DEFORMATION AND DETACHMENT OF CARBON TETRA CHLORIDE DROPLET IN THE PRESENCE OF DIFFERENT CONCENTRATION OF SURFACTANT FROM SOLID SUBSTRATE

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ABSTRACT

Detachment of droplet is important process in hydro cleaning and tertiary oil recovery from narrow passage of porous medium. Carbon tetrachloride droplet is attached on the bottom of close channel. Water is being used as a shearing fluid. Deformation and detachment of CCl₄ droplet is visually observed in the presence of surfactant sodium dodecyl benzene sulfonate (SDBS).

Key words: Carbon tetrachloride droplet, alkane and oil droplet.

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angle close 180°. At the opposite end of the flow spectrum, Durbin (1988) [5] analyzed the displacement of droplets in inviscid flow, employing free streamline theory and an asymptotic for infinitesimal contact angles. Feng and Basaran (1994) [6] conducted a detailed study of the displacement problem for steady two-dimensional flows at arbitrary Reynolds number $Re$. These authors utilized finite element solutions of the Navier-Stokes equation the yield condition for a range of Reynolds number. Feng and Basaran restricted their computation to bubbles with zero viscosity and no gravitational forces. At low Reynolds number, this work complements that of Dussan and Chow, but is not directly comparable owing to different geometries and assumptions at contact line. Dussan and Chow analyzed three-dimensional droplets attached to a smooth plane with contact angles limited by $\Theta_A$ and $\Theta_R$, while Feng and Basaran considered two-dimensional droplets attached to a slot in a plane wall with the contact line pinned at sharp boundary edge. Li and Pozrikidis (1996) [7] studied the three-dimensional analogue of the problem of Feng and Basaran in the limit of low $-Re$ flow. These authors computed the shapes of droplets as function of $Ca$ and reported on the distribution of contact angles around the contact line. Owing to the difficulty of the three-dimensional flow problem, this study was limited to fluids and droplets of equal viscosity and computations were performed for a limited range of parameter values. S. Basu et al. (1997) [8] had predicted the shear rate required to detach the oil droplet from solid substrate assuming probate spheroid shape of droplet. He predicted a drop with an equilibrium contact angle much smaller than 180° (sings 120°) slides on a solid surface due to its high contact angle hysteresis. During the sliding lotion, the drop detaches from the solid surface when the lift force equals the adhesive, gravitational and buoyancy forces of the drop. The required average fluid velocity was seen to decrease as channel height decreased.

![Figure 1 Schematic diagram of experimental setup.](image-url)
Deformation and Detachment of Carbon Tetra Chloride Droplet in the Presence of Different Concentration of Surfactant from Solid Substrate

Figure 2 Deformation and detachment of \( \text{CCl}_4 \) droplet in different concentration of surfactant in water as shearing fluid

In general, less fluid velocity is required to detach similar sized bubbles in channel of smaller height. Droplets used in this experiment is of carbon tetrachloride in different ppm of surfactant. Water is used as shearing fluid. The experimental setup is used for the visualization of droplet deformation and detachment by shear force. Overhead (a) as shown in Figure 1, field with water as a shearing fluid is installed at a constant height of 10 ft. the shearing fluid from this tank flows to the required channel (c) made of silicate glass, through the rotameter (b). The channel dimensions are, and its dimension was such in comparison of size of oil droplets (4 ml), that the effect of side walls, entry and exit length may be neglected. The range of flow in rotameter used is 2–15 lit/min and dimension of the channel which is 0.1 m (diameter) resulted in maintaining laminar flow of the shearing force during the experiment. The test section (c) was made of silica glass which is molecularly smooth and preferentially wetted by water. A hole of 50 mm diameter was located on the top of the channel and hear the half the length of the test section (channel) to release oil droplets on the bottom wall of the channel. The whole was covered with a lid during experiment so that the water does not spill out and no disturbance was created in the flow pattern of aqueous phase inside the test section. Figure 2 show shape of 4 ml droplet of \( \text{CCl}_4 \) with time, in 2 ppm, 3 ppm and 5 ppm of surfactant at different flow rates increased from zero to critical value at which droplet detaches. It is seen that the \( \text{CCl}_4 \) droplet deforms as the shearing fluid (aqueous phase) flow rate increases. The deformation of
droplet increase with increase of flow rates and at last droplet detaches from substrate. Droplet deforms more as concentration of surfactant increases because the interfacial tension decreases as ppm of surfactant increases in water. Similar plots for iso-quinoline droplet are discussed in Gupta and Basu (2008) [9]. It is seen that the CCl₄ droplet elongates as flow rates increase and at one point it detaches from substrate.

In order to elucidate the mechanism of deformation and detachment of oil As the shearing fluid (aqueous phase) flow rate increase, the oil droplet deforms and advancing and receding contact angle formed at up stream and downstream side of the droplet detaches or slides on the solid substrate depending on equilibrium contact angle and contact angle hysteresis on slides when the drag acting on the droplet overcomes the retentive force, which oil water done interfacial tension and the adhesive force between the droplet deformation increases with the increase in flow rate, surfactant concentration for given sizes of the droplet. The shear rate required for detachment decreases on the size of the droplet increases and surfactant concentration increases. The drag on the droplet in creases with the increase in size of the droplet retentive force decreases with the in surfactant concentration, which in term decreases the interfacial tension.

REFERENCES


