Contribution ID: **448** Type: **Oral Presentation**

Fitting correlation-based and neural-network-based relative permeability models to a large dataset of forced and spontaneous imbibition experiments

Tuesday, 31 May 2022 17:15 (15 minutes)

Estimating multiphase flow properties from Special Core scale Analysis (SCAL) has been extensively applied to obtain multiphase flow parameters representing the reservoir scale. Core flooding experimental data can also be used to investigate the mechanisms of more complex multiphase flow systems such as modified salinity water flooding, which has been shown to increase the oil recovery in chalk formations. However, the complexity of physicochemical phenomena cannot be captured by core flooding experiments; thus, the available models and tools which are based on input from core flooding experiments create uncertainties unless the models are tuned to many core flooding experiments, which is expensive and time-consuming. Moreover, the core flooding experiments only cover a narrow range of saturation changes. Spontaneous imbibition tests, which are usually cheaper, can serve as a complementary source of data for obtaining multiphase flow parameters; however, simulating a spontaneous imbibition test requires a model that links the diffusion of ions to the core and to/from the water film between the oil and formation water, how these ions modify the wettability of the system and alter the mobility of the phases. Furthermore, unlike the viscous-force-driven core flooding experiments that can be simulated with a 1D model, the SI test requires a 2D or 3D model which can be computationally expensive when used with an optimization algorithm for parameter estimation. We develop a numerical tool that is capable of estimating multiphase flow parameters for modified salinity water flooding using a combination of core flooding and spontaneous imbibition data. Our model is capable of capturing all the rock-fluid interactions and can be run in a reasonable computational time. First, we address the modelling of the reactive flow problem, focusing on the surface interactions between the brine and chalk formation, and the implications of the physicochemical phenomena that can alter the flow properties. We use surface complexation models to describe the ionic interactions at the oil/brine/chalk interfaces. We also use kinetic and equilibrium models to describe the dissolution of chalk. We use an empirical parameter linking the surface reactions to the relative permeability and capillary pressure model parameters. Then, we discuss a solution to the inverse problem of the model described, which can obtain parameters using a large database of in-house and literature experimental data. Our model can accurately and rapidly estimate the relative permeability and capillary pressure curves by fitting a reactive multiphase flow model to the measurements from core flooding and spontaneous imbibition experiments. Additionally, we replace the correlation-based relative permeability curves with a neural network (NN) in the multiphase reactive flow model to create a physics-informed neural network model. We fit the model to our large database of experimental data and compare the NN-based model with the correlation-based relative permeability curves. Our results indicate that a machine learning tool that combines the governing physics equations and a large set of experimental data can predict with accuracy the multiphase flow properties at a reduced running time that reasonably matches with the expected trend of relative permeability curves.

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Participation

Unsure

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