GAS ASSIST
CASE STUDY 322-8

POLYCARBONATE CONTAINER

Excerpted from "Gas Assist Injection Molding", by Paul Dier and Rick Goralski

Polycarbonate Container

A large container made of an experimental grade of polycarbonate resin.

In 1992, a molder approached us with the question of converting a part made of SMC (composite) resin, to an injection grade of thermoplastics. The part had to withstand the same types of crucial quality demands, but had to be produced with an injection molding machine. The product was to be purchased by a government agency and had quite a list of quality standards.

We met preliminarily at the molders to decide on the initial steps toward a successful campaign of conversion. The part weighed over 70 pounds in its SMC form and had nominal thickness of 6 mm. The goal was to retain the strength, while reducing wall thickness, improving surface quality, and molding this part in their 2500 ton press.

The dimensions of the part were as 50" height x 36" width x 30" depth, and nominal wall thickness was 6 mm. After looking over the designs of the existing part, we made the following observations:

1. We would like to manufacture this product with a single, center located sprue.
2. We would need a plastic resin strong enough to meet the field requirements of the product.
3. We would need to reduce the nominal wall thickness by at least 50%.
4. We needed to reduce the amount of secondary operations required to finish the part.
5. We needed to add gas channels to the part without creating interferences with the many mating doors and shelves.
6. We needed to develop a method of plugging the hole left by the entrance of gas.
7. Using the gas channel design layout, we needed to perform a mold flow simulation to determine the fill of the part.
8. We needed to find an experienced tool shop to build the mold.

After we addressed these issues, we were to present our case to the customer. The customer had been shipping product of SMC to the field for many years, and it was not going to be an easy sale without concrete proof.

Many mold flow simulations were performed on the part to show evidence that our design would work. We knew that the gas assist mold flows were primitive at the time, but would serve as a good sales point if they came out positive. That even a primitive version of simulation software was available allowed us to provide technical documentation to verify the project.

We approached the customer with the gas assist idea based on the obvious cost reductions, cycle time, part weight, and smaller machinery requirements. We also were able to propose much shorter lead times on product deliveries. The customer had an optimistic outlook on the proposal, and reluctantly agreed to look at additional details of the project. We needed to present a quotation for all of the requirements, so that he was able to monitor the cost implications.

We had the tool quoted at a very reputable company experienced in the building of gas assist tooling. We met with them twice to go over the preliminary drawings. We had an opportunity to build the tool out of aluminum, but at the time the cost of P-20 was about the same. We then chose P-20 as the desired tool steel, and designed the tool to incorporate a single sprue gate, negating the need for a manifold system.

The quote was submitted to the molder for approval. It came in where they had anticipated it to be. We double checked all of the requirements and they were covered. The tool shop also thought that the part would not fill, so they performed their own series of mold flow simulations. The simulations proved very positive. The tool shop could hardly believe the part would fill as originally laid out.

The customer was then provided all the necessary information regarding going forward on the project. After seeing the additional mold flow, the contention was to approve the mold for build.

Now it was time to follow the tool build through its entirety.

The tool build consisted of a few meetings prior to its completion, but for the most part, was fairly simple to finish. It was to produce a part with a 1.5 mm nominal wall, and where gas channels were located, overall wall thickness was to be 3 mm. The gas channel was to be cut in an **X** pattern initially, and if additional flow runners were to be required, they could be added at a later time. The main rule of thumb was to be followed, **steel safe**. After 18 weeks, the tool was built and ready for trial.

The tool was scheduled to run at a very notable tryout facility. The technicians employed there had a great deal of experience with gas assist trials. The tool was set in a 2500 ton press to simulate a production environment. The tool was slowly brought up to a fill of 85%. The remaining 15% was to be filled by the gas assist process. As initial shots proved out, the tool design had produced acceptable result. The only flaw in the process was using very high gas pressures to complete the fill. The process was set up as follows:

Gas Delay Timer	0 seconds
Injection First Stage	10 seconds at 6500 psi.
Injection Second Stage	3 seconds at 2500 psi.

