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MICROFLUIDIC STUDY OF DRAINAGE AND IMBIBITION IN POROUS MEDIA: DEFINITION OF AMOTT INDICES

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ABSTRACT

The wettability of reservoir rocks plays a critical role in oil recovery operations. This property is traditionally defined in terms of the contact angle between the fluid-fluid interface and the solid surface. In natural porous media, it has been preferred to characterize the wettability and its effects on fluid flow behavior in terms of Amott indices, through the capillary pressure-fluid saturation relationship. This "bulk" definition is based on the steady states reached by the two phases, the wetting one and the non-wetting one, upon drainage (removal of the wetting fluid) and imbibition (removal of the non-wetting fluid). These indices provide some indirect indication of the rock surface chemistry and porosity structure. Previous studies on Amott indices have mostly focused on numerical modeling of rocks.

In this paper, we present an experimental study on two phase flow in regular lattices of glass microchannels. A wet etching technique is used to fabricate $2D$ networks composed of hundreds of repeat units. The repeat units are square, hexagonal, or triangular, with a lattice parameter of about 100 micrometers. Controlling and varying the microchannel wettability, network geometry, and fluid properties allow correlating the physical chemistry of the system and the characteristics of the multiphase flow. We perform drainage-imbibition cycles by controlling the pressure difference across the device. For each pressure difference, we record and characterize the distribution of the two phases at equilibrium.

Our results capture the dependance of the Amott index on both fluid and network properties. The values obtained are consistent with previous studies on wetting phenomena at the pore level. The drainage-imbibition cycles also provide information on the patterns of invasion. We show that the study of the cycles can further predictability of Amott indices.

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