

Technical University of Denmark



Effect of anisotropy structure on plume dilution and reaction enhancement in helical flows

Chiogna, Gabriele; Ye, Yu; Lu, Chunhui; Rolle, Massimo

Publication date:
2018

Document Version
Peer reviewed version

[Link back to DTU Orbit](#)

Citation (APA):

Chiogna, G., Ye, Y., Lu, C., & Rolle, M. (2018). Effect of anisotropy structure on plume dilution and reaction enhancement in helical flows. Abstract from CMWR 2018 conference : Computational Methods in Water Resources, Saint-Malo, France.

DTU Library
Technical Information Center of Denmark

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

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.

Effect of Anisotropy Structure on Plume Dilution and Reaction Enhancement in Helical Flows

Gabriele Chiogna, Technical University of Munich, Munich, Germany and University of Innsbruck, Innsbruck, Austria

Yu Ye, Hohai University, Nanjing, China

Chunhui Lu, Hohai University, Nanjing, China

Massimo Rolle, Technical University of Denmark, Lyngby, Denmark

Key words: anisotropy; helical flow; entropy; dilution; reactive mixing

Abstract

Recent experimental and modeling works have shown how plume dilution and reactive mixing can be considerably enhanced by helical flows occurring in 3-dimensional anisotropic porous media. In this work, we propose a setup capable of generating locally helical flows due to the peculiar geometry of a heterogeneous inclusion [1]. A total of one hundred different realizations of the inclusion, were obtained by varying key parameters such as the spacing between alternated heterogeneous zones of coarse and fine materials, the permeability contrast between such matrices, the angle of the anisotropic structures with respect to the average flow velocity, and the magnitude of the seepage velocity. We performed both conservative and reactive transport simulations to investigate the effect of the inclusion's geometry and orientation on the patterns of twisted streamlines and on the overall dilution and reaction of solute plumes. The impact of helical flow on plume dilution and reactive mixing in the considered three-dimensional anisotropic setups was quantified using the flux-related dilution index [2] of both conservative and reactive tracers. This numerical experiment allowed us identifying optimal geometric configurations maximizing mixing and reactions, and yielding enhancement factors up to 15 times the outcomes of analogous simulations in homogeneous media. Interestingly, it was also possible to show that compound-specific diffusive/dispersive properties were still relevant despite the enhanced plume dilution in helical flows with important consequences for reactive mixing.

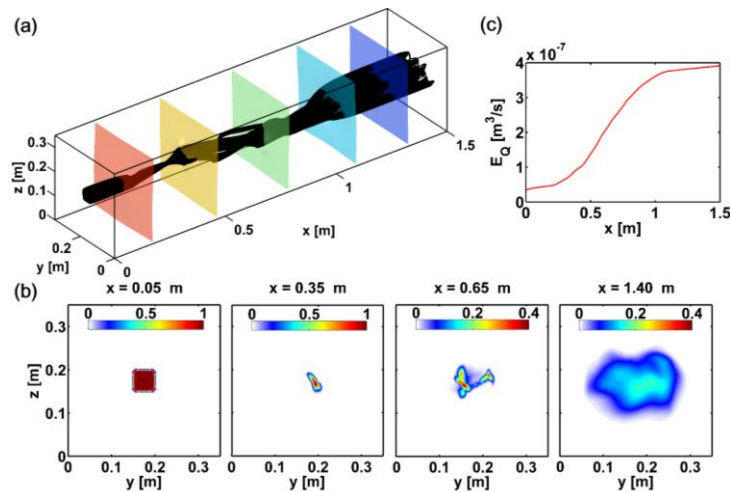


Figure 1: a) Streamlines traced from the central inlet show a twisting pattern; black lines: streamlines; colored surfaces: isosurfaces of hydraulic head; b) Concentration distribution at different cross-sections; c) Flux-related dilution index along the travel distance.

References

- [1] Y. Ye, G. Chiogna, C. Lu and M. Rolle. Effect of Anisotropy Structure on Plume Entropy and Reactive Mixing in Helical Flows. *Transport in Porous Media* (in press).
- [2] M. Rolle, C. Eberhardt, G. Chiogna, O.A. Cirpka and P. Grathwohl. Enhancement of dilution and transverse reactive mixing in porous media: Experiments and model-based interpretation. *Journal of Contaminant Hydrology*, 110, 130-142 (2009).