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The use of RFID technology to measure the compositions ether-oil-brine mixtures for solvent enhanced imbibition experiments

Description:
Recent developments in Radio Frequency (800MHz-1000MHz) Identification
(RFID) devices suggest that it is possible to use them for wireless laboratory measurements of the dielectric coefficients of fluid mixtures with possible spin-off for their use in the petroleum engineering/ hydrology practice. This contribution demonstrates the measurement of the dielectric coefficient of oleic and aqueous solutions of diethyl ether using a tag with dimensions $0.095 \times 0.008 \times 0.001$ m^3.
As a precursor to the RFID measurements, we determined the concentration dependent partition coefficient, i.e. the ratio of the of diethyl ether concentrations in the oleic and aqueous phases, using an Anton Paar density meter. The phase behavior measurements are followed by simulations of the RFID setup in COMSOL™ to provide an understanding of the response function (e.g. the minimum power at the tag position) dependence on the presence of the blocks (media) surrounding the tag. Subsequently, we describe laboratory experiments using a state of the art RFID device (RFID CISC Xplorer-200) to examine the relation between RFID response and diethyl ether volume fractions in the oleic and aqueous phase. The measurements show the feasibility of using RFID technology to accurately determine the diethyl ether-water and diethyl ether-oil compositions.

Application:
Concentration measurements in experiments for solvent enhanced recovery in fractured media.

Results, Observation, Conclusion:

(1) Simulations with COMSOL™ help to resolve design issues for implementing RFID technology, e.g. (a) the optimal volumes of the media blocks covering the tag on both sides, (b) to prove the negligible influence of the protection foil around the tag.
(2) From the graphs, where we plotted the RFID response functions versus the dielectric coefficient, we can conclude that some optimal frequencies show a larger dependence on the concentration (volume fraction) of diethyl ether in oil and diethyl ether in water than other frequencies.
(3) Due to the strong dependency of the RFID response on the dielectric coefficient, the system can, therefore, be used for measurement of dielectric coefficients and thus compositions.

Significant New Contributions:
Workflow to use RFID technology for wireless in-situ dielectric measurements and thus compositions in laboratory experiments in the porous medium flow.

Sincerely,

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