Prediction of Swell Phenomenon using Adaptive Local Mesh Refinement and Weight Optimization Procedure in Extrusion Blow Molding Process

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Extrudate swell is an observable and common phenomenon in the polymer extrusion industry. A better understanding of this phenomenon will ultimately lead to improvements in the prediction of the extrusion process, such as the optimization of both die design and processing parameters. Consequently, an adaptive local refinement procedure combined with a robust numerical simulation tool for parison formation and blowing, so as to ensure a more accurate prediction of the entire blow molding process, with an optimal computational time, remains a challenging task. The finite element software BlowParison developed at IMI is used to predict the parison formation, accounting for swell, sag and non-isothermal effects. This software is based on a hybrid approach that couples a fluid mechanics approach to represent the die flow, with a solid mechanics approach to represent the parison behavior outside the die, and a phenomenological model to capture the die geometry effect. This approach permits avoiding instability issues encountered by traditional fluid mechanics, especially at a high Weissenberg number. The local mesh refinement procedure is based on local element curvature of the final blow molded part combined with Delaunay triangulation technique. BlowDesign is a design optimization software developed by IMI to manipulate design variables or processing parameters such as the die gap opening profile and flow rate, subject to process constraints such as extrusion time and parison length. The numerical validation, in terms of thickness distribution of the final blow molded part, is performed by comparing solutions obtained using local mesh refinement to that obtained using a globally refined mesh. The gain, in terms of weight and CPU time, obtained using the adaptive local refinement procedure is presented for a blow molded part during weight optimization iterations.