THE MADISON GROUP
PLASTIC CONSULTING ENGINEERS

From the TMG Solutions Archives: Lightweighting of a Plastic Container

Keywords - Lightweighting, Virtual DOE, Injection-Molding, Simulation

Problem

A customer wanted to identify the process sensitivity of a polyethylene injection-molded container. The primary objective of the analysis was to minimize part wall thickness while maintaining a clamp force requirement below 6,000 US tons.

Evaluation

Injection-molding simulation was used to evaluate the manufacturability of the container over a range of nominal wall thicknesses. Virtual DOE was coupled with the injection-molding simulation to analyze the effects of melt temperature, mold temperature, injection time, pack time, and pack pressure on the manufacturing process. This coupling allowed for the analyst to evaluate the sensitivity of each variable on the manufacturability of the part.

The virtual DOE revealed that longer injection times, Figure 2A, and higher melt temperatures, Figure 2B, were required to maintain a reasonable injection pressure while reducing the part wall thickness. The same relationship, longer injection times with higher melt temperatures, was shown to minimize the clamp force for the part, Figure 3. Integration of the response surface plots shown in Figures 2 and 3 revealed that the part wall thickness could be reduced by 10% while maintaining a reasonable clamp force.

The DOE also revealed that part thickness is the driving factor for part weight, Figure 4A. Although that is expected, the trends displayed in Figure 4B illustrate the packing time and pressure do not significantly affect part weight for this mold. The wealth of information generated with DOE analysis, allowed for informed decisions to be made about manufacturability and cost savings.

Conclusion

Virtual DOE analysis showed that the wall thickness of the container could be reduced by 10%, and still be successfully molded in a 6,000 US ton press. Coupling DOE analysis with injection-molding simulation allowed for the key variables for reducing injection pressure and clamp force requirements to be identified, and the magnitudes of their impact quantified in an efficient manner.

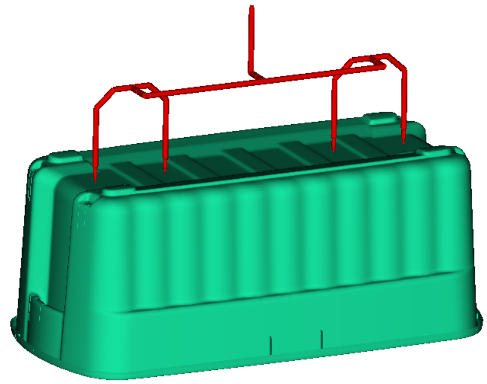

Figure 1: Container geometry with manifold system.

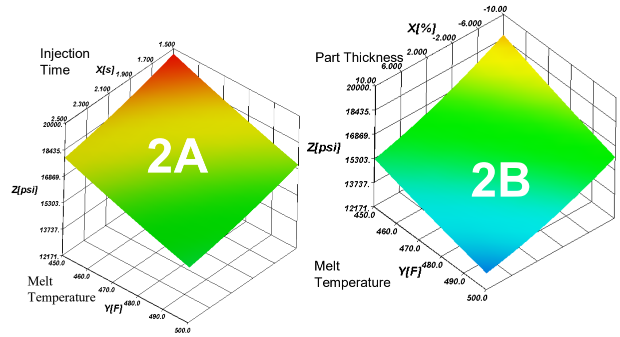

Figure 2: Surface response plots for injection pressure.

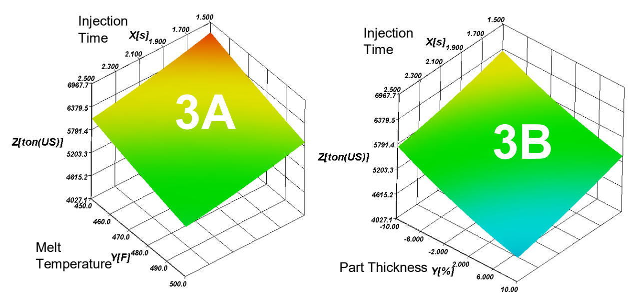

Figure 3: Surface response plots for clamp force.

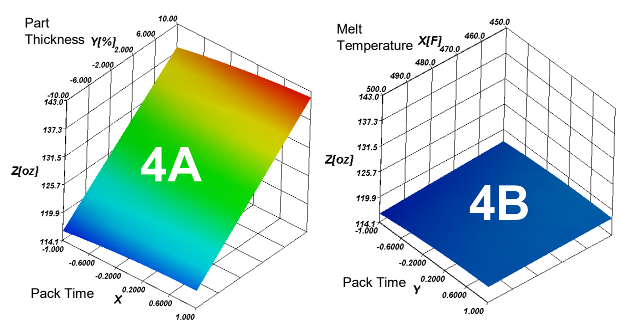

Figure 4: Surface response plots for part weight.

The Madison Group
2615 Research Park Drive
Madison, WI 53711
Ph: (608) 231-1907
madisongroup.com