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Gas Assist Case Study 322-1

Freezer Door Handle

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

Freezer Door Handle

In this case study we will examine the process by which we converted an existing mold to gas assist. The mold was a two cavity freezer door handle. The part was being produced on a 350 ton injection molding machine, in two colors of ABS, white and almond. The parts were 9 inches in length, and approximately 1 inch in diameter, and were sub-gated into a 1/4" ejector pin at one end of the part. **(See Fig 322-1A)**

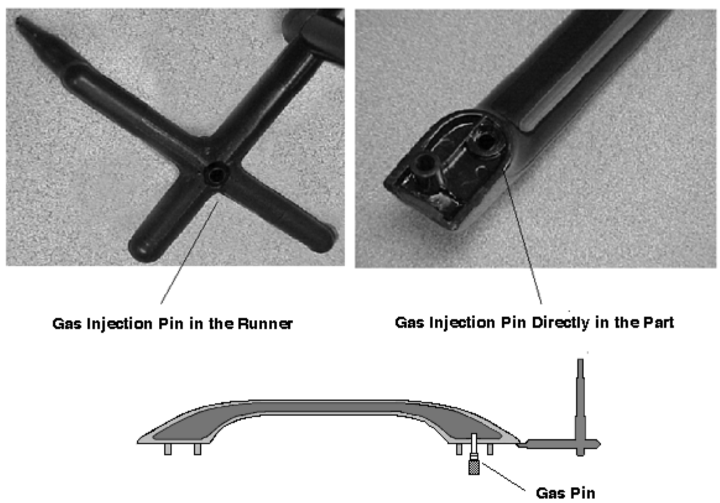

Fig. GP-1

FIGURE 322-1A When converted to gas assist, cycle time for this freezer door handle was reduced from 200 seconds to 105 seconds; shot weight was reduced from 261g to 192g; warpage, sink marks, and flow lines were eliminated; and scrap rate was reduced from 72 percent to 6 percent.

There were several problems that the molder faced when producing this handle by conventional injection molding:

1. A very long cycle time of 200 seconds, due to the thickness of the part.
2. Dimensional stability was unattainable. Due to the thickness of the handle, warpage occurred. Even with the long cycle time, the tolerance between the four mounting bosses could not be held.
3. Sink marks were evident no matter how long the cycle time. This problem was magnified due to the mirror gloss finish on the part surface.
4. Flow lines and jetting on the part surface.
5. The parts had to be submerged into a tank of chilled water to try and help cooling.

Due to these problems, the scrap rate was a staggering 72%. This mold had to run 24 hours a day, seven days a week just to try and meet production numbers. The high scrap count generated an excessive amount of regrind that could not be used. The molder informed us that they had lost more money on this job than they could ever hope to recover. They wanted to see if gas assist could produce this part more efficiently.

Upon evaluation of this handle, we were confident that we could solve most of their problems. We decided to introduce the gas through the nozzle, as this would require no immediate tooling modifications. The gas would be injected at the tip of the injection nozzle, forward of a resin shutoff valve to prevent gas from entering the machine barrel. The gas was to be vented, by using sprue-break. The start of gas signal was set at ½" before bottom. We reduced the current material dosage by 50%.

In order to have accurate shot control, the screw was set to bottom out with no cushion. It was also necessary to disable the cushion correction feature on the molding machine to maintain shot repeatability. The pack timers were set on the molding machine at zero. The hold timer was set at 0.5 seconds to prevent the screw from bouncing back after each shot. We then took 5 shots without gas. Each of the two parts was weighed to determine if the cavities were balanced, as proper balancing of each cavity is critical when using gas assist. The weighed samples showed a difference of six grams between the two cavities. At this point, we realized that we could expect limited results until the cavities were balanced. It was agreed that we would continue with the tryout and correct the problem later.

