reduce the distances and improve packing. In this type of application, the gas channel serves a dual purpose. First, it functions as a flow leader during filling, and, secondly, as a pressure manifold during packing.

If a hollow section is formed by the gas between the gate and the feature that needs packing, then 1,000 psi at the gas inlet is 1,000 psi at the feature, even if it is 20 in. away. It may even be possible to pack the extremities of the part when large areas of the part are already frozen because the gas is still a gas, even though the molten plastic may have turned into a solid. (See Fig. 5). Another variation of this approach is to simply place a gas pin near the thick feature to create local packing pressure. In this case, the part may be packed conventionally with assistance from the gas pin.

**Benefits**


Gas-assisted molding can reduce the cost of a part by allowing it to be made on a smaller molding machine. Generally, packing pressures with gas-assist are about 25 percent of peak injection pressure. Also, since a short shot is delivered to the mold, peak pressure during filling will be significantly lower than with conventional injection molding. Since clamp force is a product of pressure and projected area, these two effects can reduce clamp force by 1/3 to 1/2 of that used to mold a part conventionally.

The gas-assist process also tends to produce parts with little warpage. That is because packing pressure and volumetric shrinkage will be far more uniform. That also reduces molded-in stress on a part. Parts made by with gas assist tend to stay flat over time after coming out of the mold.

So there may be a number of reasons to consider gas assist when faced with the challenges of a designing a large part or with the aesthetic concerns arising from the need for multiple gates. The benefits from using gas assist include:

- Reduced part costs.
- Improved appearance. Reducing the number of gates reduces the number of weld-lines, improves the appearance of the part and reduce tooling complexity and cost.
- Ability to break conventional design rules by making ribs and bosses thicker than the nominal wall.
- Add structural rigidity to part without increasing weight.
- Low warpage and low molded-in stress.