Contribution ID: **24**

Type: **Oral Presentation**

Rheology and Mobility Critical Exponent of Immiscible Two-Phase Flow in Porous Media with Dual-Wettability Grains

Tuesday, 23 May 2023 12:00 (15 minutes)

A large class of porous media consists of consolidated grains. If there is a mixture of different grain types, capillary forces may be strongly affected under immiscible two-phase flow. We have studied the effect of a random mixture of two types of grains having different wetting properties on the transport properties of immiscible two-phase flow in porous media under steady-state flow conditions using a dynamic pore-network model.

Immiscible fluids A and B flow through pores between two types of grains denoted “$+$” and “$-$”. Fluid A is fully non-wetting with respect to grain type “$+$” and is fully wetting with respect to grain type “$-$”. Fluid B is fully wetting with respect to grain type “$+$” and is fully non-wetting with respect to grain type “$-$”. We model the pore structure as the links in a square lattice. The nodes of the dual lattice is populated by the grains. The grains of type “$+$” are assigned with a certain probability and the rest of the grains are assigned type “$-$”. There are no spatial correlations among the grains. If a link passes between two “$+$” type grains, the capillary force at fluid interfaces in the link will point in the direction of fluid B. If a link has type “$-$” grains as neighbors, the capillary force at fluid interfaces in the link will point towards fluid A. If the link lies between type “$+$” grains on one side and type “$-$” grains on the other side, we assume the capillary force to be zero between the two fluids.

For a window of grain occupation probability values, a percolating regime appears where there are active connected paths with zero capillary forces. Due to these paths, no minimum threshold pressure is necessary to start a flow in this regime. Furthermore, while varying the pressure drop across the porous medium from low to high in this regime, the relation between the volumetric flow rate in the steady state and the pressure drop goes from being linear to a power law with an exponent 2.5, then being linear again. The linearity in the initial low pressure drop regime is due to the active connected paths with zero capillary pressures, which remains the same with small increase in the pressure drop. The non-linearity at the intermediate regime is due to the opening of new paths with the increases in the pressure drop whereas the linearity in the high pressure regime is essentially due to the entire network being active.

We also measure the mobility of the system at the percolation threshold of the grain occupation probability, which exhibits a critical behavior reminiscent to the conductivity of a random resistor network. We measure the critical exponent related to this mobility and find it approximately equal to 5.7.

Participation

In-Person

References

MDPI Energies Student Poster Award

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

Country

Norway

Acceptance of the Terms & Conditions

Click here to agree

Energy Transition Focused Abstracts

Primary author: FYHN, Hursanay (NTNU)

Co-authors: Dr SINHA, Santanu (UiO); Prof. HANSEN, Alex (NTNU)

Presenter: FYHN, Hursanay (NTNU)

Session Classification: MS06-A

Track Classification: (MS06-A) Physics of multiphase flow in diverse porous media