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Use of topological principles to determine wettability from pore-scale images

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There are numerous challenges associated with measuring the wettability of a porous material. Surface roughness and chemical heterogeneity obscure representative characterisations via contact angle hysteresis. Micron-resolution X-ray CT imaging has enabled direct geometric measurements of contact angle inside core samples but due to uncertainty and error at the contact line, this method tends to skew values towards 90°. The recent inception of an alternative topological approach has resulted in an approximate relationship between contact angle and interfacial curvature for individual clusters of the non-wetting phase, though its application has been limited to images of water-wet rocks at residual oil saturation. Here, previously published topological methods are demonstrated to be only applicable at these conditions. Furthermore, the wetting phase is not specified, leading to ambiguity for heterogeneous mixed-wet samples. We present a more generalised model to include any wettability and saturations with high phase connectivity. A practical workflow has been developed for application to experimental pore-scale images, with processing parameters optimised using results from lattice Boltzmann simulations. Correcting for the relative orientation of the contact line with the solid surface, lacking from previous methods, is shown to significantly reduce error. Comparison of measurements from both techniques on experimental and simulated images at similar conditions suggests that the topological approach presented here provides the more accurate quantification of contact angle for both water-wet and mixed-wet Bentheimer sandstone samples. Consistent 3D spatial distributions of contact angle for these images can now be observed, enabling wettability in porous media to be studied in much greater detail.

Time Block Preference

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

References

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