Molding Filling Simulation Guidelines for the MuCell® Process

The MuCell® microcellular foaming process has two fundamental effects on the molding filling process. These are:

1) A reduction in material viscosity due to the single phase solution of molten polymer and supercritical foaming agent and;
2) Replacing the tradition pack/hold step of the solid molding process with cell growth

These two changes require that certain adjustments be made when running a mold filling simulation. The changes are outlined below.

This MuCell adapted procedure below only looks at the filling characteristics and does not involve other aspects of these software packages such as cooling and warpage predictions.

Simulation Procedure:

The basic modifications for simulating the MuCell process with the standard mold filling software are:

1) Identify a grade of material that is similar (same filler level and chemical composition) to that being used for the part but with a 12-15% lower viscosity. This accounts for the reduction in viscosity that occurs with the MuCell process.
2) Pick an injection speed that will match what is expected for the application.
    a. Keep in mind that the injection velocity for the MuCell process is typically 25% to 50% faster than for the solid process.
    b. Profiling of injection velocity is common when using subgates to prevent heavy surface splay around the gates.
3) Decrease hold pressure to 25% of the injection pressure.
4) Lower the pack and hold time to 2 seconds.
    a. While the actual process will typically use a pack and hold time closer to 0.5 to 1 second, it has been seen that some mold filling software packages give poor results if the time is set below 2 seconds.
5) Make gates 30% to 50% larger.
    a. The faster injection velocity can lead to shear induced blisters and surface imperfections around the gates. The increased gate size minimizes this effect.
    b. This recommendation may not be appropriate for subgates as it may prevent proper degating in the mold.
6) Material and mold temperatures should be set as expected for the process.

Evaluation of Results:

When running a mold filling simulation for the MuCell Process, the goal is to determine the types of conditions that can limit weight reduction in the part and remove them. The most common issues are high flow length to thickness ratio, unbalanced fill, thin areas at the end of fill and a lack of appropriate venting.

When evaluating the results of the fill simulation, the following should be considered:

1) Balanced fill pattern. There should be 2 to 4 areas of the mold that are not filled until just before the end of the simulation. These areas should be weld lines between gates or end of the part and not back flow areas.
    a. It is usually necessary to run multiple simulations with adjustments to gates or through the use of flow leaders to achieve the best results.
    b. This is an indication of balance of fill. Imbalances in fill pattern will limit the obtainable weight reductions.
2) Location of weld lines. Identify all weldlines in the simulation and determine the ability to vent these areas.
    a. If venting is not feasible, it will be necessary to re-run the simulation with adjustments to the number of gates and/or gate locations.
3) Look for race tracking that can close off perimeter vents resulting in gas traps.
4) Check complete fill
    a. Pay particular attention to standoffs at or near the end of fill and thin areas at the end of fill.
        i. Gating into thin sections is often preferred for optimizing the MuCell process benefits
5) Maximum pressures to fill the cavity less than 8000 psi. Injection pressure will increase as the flow length to thickness ration increases or material viscosity increases
    a. Experience has shown that weight reductions of 8% to 10% can be achieved at 8000 psi or lower pressure to fill the mold cavity.
    b. Pressures of 8000 to 10,000 psi usually result in weight reductions of 5% to 8%
    c. Pressures of 10,000 to 12,000 psi usually result in weight reductions of 3% to 6%

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