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Parametric Testing of Network Modeling

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Abstract

This work summarizes a network modeling–based approach to understanding single phase and two-phase flow in porous media. Properties of the network model are varied (pore size, aspect ratio, connectivity, and uni-modal vs. bi-modal pore histograms) and the results illustrate how changing these properties will affect both single-phase and multi-phase flow properties in different rock systems.

Network modeling is a relatively recent development in the oil and gas field, in which computer generated porous networks are created and then multiphase flow is simulated through it. Network modeling is important as it allows information to be generated about how a reservoir will behave while needing only basic inputs, which can be gathered from core samples (permeability, porosity, pore sizes and shapes). It can also be used to simulate recovery processes such as water floods, and some enhanced oil recovery mechanisms.

Dr. Martin Blunt at the Imperial College, London has developed a program that can generate a cubic pore network using modified Weibull distributions given pore geometries as inputs. A separate program developed by Dr. Blunt then takes this network and simulates two-phase flow through it using fluid properties such as contact angles, and viscosities as inputs. The goal of this paper is to verify that Dr. Blunt’s program generates realistic data and the program’s behavior when its inputs are altered.

The methodology used was to create a baseline set of data based on Berea sandstone reservoir rock to which all other data gathered will be compared. Then a series of parametric tests will be conducted varying inputs such as pore size, pore throat length, pore size distribution, and pore shapes to determine their effects on the model. Other characteristics will also be tested such as the use of bimodal pore size distributions, and alterations of fluid properties to simulate chemical floods. All the data generated will then be analyzed and compared with real world data when available to determine its accuracy. By using this approach, the applications and the limits of the model can be found.

By varying the properties of the porous medium (pore body size, pore throat size and connectivity), it is possible to understand how properties of flow in porous media can be affected. This allows for a phenomenological understanding of how different porous media will behave in single-phase flow (i.e. permeability) and in trapping vs. displacement in multi-phase flow systems.