Bubbles: from fundamentals to profit

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The presentation covers two aspects of the author's research: the use of single bubble rise velocity to identify surfactant properties, and the exploitation of bubble swarms to enhance flotation.

Flotation is one of the largest applications of surface chemistry. To produce the swarms of fine-sized bubbles required involves a class of surfactants known as frothers, usually alcohols and polyglycols. Commonly referred to as 'weak' or 'strong', trying to define more quantitatively has triggered fundamental investigations, in the author's case using single bubble rise velocity. In one investigation, surfactant concentration giving minimum velocity (CMV) was determined. This revealed novel findings, among them: for alcohols branched-chain isomers are superior to straight chain, the best combination being OH at the terminus and the methyl branch as far away as possible. Interpretation considered the effect of structure on surface activity, mass transfer rate, H-bonding, and molecule packing. Parallel studies identified an oscillation in bubble rise velocity related to shape, as the bubble became more spherical it slowed down. This was explained by competition between forces, one surface tension driven due to the surfactant the other due to hydrostatic pressure across the bubble.

Over a century ago Pickard observed[*]: "*The man who understands the mystery of a soap bubble has mastered the chief mystery of flotation"*. Recent development of online sensors to measure bubble size, air holdup and air velocity have unraveled the mystery enabling bubble swarms to be profitably manipulated, for example, optimizing frother addition and air distribution to flotation machines. Linking Flotation rate constant to gas holdup has ushered in novel machines now making commercial inroads.

[*]Pickard, T.A. 1916. The Flotation Process, Mining and Scientific Press, 364 pages.