Contribution ID: **362**

Type: **Poster Presentation**

Water-Oil Relative Permeability determination in 2D micromodels of vugular porous media

Tuesday, 23 May 2023 16:10 (1h 30m)

It is estimated that 50% of world oil production comes from naturally fractured carbonate reservoirs. One of the biggest challenges in this type of formation is its heterogeneous nature. Besides the presence of fractures that longitudinally connect the porous media, vugs at different scales and distributions are scattered throughout the porous matrix. These cavities cause fluid flow characteristics to significantly differ from those of homogeneous reservoirs and bring the need to evaluate equivalent petrophysical properties of the system. Permeability is a key property to understand and predict operations involving one or more phases flowing through porous media. However, for vugular formations, obtaining representative rock samples to perform measurements is especially difficult. In addition, interpreting equivalent relative permeability maps can be challenging, since fluid saturation may not be uniform throughout the porous and vugular space.

Microfluidics approaches by means of artificial porous media micromodels have been widely used for pore-scale multiphase fluid flow visualizations, in order to relate macroscopic fluid flow properties to microscopic displacement mechanisms. When these devices are coupled with precise pressure drop measurements, additional information gathered from permeability determination could lead to important advances in this area. For example, improving the interpretation of data that are fed into simulations or that are obtained from core-flooding experiments.

In this study, a microfluidic approach is used to determine the water and oil relative permeability curves and phase distribution profiles in 2D micromodels of vugular porous media. It involved prototyping a randomly-constricted porous matrix, incorporating different designs of vugs, and microfabrication of PDMS-glass micromodels. Steady-state water-oil injection experiments were performed in these devices at different fractional flow, monitoring the dynamics of the pressure drop and visualizing the fluid displacement at the pore scale. Live-image acquisition through fluorescence microscopy made it possible to examine the evolution of the saturation of water and oil phases. The direct comparison between the relative permeability curves of well-characterized vugular porous media and its porous matrix showed that the incorporation of vugs leads to (i) higher equivalent absolute permeability, especially with longer cavities and higher vug density, (ii) increased oil occupancy in the porous matrix, due to less efficient water invasion into the porous matrix, and (iii) higher relative permeability to water, which flows preferentially through the vugular space. These results are consistent with the oil-wet nature of micromodels, since the vugs are offering less capillary resistance to the flow of the non-wetting phase. Our low-cost microfluidic approach will likely allow us to systematically study more complex vugular-fractured systems.

Participation

In-Person

References

Honarpour, M. and Mahmood, S., 1988. "Relative-Permeability Measurements: An Overview". Journal of Petroleum Technology, Vol. 40, No. 08, pp. 963–966.

Moctezuma-Berthier, A., Vizika, O., Thovert, J.F. and Adler, P., 2004. "One- and two-phase permeabilities of vugular porous media". Transport in Porous Media, Vol. 56, pp. 225–244.

Okabe, H. and Blunt, M., 2007. "Pore space reconstruction of vuggy carbonates using microtomography and multiple-point statistics". Water Resources Research, Vol. 43.

Kusanagi, H., Watanabe, N., Shimazu, T. and Yagi, M., 2016. "Relative Permeability Curves for Two-Phase Flows Through Heterogeneous Vuggy Carbonates"of SPWLA Formation Evaluation Symposium of Japan.

MDPI Energies Student Poster Award

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

Country

Brazil

Acceptance of the Terms & Conditions

Click here to agree

Energy Transition Focused Abstracts

Primary author: FERNÁNDEZ, Jesús Daniel (PUC-Rio)

Co-authors: AVENDAÑO, Jorge (Pontifical Catholic University of Rio de Janeiro PUC-Rio); CARVALHO, Marcio (PUC-Rio)

Presenter: AVENDAÑO, Jorge (Pontifical Catholic University of Rio de Janeiro PUC-Rio)

Session Classification: Poster

Track Classification: (MS11) Microfluidics and nanofluidics in porous systems