The gas, again, was introduced to the part through the nozzle. This allowed for venting of the gas to occur using the molding machines' sprue break. The initial process provided parts that were able to run through a capability study. A run of 30 parts was taken so that statistical data could be compiled.

After the parts were measured and approved by the molders quality department, the cabinets were sent to finishing department for the fitting of mating parts. The gas channels did cause some interference to the mating shelves, but that was an item that had already been considered. The shelf tools were then modified to allow proper mating with the cabinet.

Along with the finished products, the capability study was sent with the shipment to the customer. The customer was then to perform their own quality testing on the products. After customer testing, the product was approved and orders were to follow. The molder now wanted to run the tool in their 2500 ton press. It was much older, and not much confidence was evident that the process from the tryout shop could be repeated. They set the tool and shots were again taken. The results of the run proved that the tool produced product equal to the trial shots, but some inconsistency of fill was realized without using the higher gas pressures. The molder, however, wanted to provide a much larger process window to work with. So we needed to address the gas channel design and determine how we could improve it, so that we could reduce the gas injection pressure and allow an easier fill to occur.

The part, as we know, had a nominal wall thickness of 1.5 mm. The **X** pattern gas channel worked quite well, but did not provide enough flow of resin and gas for the easiest possible fill.

We evaluated many different ideas and finally came up with the final gas channel configuration. **(See Fig. 322-8A)**

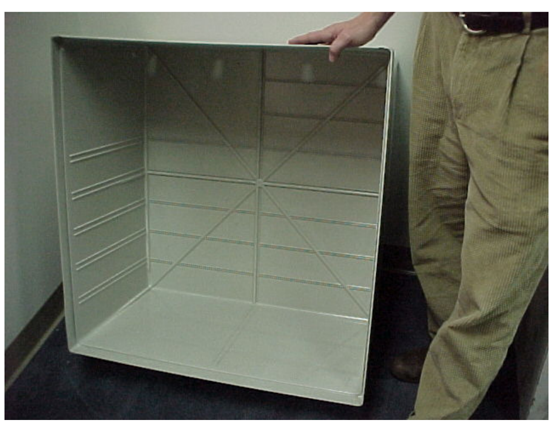

FIGURE 322-8A A cabinet made of sheet molding compound had to be converted to injection molding while maintaining a long list of quality standards.

We decided to add more channels vertically, and horizontally, over the back of the part. Having the additional gas channels in the mold would allow us to fill the areas of the part we were having the most problems with. The tool was sent to the tool shop for the modifications; when the tool work was completed, the molder set up another tryout. Again, the press would be the same 2500 ton press they had at their facility. When we started up the press, we immediately noticed that the filling pattern had been improved significantly, and we again filled the part with resin to the 85% mark.

We started with the original gas profile to assure fill of the part, then reduced the gas pressure to 3700 psi. We found that we could easily fill this part with the lower pressure and obtain the same results regarding the product. No further modifications were necessary. We could have again performed modification to the gas channels, but none were thought to be necessary. The parts coming out of the mold were better than anyone thought they would be, and the tool has been in production ever since.

As for the hole at the sprue, a metal type label was developed to conceal it, and provided the end customer to identify his product at the same time. Cycle time of the part is 230 seconds, and the part has been reduced in weight to 32 pounds.

Final facts indicated the following:

1. Cycle Time = 230 Seconds
2. Weight of Injected Part = 32 lbs, a savings of 38 lbs.
3. Part to original dimensions.
4. Finishing of the cabinet itself was no longer required.
5. The part was manufactured with a single sprue, no manifold system was necessary.
6. Nominal wall thickness had been reduced from 6 mm to 1.5 mm.
7. The mold produced acceptable product on its first run.
8. The molder was now able to justify the conversion of many other tools within his plant.

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