



Contribution ID: 178

Type: Oral Presentation

Transport and retention of nanoparticles in natural porous media-Effect of pore structure and geometry.

Monday, 30 May 2022 11:35 (15 minutes)

The understanding of the transport of nanoparticles (NP's) in saturated porous media is key during nanoremediation technology. There is a gap in knowledge regarding the processes occurring at the pore scale for a successful nanoremediation technique to be applied at larger scales (Pak et al., 2020). NP (e.g., zero-valent iron) transport mechanism at the pore scale is studied in a non-destructive way using X-ray computed microtomography (X-ray micro-CT) (Pak et al., 2019).

In this study, the effect of grain composition and size (fine sand, coarse sand, carbonate, and a mixed sample of carbonate and sand) on the mobility and deposition of NP's is reported. The porous materials were filled in small columns that were initially saturated with water, the injection of NP suspension followed with a post flush stage to remove the mobile particles. Lastly, X-ray micro-CT imaging is performed. 3D micro-CT data of these four columns is used in this study. All tomographic data are at 4.52 μm resolution.

The images obtained consisted of three phases (grains, pores and NP's) which were qualitatively studied using the free and commercially available software ImageJ and Avizo respectively. The images were filtered to remove any noise present, segmented (to identify the phases present) using several algorithms such as simple threshold, Weka and watershed segmentation. Pore network modelling and labelling analysis for the visualization of the pores geometry and to extract some other useful information aimed at understanding the relationship between the topologic and geometric properties of the porous media (Pak et al., 2018).

The objective of this work is to understand the effect of NP's injection on the structural and geometric properties of the pores and to identify the NP's transport mechanism at the pore scale.

Given the success in the characterisation of these natural rocks using μCT , we foresee these data as a teaching and research resource (Pak et al., 2019). The outcome of this experiment shows that, the structure of the porous media remains unchanged while the geometry of the pore system changes after NP injection. Pore clogging is noticed with a left shift of the pore and throats channel length size distribution due to decreasing absolute permeability (Hosseini et al., 2013; Pak et al., 2020). The porosity reduces with an increase in the geometric tortuosity due to NP injection. The work brings out the relationship between the size of the porous media, NP deposition and its effect on the permeability reduction. The amount of nanoparticle deposition in sand increases with reduction in grain size. NP saturation in the pore space follows the trend; fine sand (11.47) > coarse sand (8.80) > mix sand (8.44) > carbonate (6.15). Also, it is seen that permeability reduction increases with reduction in grain size; fine sand (24.21) > coarse sand (18.76) > mix sand (16.45) > carbonate (11.71). The accurate quantification of the evolving trends among geometric, hydraulic and mechanical rock properties is important as it contributes to a sustainable exploration and utilisation of the geological subsurface.

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References

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Pak, T., Archilha, N., Mantovani, I., Moreira, A. and Butler, I., 2018. The Dynamics of Nanoparticle-enhanced Fluid Displacement in Porous Media - A Pore-scale Study. *Scientific Reports*, 8(1).

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Time Block Preference

Time Block B (14:00-17:00 CET)

Participation

Online

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