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Preferred Topics (up to 2):

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Fluids and flow characterization

Fluid separation and on-chip analysis

Synthesis and performance monitoring

New technologies for the environment and alternative energies

Keywords (up to 5):

- Enhanced oil recovery
- Calcite
- Packed bed
- Confocal fluorescence microscopy
- Microfluidics

MEASURING OIL RECOVERY USING OPTICAL MICROSCOPY WITH PACKED BEDS IN MICROFLUIDIC CHANNELS

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OBJECTIVE

We have developed a microfluidic platform as a complementary tool for core flooding procedures concerning enhanced oil recovery (EOR). Assessing the effects of water compositions on oil recovery using core rock is time and cost intensive. By mimicking the structure and process on a microfluidic scale and by visualization of in situ oil and water distributions, almost immediate results and mechanistic insights can be obtained. With this motivation, we introduce a microfluidic platform for 'rock-on-chip' experiments and related data analyses procedures concerning oil recovery.

METHOD

The chip design consists of a polydimethylsiloxane channel sealed with a glass coverslip. Synthetic calcite particles are assembled into a packed bed by using a barrier within the channel. The packed bed is first aged with formation water and then with oil. Next water flooding process is mimicked by injecting distinct brines at controlled flow rate (c.q. capillary number). Confocal fluorescence microscopy is used to visualize the spatial distributions of calcite, brine and oil, up to a depth of 5 μm . To quantify mineral, water and oil distributions, three-dimensional image data are collected and an automated image analysis is applied to convert grayscale images to residual oil percentages.

RESULTS

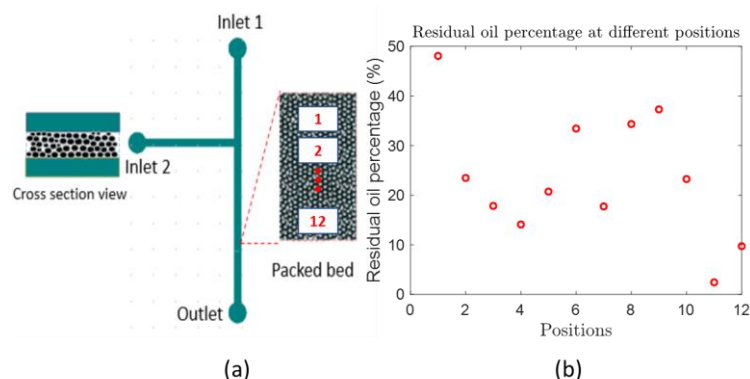


Figure (a) illustrates the calcite packed bed within the microfluidic channel and data acquisition performed at different positions. From image post-processing, figure (b) shows residual oil percentage at 12 positions along the packed bed after water-flooding.

NOVEL/ADDITIVE INFORMATION

Experimental simulation of EOR processes by microfluidic platforms is currently in infancy. Few visualization studies using packed beds were done using an artificial chemistry/quasi-monolayer [1,

2, 3]. We focus on the in situ chemical aspects by using packed mineral particles and process relevant fluid compositions. Our microfluidic platform should produce similar trends as for 3D rock system, will be extended to elevated temperatures and real rock material.

References

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