ASHLAND

Cycletime Tips - General

Volume 20: Simply the Best Molding

By Sean Mertes

General Polymers Division of Ashland Chemical, strives to be “simply the best.” But how does the injection molding process strive to be “simply the best?” Is there value in trying to improve a process when the current method is already considered “the best?” If approached analytically, this fundamental question can be applied to many processes to attain measurable improvements.

The first step is to break down a process into its components. For injection molding, we will summarize these components as filling, pack/hold, cooling, and demolding. If each stage is optimized before moving on to the next, you can attain a process that is “simply the best.”

The first event is filling (best results are yielded from changing over on position). If the mold is capable of making shortshots, always start with shortshots and increase changeover position until the parts are 95 percent to 99 percent full on first stage. This requires no second stage pressure and only first stage filling. Since plastic is non-Newtonian (flows easier with higher fill speeds), it is recommended to start with the fast fill speeds and then slow down to lesser speeds. By starting with a fast fill and incrementally slowing down, it’s logical that the part will never completely fill or overpack as the speed decreases. Since the cavity is not being filled completely, there will be very little cavity pressure exerted on the cavity walls.

A very important aspect of filling consistently is to ensure the process is not pressure limited. Pressure limitation means the press is hitting the set pressure and equalizing pressure on the plastic side and the pump side, thus not allowing the flow control valve to work correctly (flow control valves only work correctly in one direction) and could cause inconsistency if any changes occur in the plastic viscosity.

Pressure limitation is diagnosed if the set pressure is increased and there is no resultant change in filling pressure. It is recommended to have approximately 10 percent higher set pressure than the mold requires. Once you have 95 percent to 99 percent full at fast fill speeds and are not pressure limited, slow down the speed and retain the shortshot samples of various fill speeds.

Once complete, visually inspect the parts and determine the optimum fill speed by aesthetics, fill balance and melt flow curve (if available). Set the press to the desired speed and adjust change over position to achieve 95 percent to 99 percent full parts. From this data, you will know fill pressure and fill time. Keep this recorded for your records later.

The second event is a combination pack and hold. These items can be separated if cavity pressure transducers are used, but for simplification, they will be combined. Since on fill we only filled the part 95 percent to 99 percent full, the part needs to be packed out by second stage pressure. This pressure is only a set pressure for a given amount of time.

The pressure required is most easily found by starting low and working up. Generally it requires a minimum of approximately 1/3 to 1/2 of fill pressure on second stage. Since plastic is non-Newtonian and can set up quickly, it is imperative to keep the flow front moving forward.

If the second stage pressure is not sufficient, the injection ram will be moving forward with first stage and when the changeover position is met, the internal mold pressure may overcome the set second stage pressure and thus stall the ram or even slightly bounce backward. This “ram bounce” will be enough to hesitate the flow front and cause potential problems.

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Once the pressure is high enough to eliminate ram bounce, you have found the minimum pressure needed to keep the plastic moving. Continue increasing the pressure until the parts look acceptable and higher pressure does not yield any better appearance or cause sticking in the mold. Once the pressure has been found, time needs to be determined. Start with a short interval of time and the pressure just determined. Retain samples and weigh only the parts, not including runner, mark all samples. Continue to increase the time until the part weight does not continue to increase.

Chart the results with the part weight on the vertical axis and time on the horizontal axis. If you have enough samples, you should notice a rising increase of weight with the increased time and then it should flatten out at the maximum weight. The time of the plateau is the time needed for “gate seal.” (Gate seal is generally better for tight dimensional parts. No gate seal may give you more stress- free parts and yield a quicker cycle). Submit one of each part with and without gate seal to determine which one produces more quality parts. From this data, you will know second-stage pressure and gate seal time, if needed. Keep this recorded for your records later.

The third part is cooling. The cooling time is found by starting quick and extending the time until the parts come out of the mold with enough rigidity to hold dimensional stability and warp reduction. Continue increasing the cooling time until you feel comfortable with the aesthetics and dimensional stability. (Hopefully the cycle time at this point will be less than or equal to what you quoted.) Increase the cooling time to quoted cycle and possibly one cycle between the quickest and slowest. Have the parts checked for stability and aesthetics. From this you should know the best cooling time. Since cooling is generally approximately 85 percent of the entire cycle, it is imperative to have sufficient cooling lines.

The fourth and final part is demolding. Open the mold quickly and only as far as necessary to eject the parts completely and safely. Close the mold as quickly as feasible and use low pressure close. By separating fill, pack/hold, cooling and demolding, the set-up technician is given the ability to evaluate an optimal separate process rather than deciding what is adequate as a whole. If this analytical approach is followed, the “best” possible set-up for that particular press/mold combination will be the result. For further reading, please refer to Mark Shade’s CycleTime Tips, March 1997, entitled Four Injection Molding Variables. The article describes four molding variables that need to be monitored in conjunction with the above and John Bozzelli’s CycleTime Tips, November and December, 1997, entitled How to Set First Stage Pressure.

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