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Modelling of Parison Formation and Process Optimization for Blow Molded Parts

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Parison dimensions in extrusion blow moulding are affected by two phenomena, swell due to stress relaxation and sag drawdown due to gravity. The availability of a modelling technique ensures a more accurate prediction of the entire blow moulding process, as the proper prediction of the parison formation is the input for the remaining process phases. Numerical simulation of parison formation remains a challenging task when it comes to high production rates in particular when high Weissenberg numbers are present.

The finite element software developed at IMI, couples a fluid mechanics approach to represent die flow, with a solid mechanics approach to represent parison behaviour outside the die. To our knowledge, this approach is the first that is able to yield stable predictions based on first principles, at high Weissenberg numbers.

The work deals with the integration of parison formation and part inflation prediction into an optimization iteration. This is done in an effort to optimise die gap programming profile, for a given final part thickness distribution. The process optimization employs a gradient-based algorithm that manipulates the die gap programming profile to minimize the part weight subject to a constraint of a minimum thickness.

The parison thickness has a highly non-linear relationship with die gap opening, in particular at lower die gaps when the gradient can completely reverse direction. This causes the optimization problem, to be extremely challenging to solve from a mathematical and consequently a numerical perspective.

A second major challenge for the process optimization is the addition of a constraint of constant parison length for the individual iterations. Parison length is strongly dependent on the die gap opening. This constraint is satisfied by manipulating the flowrate and the extrusion time of each die gap opening.

The efficiency of the proposed approaches will be illustrated on a plastic fuel tank.