Science Talks

Computational Rheology with OpenFOAM® Computational Library

--Manuscript Draft--

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Title

Computational Rheology with OpenFOAM® Computational Library

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Keywords
Computational rheology, OpenFOAM, polymer processing, viscoelastic fluids

Abstract
The current capabilities of numerical codes, which able to model very complex processes, and the existing powerful computational resources, clearly promote the employment of numerical modeling tools to assist design-related tasks. The Computational Rheology Group, from the Institute for Polymers and Composites (IPC) of the University of Minho (UMinho), has been developing and exploiting modeling codes for more than one decade, with a special focus on polymer processing applications. During the last 6 years, most of the numerical developments of the Computational Rheology Group were based on the OpenFOAM® computational library.

This talk aims at providing an overview of the computational rheology-related work done at IPC/UMinho, in close cooperation with industry, and at illustrating the advantages of using the computational library OpenFOAM® for the development of new codes. The presentation will cover both the work done by the group to support the design of polymer processing tools and the development of new solvers in the OpenFOAM® computational library.

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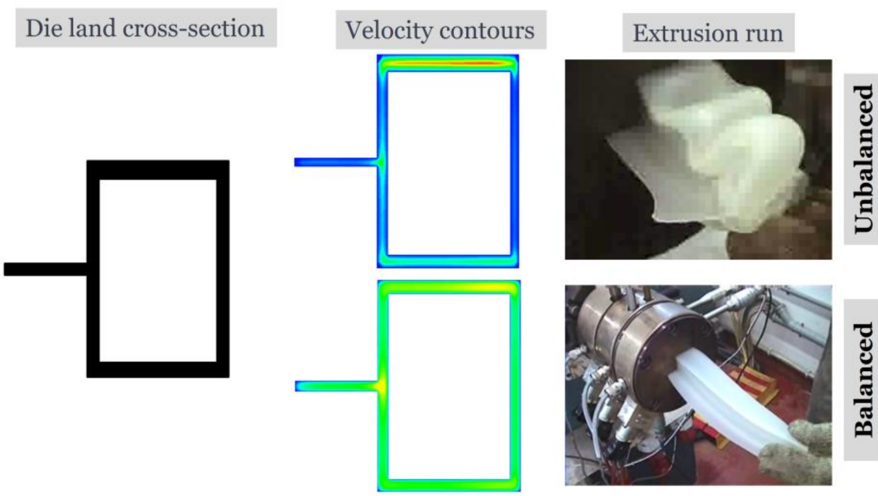
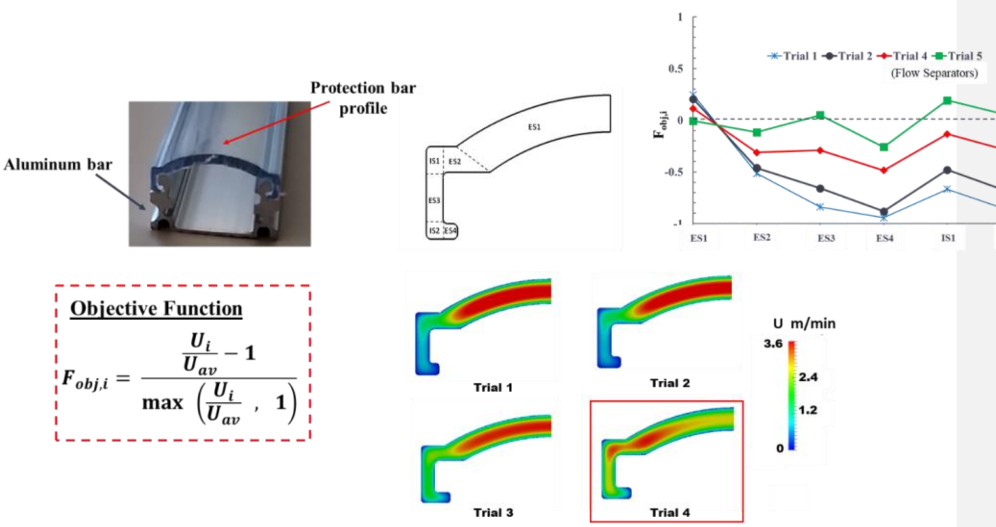


Figure 1. Flow distribution in profile extrusion dies.



A Rajkumar et al., An Open-source framework for the CAD of Complex Profile Extrusion Dies, International Polymer Processing, 33, 2018

Figure 2. Optimization of a profile extrusion die.

