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Direct numerical modelling of multiphase flow through reinforced porous media

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Understanding multiphase flow through porous media is an important study in many scientific and engineering processes. An example of such process is corrosion of steel inside reinforced porous materials, such as soil or concrete, where air-water distribution at the steel surface is directly related to corrosion mechanisms and has a great impact on durability of reinforced structures [1].

Prediction of water movement throughout unsaturated porous materials is generally based on traditional models relying on a macroscale modelling derived using representative elementary volume (REV) concept [2]. However, such models are not capable of providing detailed insight into water distribution at the steel-porous media interface which is crucial to understanding of relevant degradation mechanisms such as corrosion.

One approach that overcomes mentioned limitation of macroscale models is direct numerical simulation of multiphase flow directly at pore scale [3]. Such approach is based on solving Navier-Stokes equations where in addition to inertial, viscous, and surface forces, model accounts for interfacial tension and wall adhesion effects while fully resolving motion of the interfaces between different phases. Moreover, these models are capable to account for complex microstructure heterogeneities of real pore structures obtained by pore-scale imaging, such as X-ray microtomography or FIB-SEM techniques. Combining detailed resolution of pore-scale multiphase processes with realistic 3D geometry of pore space has large potential to improve our understanding and lead development of improved macroscale models by upscaling microscale mechanisms to obtained more accurate macroscopic properties required for practical large-scale modelling [4].

Thus, the aim of this work is to use direct numerical simulations of multiphase flow to improve our understanding of air-water distribution at interface between porous media and embedded steel. Main focus is on capillary driven multiphase flow using pore scale images with nano- to micro-scale resolution. Influence of different geometries, both synthetic and realistic 3D pore structures, as well as different flow conditions and different fluid-solid properties (gas/liquid - porous skeleton/steel) will be investigated.

Participation

In-Person

References

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