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Evaluation of the flotation efficiency of nano and microbubbles tailored to optimize bubble size distribution using a kinetic model

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ABSTRACT

Bubble size is among the most important factors that determine flotation efficiency. The bubble used for flotation varies from nanobubbles (NBs) to microbubbles (MBs). In this study, the flotation experiments were carried out, and then the flotation efficiency was calculated based on the collision-attachment efficiency and the number of NBs and MBs bubbles using the kinetic model. The flotation efficiency was highest for tailored bubbles, followed by MBs and NBs. We determined that flotation efficiency increased as the interaction between the attachment ability of NB and the flotation ability of MB. We also determined the optimal mixing ratio by adjusting the amount of NB and MB to increase flotation efficiency. We found that the most important determinant of flotation efficiency was the ratio of MB and confirmed that NB acts as an auxiliary material that increases the attachment efficiency of floc and bubble. Also, when the amount of NB was too small flotation efficiency decreased, confirming that the flotation efficiency increased only when an appropriate ratio of NB was injected to increase the attachment efficiency.

Keywords: Bubble diameter; Dynamic light scattering; Flotation; Microbubbles; Nanobubbles

1. Introduction

Bubble size is one of the important parameters affecting flotation efficiency [1]. The flotation process can be simply described using Eq. (1).

$$E_f = E_C \times E_S \times \left(1 - E_d\right) \quad (1)$$

where E_f represents overall flotation efficiency. E_C is the collision-attachment efficiency of bubbles and particles, E_S is the efficiency at which bubble-particle aggregates (formed by the attachment of bubbles to particles) are separated from the water body, and E_d is defined as the efficiency at which bubbles and particles are detached from the formed bubble-agglomerates. Generally, E_d is close to 0 and can be ignored when conditions for flotation are well controlled.

Flotation that relies on microbubbles (MBs) is widely incorporated into traditional water treatment processes and is highly efficient at removing small particles (such as algae). The flotation process requires less coagulation time and solid–liquid separation time than a sedimentation process, so it has the advantage of configuring a small facility area and a compact process [2,3]. To date, saturator-type MBs bubble generators are mainly used in flotation systems [4]. Recently, an ejector-type bubble generator that uses cavitation has been developed. The ejector-type device generates smaller-sized bubbles [5] and enables water treatment using nanobubbles (NBs) [6]. Many researchers have

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