Motion of an oil droplet through a capillary with oppositely charged surfaces

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ABSTRACT

Some of the most challenging problems in the field of foam and emulsion science concern systems in which the foam or emulsion is confined in a porous medium. To understand the system behaviour, it is then necessary to consider not just how the two phases of the foam or emulsion interact with one another, but also how they interact with the walls of the medium. In this work, a classical problem [1] of a bubble or analogously an oil droplet moving through a capillary is revisited, to consider how oil might be recovered during waterflooding operations in the petroleum industry. In real systems however, physical chemistry dictates that the surfaces both of the droplet and of the pore walls are charged, and moreover these surface charges can be manipulated by changing the salinity of the waterflood [2, 3]. A special case is considered here in which the salinity is such that the charges on the droplet and pore walls become opposite and equal. These opposite and equal charges attract, and as a result, an aqueous film that is formed separating the droplet from the pore wall is thinner than in the classical uncharged case [1]. However it is shown that multiple solutions are found for the permitted film thickness. Moreover moving from the thin film towards the front of the droplet, spatial oscillations are found on the droplet surface. In the classical uncharged case [1] such oscillations are only ever seen at the rear of the droplet, not at the front.

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