Cycle Time Reduction by 30% in Injection Molding: Liquid CO_2 Spot Cooling

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Introduction

In custom injection molding, time plays a key role to how much each part is worth; where conventional water cooling methods may take up to 40-60% of the overall cycle time. Vision Plastics sees this is as an opportunity to embrace a more efficient method of managing cycle time called CO_2 Spot Mold Cooling (SMC) technology. This injects liquid carbon dioxide (LCO_2) in controlled pulses through tiny capillary tubes into strategic areas of the mold. By supplementing existing water lines with this method of cooling, we can potentially decrease the cooling time by up to 50% and the overall cycle time by 30% in some cases.

Install and Implement

To prove out the CO_2 SMC technology, a test run was recently performed on an existing part (Figure 1). By burning a pocket inside the core pin, using Electrical Discharge Machining (EDM) process, stainless steel capillaries were fitted into hard to reach locations to cool thicker wall sections of the part (Figure 2 & 3) creating uniform temperature throughout the mold which will reduce the likelihood of cosmetic defects. One other advantage of the Spot Mold Cooling process is that chambers for the capillaries can either be designed during the initial tool design or be retrofitted in after the tool is built, giving flexibility to both the part and tool design process.

Figure 1: Molded test part.

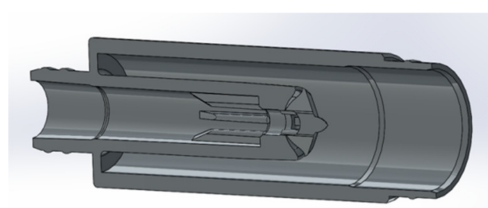

Figure 2: Section view of molded test part.

Trial Set-up

With each trial, a variation in pulsating cooling sequences was tested to determine the optimum process, all beginning with a 1.5 second delay accounting for the mold closing to allow the injection phase to occur. All of these adjustments were made on a separate control unit which communicates with the PLC (Programmable Logic Controller) of the injection molding machine indicating when the mold will close and begin the spot cooling cycle.

Test Results

Trial 1	Delay	On	Off	Cycles
	1.5 secs	0.1 secs	3 secs	5

Cooling Time: 11 seconds
Overall Cycle Reduction: 16.39%
Center Core Post Mold Temp (10 seconds): 220° F

Trial 2	Delay	On	Off	Cycles
	1.5 secs	0.15 secs	2.6 secs	5

Cooling Time: 9 seconds
Overall Cycle Reductions: 24.59%
Center Core Post Mold Temp (10 seconds): 232° F

Trial 3	Delay	On	Off	Cycles
	1.5 secs	0.2 secs	2.5 secs	5

Cooling Time: 9 seconds
Overall Cycle Reductions: 24.59%
Center Core Post Mold Temp (10 seconds): 232° F

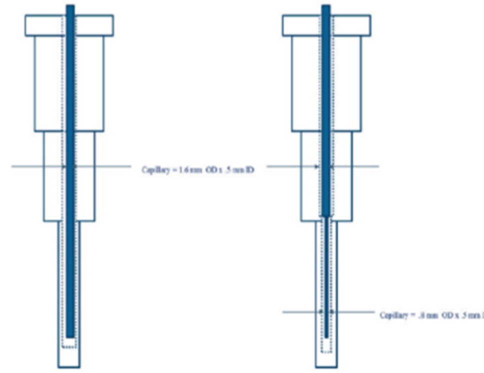

Figure 3: Capillaries inside core pins. Courtesy of Linde LLC

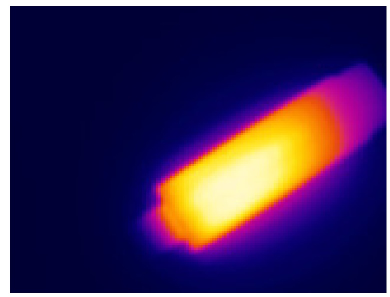

Figure 4: Infrared image of molded test part. Courtesy of Linde LLC

Trial 4	Delay	On	Off	Cycles
	1.5 secs	0.3 secs	1.8 secs	6

Cooling Time: 10 seconds
Overall Cycle Reductions: 20.59%
Center Core Post Mold Temp (10 seconds): 232° F

	Current Production Metrics	CO_2 Spot Cooling Metrics
Material	12 Melt Polypropylene	12 Melt Polypropylene
Injection time	1.0 Seconds	1.0 Seconds
Cooling time	15 Seconds	9 seconds
Overall Cycle Time	24.4 Seconds	19.4 Seconds
Cooling Time Reduction	N/A	40%
Cycle Time Reduction	N/A	20%

Table 1: Cycle time comparison between production and test run using Spot Mold Cooling technology.

With some additional tool modification allowing the capillaries to run deeper inside the core pin, reduce the mold temperature (Figure 4), and supplemental processing optimization methods, we can conclude a 50% reduction in cooling time and 30% reduction in overall cycle time is highly achievable (Table 1).

Estimated Cost Savings using SMC

Upon completion of the test run, a conversion table was created to quantify the impact part pricing would have given specified reduction in cycle time.

	Cost Savings per Part
15% Cycle Time Reduction	2.5%
20% Cycle Time Reduction	6.25%
30% Cycle Time Reduction	16.25%

Table 2: Cost per Part Reduction using SMC.

While Table 2 represents the savings of one particular part geometry, it can also serve as a benchmark of the potential cost reduction this technology can have with bigger and more complex parts.

Conclusion

To stay competitive in the custom injection molding industry, there are countless variables to take into consideration. With its low investment cost and easy installation, Vision Plastics recognizes the opportunity to utilize Linde's CO_2 Spot Cooling technology to significantly reduce overall cycle time and part cost.

About the Authors:

Joe Holt is the Engineering Manager at Vision Plastics since 2012 with over 26 years of experience in the plastics and injection molding industry.

Kevin Ng, a Project Engineer, was a recent addition to Vision Plastics' growing engineering team who graduated Western Washington University's Plastics Engineering program in 2012.