3D adaptive finite element simulation of fluid flow in twin-screw extruders
Sarhangi Fard, A.; Anderson, P.D.; Meijer, H.E.H.

Published: 01/01/2007

Document Version
Publisher’s PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:
• A submitted manuscript is the author's version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher’s website.
• The final author version and the galley proof are versions of the publication after peer review.
• The final published version features the final layout of the paper including the volume, issue and page numbers.

Link to publication

Citation for published version (APA):

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Download date: 12. Dec. 2018
3D adaptive finite element simulation of fluid flow in twin-screw extruders

A. Sarhangi Fard, P. D. Anderson, and H. E. H. Meijer
Eindhoven University of Technology

Introduction
The simulation of fluid flow in industrial processes often involves geometries with moving internal parts [1]. A typical example is that of the twin-screw extruder, a continuous mixer frequently used in polymer processing. It is evidence to CFD practitioners that the use of classical finite element methods to tackle such problems is far from being trivial since a new mesh is needed at each time iteration owing to the motion of the internal parts (Fig. 1).

![Figure 1](image)

(a) Intermeshing co-rotating twin screw (TSE) extruder, (b) Domain meshes at two different rotation angles.

Objective
3D simulation of fluid flow for a Newtonian isothermal polymeric melt in the twin screw extruders (TSE).

Methods
We use a combination of the fictitious domain and finite element methods [1,2]. Periodic boundary conditions were applied for inlet and outlet boundaries. Non-conformal mesh refinement using a Lagrangian multiplier has been implemented for adequate accuracy.

Results
Collocation points optimization
We select a 3D concentric co-cylindrical system with inner rotating cylinder as a test case study (Fig. 2).

![Figure 2](image)

(a) Co-cylindrical geometry, (b) main mesh with collocation points (red points), (c) cubic element with characteristic length $l$ and collocation points element with characteristic length $l_1$.

Comparison with the analytical solution learns that accurate results for velocity and shear rate inside the fictitious domain are found for $l/l_1 = 1$ (Fig. 3).

![Figure 3](image)

Comparing numerical and analytical results

TSE
Next, we implement methods for standard conveying screw elements in a twin screw extruder (Fig. 4).

![Figure 4](image)

(a) Velocity profile at $x$ direction at different cross section of TSE, (a) vector, (b) streamline

Mesh refinement
Non-conformal mesh refinement is needed to obtain adequate accuracy. The reference mesh may be adapted locally according to the position of the collocation points in the computational domain (Fig. 5). Ensuring continuity at the interface between non-conformal elements, is implemented by using a Lagrangian multiplier.

![Figure 5](image)

(a) Element refinement technique, (b) a 2D cavity with rotating object in the center as a test case, (c) velocity contour at $x$ direction

Conclusions
- The characteristic length of the mesh for collocation points and the main finite element mesh in 3D should be equal.
- A method to compute the flow field in TSE has been successfully implemented.
- Ensuring continuity for non-conformal elements is enforced by using a Lagrangian multiplier.

References: