CFD modelling of thickened tailings

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Introduction

- The aim of the research is to model thickened tailings behaviour and spreading in tailings pond with computational fluid dynamics (CFD).
- Modelling geometry is a cross-sectional surface of a tailings pond at the location of a paste discharge pipe.

Introduction – paste modelling

- Concentrated mineral tailings often behave as non-newtonian fluids. These fluids have a yield stress and the fluid viscosity varies with shear rate.
- Commonly used models are:
  - Bingham model for yield stress material and
  - Herschel-Bulkley model for yield stress and shear-thinning or -thickening material.

Reference: Sofra F. Rheological Concepts. In: Paste and Thickened Tailings – A Guide, editors Jewell R.J. & Fourie A.B. Australian Centre for Geomechanics, Australia 2015.

Introduction – Computational Fluid Dynamics, CFD

- Physical aspects of fluid flow can be described with
  - Mass is conserved
  - Newton´s 2nd second law (i.e. momentum is conserved)
  - Energy is conserved.
- In CFD these equations are solved to obtain numeric values for the flow field at discrete points (grid points) in the domain.
- Accuracy of CFD solution is strongly influenced by the number of cells in the mesh.

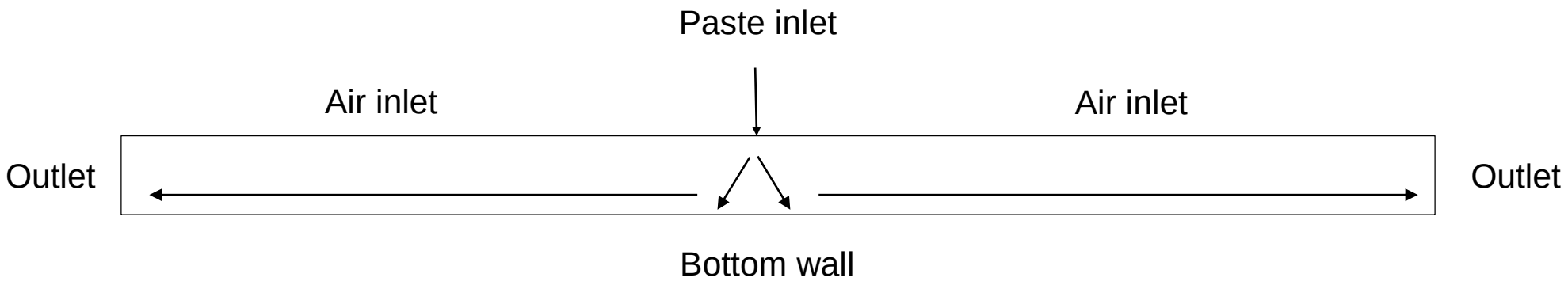
Reference: Anderson J. D. Jr. Computational fluid dynamics: the basics with applications. New York, McGraw-Hill 1995.

Research methods

- Paste behaviour is modelled with ANSYS Fluent software.
- Modelling domain includes 2 fluids: paste and air.
- Phase interphase is modelled with Volume of Fluid (VOF) multiphase model.
- Non-Newtonian behaviour of the fluid is taken into account with the Herschel-Bulkley model.

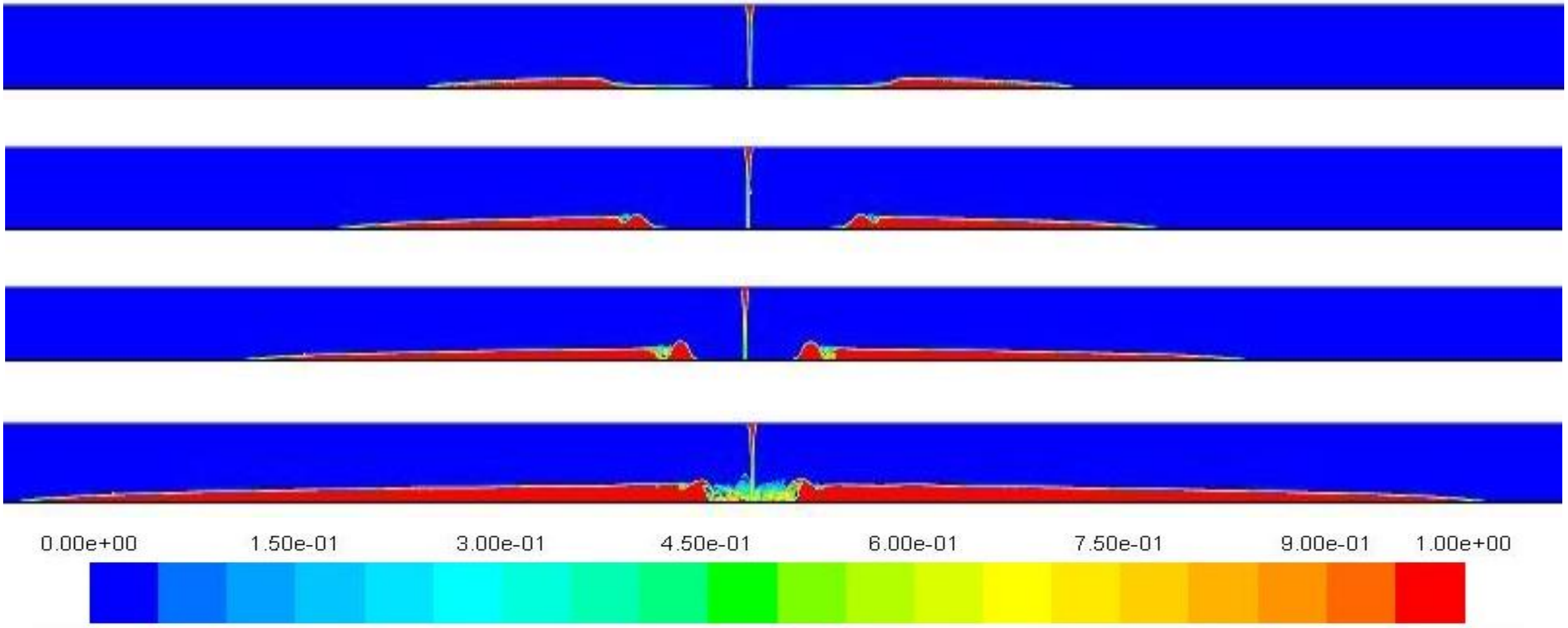
Modelling domain

- Simplified 2D geometry is created for the close proximity of a discharge pipe.
- Schematic drawing of the modelling domain (not in scale):



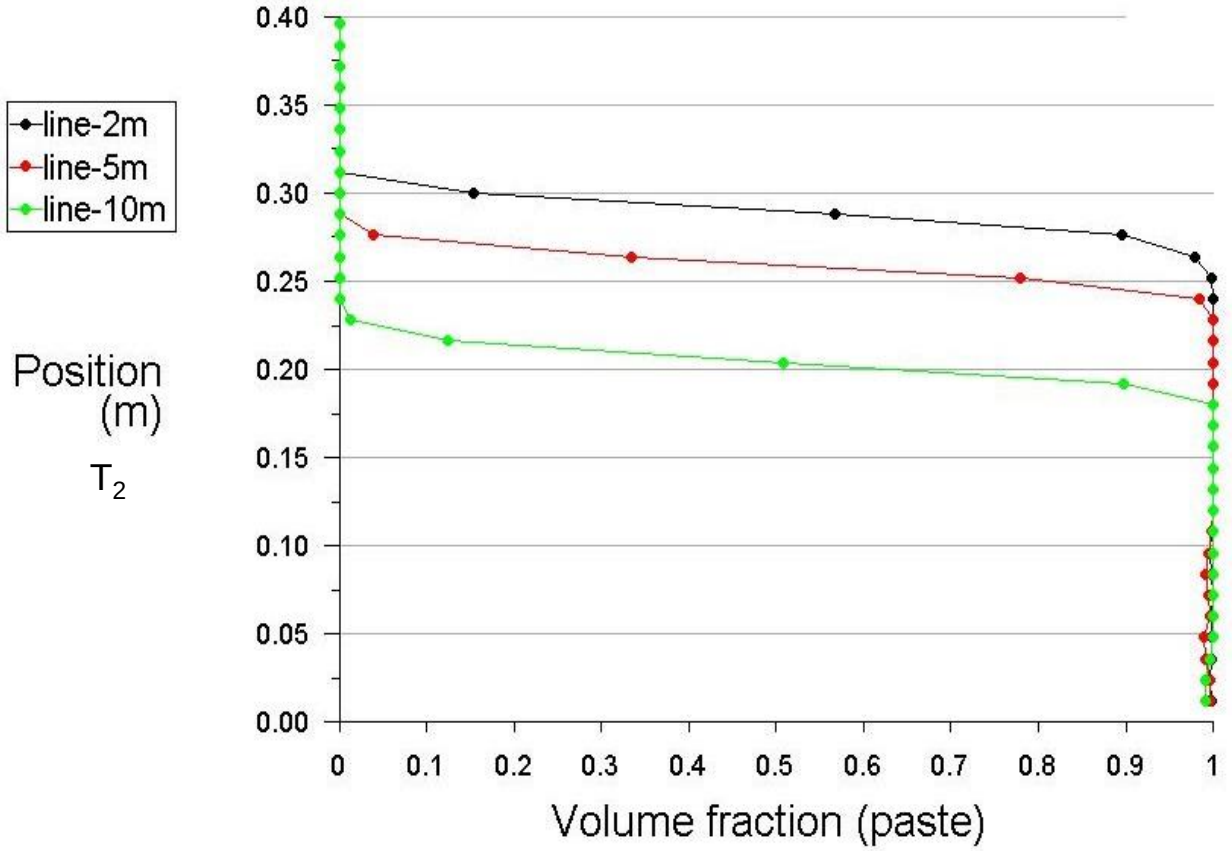
Example of results – contours of volume fraction