It was now time to start injecting gas. The cooling timer was reduced on the molding machine from 170 to 90 seconds. Our initial gas control settings were:

Gas Delay Timer	0.5 seconds
Injection First Stage	4.5 seconds at 2000 psi.
Injection Second Stage	3.5 seconds at 1500 psi.

All other pressure stage settings were not used. Our first objective was to get gas into the parts and establish the correct shot size. The first shot with gas was a blow through, meaning that there was not enough resin in the cavities to hold the gas inside. This is the equivalent of a short shot in conventional molding. We started adding a small amount of resin to each subsequent shot until the gas was held in the parts. We knew we had the shot size correct when we heard the sound of the gas escaping as the barrel was retracted during sprue-brake. We took five consecutive shots for evaluation.

These first parts were weighed for comparison. The weight of a conventionally molded shot was 261 grams. Our first gas assist shots were down to 198 grams. We already had produced some very encouraging results in the first few minutes of the tryout.

Upon visual inspection of the parts, we found there were prominent flow lines on the part surface opposite the gate area. Hesitation lines were also evident where the short shot stopped before the gas took over the filling of the cavity. As the parts cooled, cavity # 1 showed a bad sink at the end of the fill. Each of these problems would need to be corrected for this project to be successful.

The first problem we addressed was the flow lines. As these flow lines were at the gate end of the parts, the problem was occurring before the gas was introduced. To correct the problem we started experimenting with different resin fill speeds. The problem was that the part was gated into a 1/4 inch ejector pin. This ejector pin then flowed into a 1 inch diameter section of the handle. As the resin came in contact with the mirror surface of the cavities, it cooled and rolled over creating the flow lines. We were able to correct this problem, by introducing the first 3/4 inch of shot at a very slow rate of speed (0.2 inches per second). This allowed the resin to puddle into the cavity without the rolling effect. After the first 3/4 inch of shot we increased the resin speed to 1.5 inches per second.

In order to correct the hesitation lines, we adjusted the timing of the gas. The idea was to shorten the amount of time between the end of resin injection, and the start of gas injection. This would allow for the continuous flow of resin within the cavities without the split second hesitation. We started by decreasing the gas delay timer in one second increments. When we reached zero on the delay time, the condition improved, but did not completely go away. Next we tried increasing the first stage gas pressure. This seemed to help a great deal. We ended up with zero gas delay, a first stage gas pressure of 4000 psi for 0.2 seconds, second stage gas pressure 2000 psi for 4.0 seconds, with the third stage at 1500 psi for 3.5 seconds. This provided the quick burst of speed, at the correct time, needed to eliminate the hesitation lines.

Had we used gas injection pins in the mold, this problem would have been easier to correct, as we would have been able to inject gas and resin at the same time. This was not an acceptable option to this customer, so we managed to eliminate the problem with precise control of timing and pressure.

At this point, we had one acceptable part and one with a sink. To correct the sink, we needed to balance the tool. The mold was sent to the tool shop and flow restriction block inserts were placed into the runner system. Now the tedious job of balancing the cavities could be performed while the mold was running. We had a toolmaker grind the blocks while we weighed the cavities, and were able to get the parts within 1.5 grams of each other. This was sufficient to eliminate the sink at the end of the part.

We were now able to produce acceptable parts on a consistent basis; however, there were still improvements to be made. The gloss level of the part needed some improvement. They were running the mold on chilled water to help eliminate the problems that they had in conventional molding. With gas assist, this was not necessary. We changed to warm water on the mold set at 90 degrees. This not only helped the surface appearance, but also allowed us to reduce the part weight even more. We now had a capable gas assist process.

The final results of this conversion were:

1. The cycle time was reduced from 200 seconds to 105 seconds.
2. Total shot weight was reduced from 261 grams to 192 grams.
3. Warpage was eliminated.
4. Sink marks were eliminated.
5. Flow lines were eliminated.
6. Cooling water tank was eliminated.
7. Scrap rate was reduced from 72% to 6%.
8. Seven day production schedule was eliminated.
9. Molding machine capacity was reduced.

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