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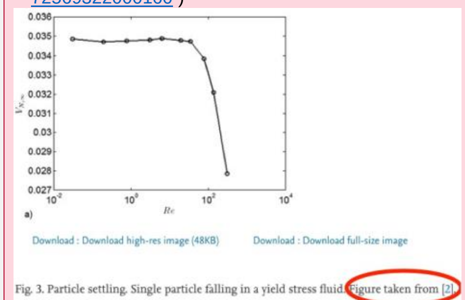

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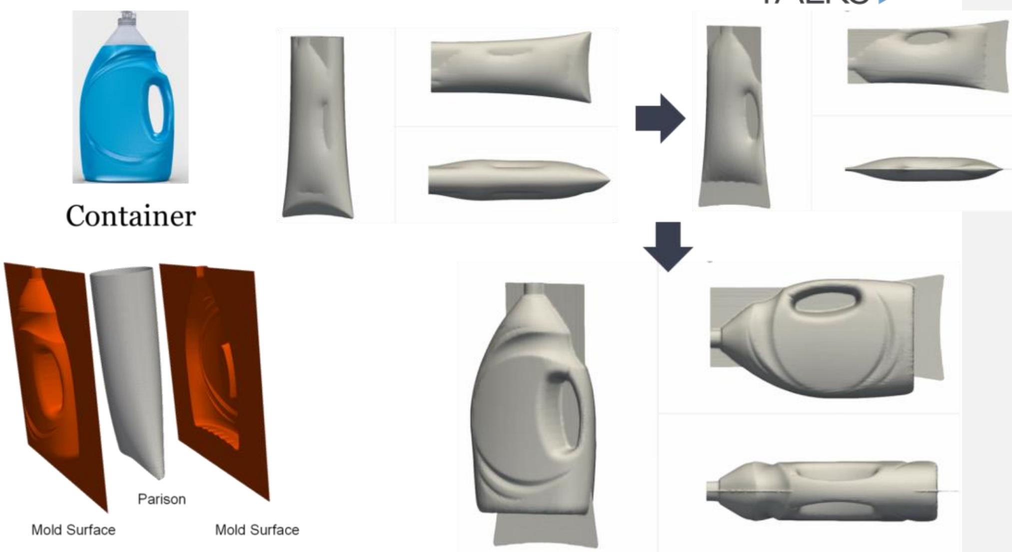


Figure 3. Extrusion Blow Molding - Mold Clamping and Inflation phases

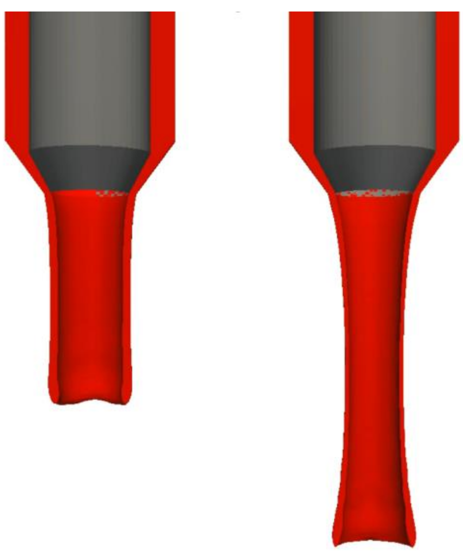


Figure 4. Extrusion Blow Molding – Effect of density in parison extrusion.

