

Can we control the microstructure of injection moulded parts?

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Can we control the microstructure of injection moulded parts?

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introduction

The macroscopic properties of injection-moulded products are defined by the molecular structure of the polymer, the processing conditions and the part geometry. The microstructure of the material develops accordingly to the local thermal-mechanical deformation at each material-fluid point. In order to relate flow histories with resulting microstructures, the use of experimental setups in which flow conditions can be manipulated is envisaged.

objectives

- Design a new experimental setup to generate different flow histories.
- Develop a numerical tool to model the experiments.
- Relate kinematics with microstructure.

methods

An innovative moulding tool, RCEM (Rotation, Compression and Expansion Mould) [1] is used to control the microstructure development of injection-moulded materials (see fig.1). One wall can rotate or translate during the filling stage, e.g. combine pressure driven, drag and squeezing flow. A finite-element model, VIP3D, is adapted to compute different flow kinematics as generated by the RCEM mould.

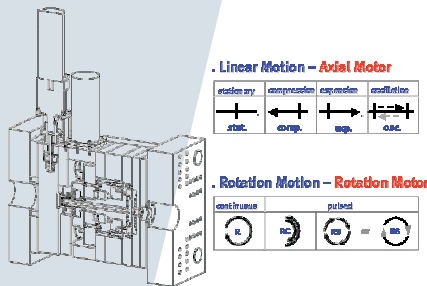


figure 1. RCEM mould and the possible operating conditions.

experimental results

Samples were injected under different conditions. The microstructure was analyzed by optical light microscopy.

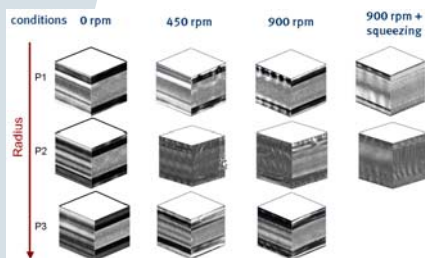


figure 2. Polarized optical light microscopy results for two flow directions along the radius.

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modelling

Centre gated disk geometry modelled with brick elements.

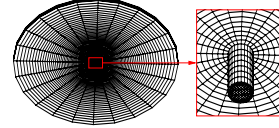


figure 3. FE mesh. Number of nodes = 105221.

Filling results for a gate velocity of 10 ms^{-1} :

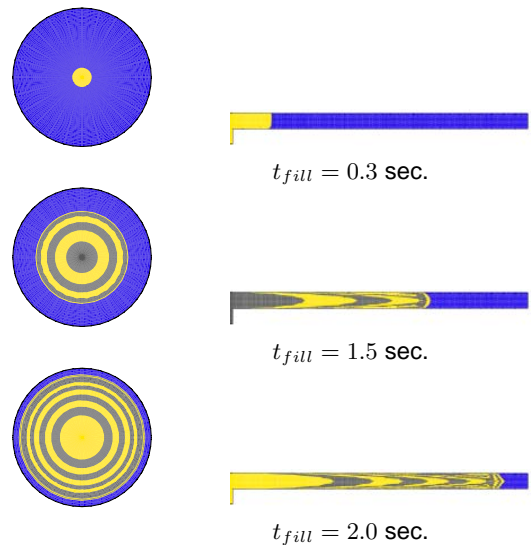


figure 4. Material-time labels for different filling times. Cross sections are taken in the midplane (left) and in the radial direction.

Effect of wall rotation on the shear field for different rotation speeds:

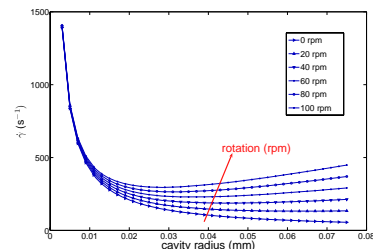


figure 5. Shear rate along the radius as a function of rot. speed.

conclusions / future work

The developed finite element model captures the different flow kinematics induced by the RCEM mould. Computations with non-Newtonian fluids and filling analysis under non-isothermal conditions are to be done.

References:

- [1] SILVA, C., ET AL.: *International Polymer Processing*, Vol. XX, n.1, p.27-34. (2005)
- [2] HAAGH, G.: *Ph.D. thesis*, Eindhoven University of Technology (1998)