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Effect of non-ionic surfactants on velocity of single rising bubble

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Surface-active agents are essential components in numerous industrial multiphase processes, where they significantly alter the properties of phase interfaces. The present study investigates the influence of non-ionic surfactants on the behavior of an isolated bubble rising in a stationary liquid. This simple type of experiment is ideal to monitor changes in bubble velocity, which is a key parameter for determining bubble surface mobility and its degree of contamination. Uneven surfactant distribution generates Marangoni stresses, increasing the drag coefficient (Manikantan, 2020). Five non-ionic surfactants (n-propanol, n-pentanol, n-octanol, α-Terpineol, Triton X-100) differing in their molecular structure and adsorption/diffusion dynamics at the gas-liquid interface are examined. A wide range of surfactant concentrations was tested, and adsorption/diffusion dynamics were evaluated using equilibrium and dynamic surface tension measurements.
The results demonstrate that the degree of surface immobilization and the resulting reduction in bubble velocity strongly correlate with the surfactant's molecular structure and adsorption kinetics. A significant contrast was observed between short-chain alcohols and large surfactant molecules; for instance, Triton X-100 induced complete surface immobilization at concentrations six orders of magnitude lower than those required for n-propanol. Furthermore, local velocity profiles revealed different rates of surface loading. The study provides a comprehensive overview of the influence of the absorption kinetics of nonionic surfactants on bubble behavior.

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