Contribution ID: **827** Type: **Oral Presentation**

Pulsed Flow Injection Strategies for Enhancing Subsurface Mixing

Tuesday, 23 May 2023 14:30 (15 minutes)

Pulsed flow has been proposed as a means of enhancing mixing in porous media. Compared to diffusion alone, a zero time-averaged advective flow has been found to accelerate mixing by hundreds to thousands of times[1]. There are many potential applications where this would be beneficial, for instance remediation of subsurface contamination, open-loop geothermal, ground improvement by grouting, and even when making the perfect shot of espresso. The pumps used for these applications typically produce flow that pulses to some degree, the nature of which depends on the pump mode of operation, the required flow rate, and properties of the porous media such as permeability, network connectivity, and the systems compressibility.

In this research, we explore the implications of pulsed flow on transport and mixing in porous media seeking to understand how injection strategies can incorporate deliberate flow pulsing so as to enhance mixing.

Methods:
The pressure pulse characteristics of several common pumps were measured: lab-scale syringe, piston and peristaltic pumps, field-scale screw and diaphragm pumps, and a home espresso machine.
OpenFOAM was used to model flow and transport through i) a set of individual stylised pores, ii) a 2D pore network, and iii) a 3D X-ray scan of a sand packed column. Representative pressure pulse profiles were used as the inlet boundary condition to these pore-scale numerical models.
To validate the numerical model, a complementary microfluidic experiment was carried out in which transport of a fluorescent tracer through a stylised 2D pore was observed under pulsed and non-pulsing flow.

Results:
Model results indicate that flow/pressure pulsing has a relatively minor effect on pore-scale mixing under truly laminar conditions, however mixing becomes more pronounced as flow becomes transitional (pore Reynolds numbers >10) due to enhanced mixing in dead-end pores. Likewise, mixing is enhanced substantially in a multiphase system when the stationary phase is compressible, for instance water injected into an initially dry or partially saturated rock/soil/coffee.

There are clearly scenarios in which a pulsed injection strategy could be adopted so as to reduce the total time or the total injected volume required to mobilise a pollutant and, equally, there are scenarios in which pulsed flow will have little impact.

Participation

In-Person

References

MDPI Energies Student Poster Award

No, do not submit my presenation for the student posters award.

Country

United Kingdom

Acceptance of the Terms & Conditions

Click here to agree

Energy Transition Focused Abstracts

This abstract is related to Energy Transition

Primary authors: MINTO, James (University of Strathclyde); Dr CASTRO, Gloria (Postdoctoral researcher, Civil and Environmental Engineering, University of Strathclyde); Dr ROBERTS, Jen (University of Strathclyde)

Presenter: MINTO, James (University of Strathclyde)

Session Classification: MS08

Track Classification: (MS08) Mixing, dispersion and reaction processes across scales in heterogeneous and fractured media