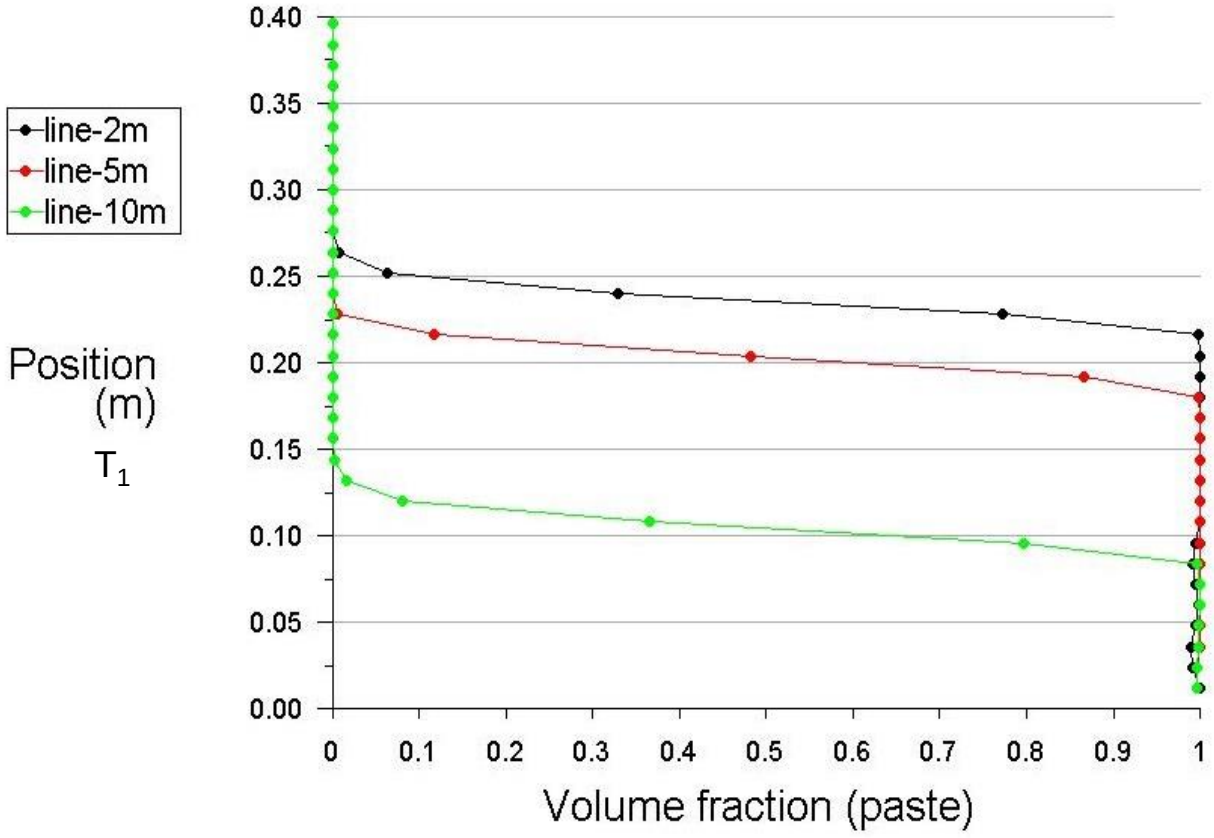
Volume fraction of paste at different time points:



Example of results – volume fraction of paste

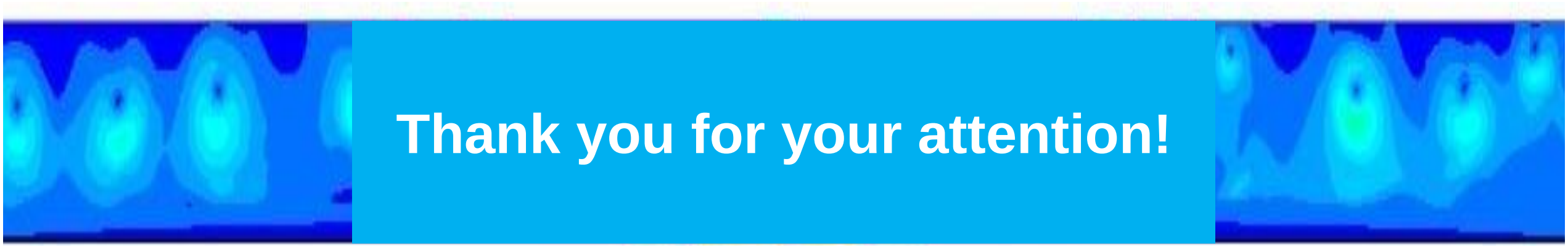
The amount of paste at different distances from the inlet:





Conclusions

- CFD modelling is a promising tool in tailings dam modelling.
- Simulations produced interesting results.
  - Further model and parameter testing, as well as small-scale validation tests would give valuable supplementary data.
- Transient calculations required quite small time step.
  - Simulations take some time.
- Large scale models are computationally expensive.



Thank you for your attention!