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Challenges in modelling two-phase flow in industrial porous media

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Various industrial processes involve two-phase flow in porous media. Examples are found in fuel cells, filtration, paper, food, concrete, ceramics, moisture absorbents, and membranes, to name a few. The common practice in modelling flow and transport in such porous media is to employ the concepts,
models, and algorithms developed in geosciences. However, many industrial porous media are significantly different from soil and flow and transport processes occur in different regimes. Some major challenges are:
- Most industrial porous media are made of a stack of think porous layers. It is not straight forward to measure their material properties, such as permeability and capillary pressure curve. This is because of the small volumes involved in a layers and their deformability.
- Due to their small thickness, there are often only a few pores present across the thickness. So, the applicability of three-dimensional continuum theories is questionable.
- The space between layers is known to affect the distribution of fluids in the layers. It is not clear how such an interlayers space should be characterized and how its effect should be included in a three-dimensional model
- Constitutive relations (e.g., capillary pressure curve) are commonly obtained under equilibrium conditions whereas many industrial flows are very fast.
- Deformations of soils/rocks are infinitesimal or negligible or slow; not always so in industrial flows

There is a clear need for developing theories, models, and measurement techniques specifically applicable to industrial porous media. In this presentation, we highlight the special features of industrial porous media through the discussion of results studies of two industrial applications: penetration of ink into paper and the absorption of liquids in diapers. We also discuss how formulation of two-phase flow in such systems should be modified.

References

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