Salinity effects on oil droplet remobilization in constrained capillary tubes: pore-scale mechanisms

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Motivation
Numerous controlling mechanisms have been proposed to explain the oil remobilization due to low-salinity effects, but these mechanisms are among them. However, our knowledge of the contributions of osmosis and water-in-oil emulsification is limited, and they are associated with time scales that are not well understood. In this paper, 11 capillary tubes with an inner diameter of 800 μm are used to inject a sequence of low-salinity water, crude oil, and high-salinity water phases and observe the evolution of the system.

1. Introduction
When the crude oil is in contact with water, the polar components in the crude oil, such as naphthenic acids, resins and asphaltene, are adsorbed at the phase interface which could bond with water molecules and produce water-in-oil emulsions [1,2]. It is indeed known that, in a low-salinity water environment, when the salinity is less than a threshold value, there is a higher water content in the oil phase [3].

2. Hypothesis of emulsification and water diffusion in the oil phase
The crude oil phase is considered to have been in equilibrium with brine. Water not only diffuses molecularly in oil but also exists as reverse micelles.

3. Experimental Methods
We monitored and measured oil globule movement, contact angle change, pressure change in mini-capillaries within 40 days using 2 observation setups and microscopic pressure sensors.

4. Results
Oil droplet movement

5. Conclusions
- In the water-wet capillaries the oil droplet moved a distance of about 524 μm.
- The contact angles of LSW/HSW with crude oil gradually decreased by 34.32° and 18.23°, respectively, during the first 15 days.
- The pressure difference between HSW and LSW phases reached a plateau with a maximum value of 1.68kPa during a period of 24 days.

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Reference