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Permeability and porosity modeling in artificial core

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In EOR research, the use of natural reservoir core is faced with four main problems: 1. The repeatability of the petrophysical properties in natural reservoir core is poor, making it unsuitable for contrast and repeat experiments to examine the influence of individual petrophysical factor under specified physical conditions. 2. The physical properties of the natural reservoir core are uncontrollable and cannot be tailored to provide the macroscopic material properties according to the research needs. Thus natural reservoir core is unsuitable to be used to carry out controlled experimental studies, such as the research on mechanism by which permeability and wettability influence seepage and oil displacement. 3. The natural reservoir core has complex mineral composition and physical properties. The influence on seepage and oil displacement in natural reservoir core is thus a combined result of many complex factors, with quantitative analysis of contribution from each individual factor and interpretation of the experimental result difficult. 4. Natural reservoir core are typically cored from a localized zone in the reservoir and thus cannot model the macroscopic heterogeneity of the reservoir. Additionally, the size of natural reservoir core is generally rather small with large end effect, and thus cannot be used for two-dimensional experiment nor experiment to investigate distributive properties (e.g. pressure distribution, etc). These shortcomings of natural reservoir core highlight the importance and irreplaceability of artificial core. The authors introduce an artificial core synthesized with a specialized adhesive served as binding in this study that addressed the mentioned shortcoming of the natural reservoir cores in two ways. First, permeability of the artificial core introduced in this work can be tailored to be in the range of 10-5000 mD through adjustment of the ratio of differently sized sand particle, optimization of sand compression pressure, and optimization of sand compression time. This is accomplished by first finding out the relationship between sand particle size and resultant porosity/permeability of the synthesized artificial core. Second, through this established relationship between sand particle size and the porosity/permeability of the synthesized artificial core, authors were able to accurately synthesize artificial core with comparable porosity and permeability within a tight tolerance to the target natural reservoir core . Through this study, the adjustment of the ratio of differently sized sand particle can achieve synthesized artificial core with different permeability and porosity. The method introduced in this work can match closely the permeability and porosity to the natural reservoir core, but the work load is large to find the correct ratio of each type of sand. Also, the accuracy of the other petrophysical properties of the synthesized artificial core is not guaranteed, such as the particle size distribution and pore throat distribution.

References

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Primary authors: Prof. YUE, Xiang'an (China University of Petroleum (Beijing)); Mr FU, Joseph (China

University of Petroleum （Beijing））; Mr ZHANG, Bo (China University of Petroleum (Beijing))

Presenter: Prof. YUE, Xiang'an (China University of Petroleum (Beijing))

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