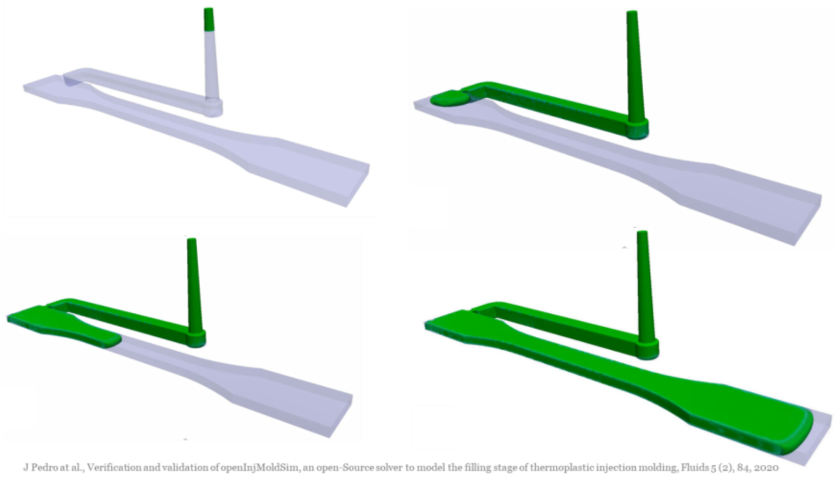
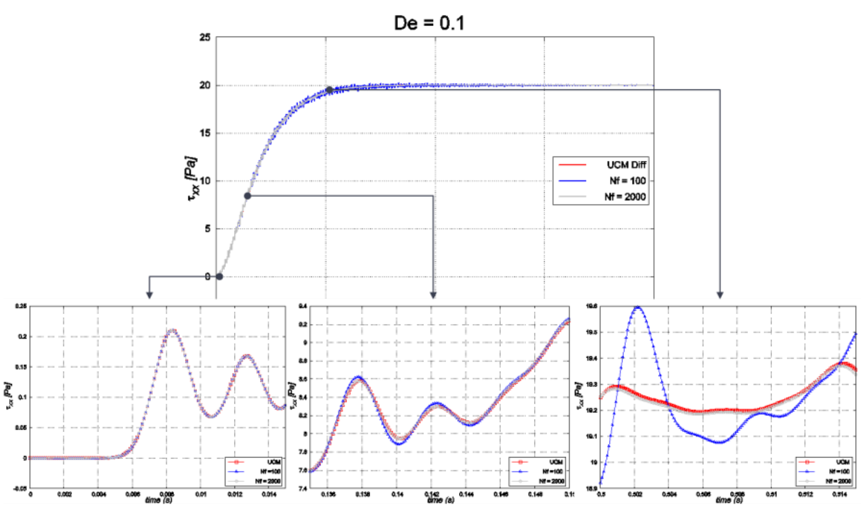
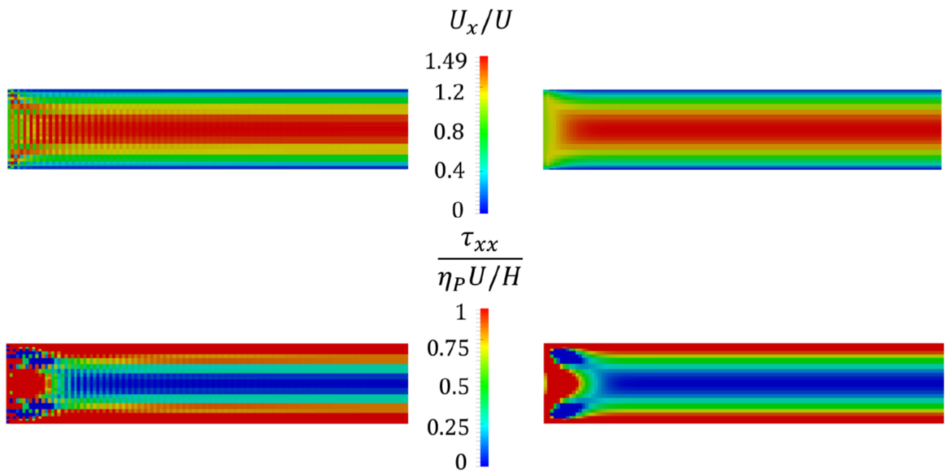

J Pedro at al., Verification and validation of openInjMoldSim, an open-Source solver to model the filling stage of thermoplastic injection molding, Fluids 5 (2), 84, 2020

Figure 5. Injection Molding



MSB Araújo, C Fernandes, LL Ferrás, Ž Tukovic, H Jasak, JM Nóbrega, Novel Trends in Rheology V, 2015

Figure 6. Normal stress evolution for Couette flow with the Integral viscoelastic flow solver.



C Fernandes et al., Improved Both Sides Diffusion (iBSD): a new and straightforward stabilization approach for viscoelastic fluid flows, JNNFM, 249, 63-78, 2017

Figure 7. Effect of iBSD coupled approach in a simple Poiseuille flow.

Credit author statement

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Acknowledgments

- Alves, F. – Logoplaste Inovation Lab, USA
- Araújo, M. – Universidade Federal do Pará, Brazil
- Carneiro, O. S. - University of Minho, Portugal
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Declaration of interests

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J. Miguel Nóbrega is Associate Professor at the Polymer Engineering Department of the University of Minho, and member of the Institute for Polymers and Composites. In 2004, he received is PhD degree from the University of Minho, in Polymer Science and Engineering. He is the Digital Transformation in Manufacturing area leader of the MIT Portugal Program, president of the Portuguese Society of Rheology general assembly, editor of OpenFOAM Wiki, founder member of the Iberian OpenFOAM Technology Users and member of the OpenFOAM Workshop Committee. His research activity lies on three overlapping areas: product development, polymer processing and material rheology. For this purpose, he has been developing computational rheology tools to model the behavior of complex materials in various manufacturing processes. Regarding the product development area, he has been involved on the design and manufacture of products for several fields, comprising applications for health, textile, sensoring/monitoring, construction and mobility.

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