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Study on the Stability of Fine Bubbles in Seawater and in their Salt-Containing Solutions

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Summary

The stability of Fine Bubbles was studied for saline solutions considering microscopic and macroscopic features. Fine Bubbles (FB) are gas bubbles of less than 100 μm. They are subsequently classified into Micro Bubbles (MB), gas bubbles between 100 and 1 μm, and Ultra Fine Bubbles (UFB), gas bubbles less than 1 μm. FB are often produced using hydrodynamic or acoustic cavitation (i.e., ultrasound). Hydrodynamic cavitation is produced using a Venturi tube, swirling flow, injection of pressurized water containing gas, etc. This research uses a Venturi tube with obstacles that promote gas-liquid contact.

The stability of FB is related to macroscale and microscale characteristics. In this research, the zeta potential (ζ) and the particle size distribution are measured to know the FB microscale characteristics. The zeta potential is the potential difference caused by the surface charge of a bubble, measured in millivolts (mV). It measures the electrostatic repulsion or attraction between particles and bubbles. Thus, it predicts long-term stability in a colloidal system. If all the particles in suspension show a zeta potential more positive than +30 mV or more negative than -30 mV, they tend to be stable for a long time. The size distribution of FB was measured through the Dynamic Light Scattering (DLS) method, in which a laser beam irradiates on the surface of small enough particles.

Oxygen gas absorption experiments were done to validate the FB macroscale characteristics. The dissolved oxygen (DO) concentration in the liquid is fast when FB exist. Therefore, the solution must be supersaturated to maintain a balance between the self-pressurizing effect and the double-layer electric charge of FB existing in the solution.

The experiments showed the stability of FB in seawater solutions. The zeta potential ranged between -80 and -20 mV while the size distribution of FB ranged between 100 and 200 nm, which means that from the microscopic measurements, FB are stable. Moreover, for high salinity concentration (PSU = 42), the zeta potential values were the highest, implying that FB is more stable at high salinity. The DO concentration using FB was higher than using conventional gas bubbling under all conditions. Therefore, the FB generated by the hydrodynamic cavitation method are stable from the microscopic and macroscopic viewpoints.