Abstract

Microbubbles with diameters on the order of 10 μm have their unique characteristics which are often called size effect. Their amazing effectiveness for closed-water purification pushes them into limelight in the field of water treatment. However, except for the several successful cases, there is few fundamental and specific research data reported. Moreover, the present microbubble generation methods all have their own merits and demerits and they need to be improved to meet the requirement for water treatment. In this study, the author firstly evaluates the characteristics of a newly-developed microbubble generator, and then makes some attempts to improve its microbubble generation efficiency. The improved microbubble generation system is then introduced to the advanced water treatment processes and examined for the effectiveness. The applications to advanced water treatment studied in the present research include air flotation and ozone oxidation.

Air flotation is widely used as an alternative to sedimentation in the field of water treatment to remove algae from nutrient-rich stored water or to treat low turbidity, high colored water at low temperature. The most popular type of air flotation, Dissolved air flotation (DAF), has its inherent disadvantages, such as high electrical power requirement, complex system and higher service cost. The author tried three different microbubble generation methods to develop an efficient Induce Air Flotation (IAF) system. Kaolin suspension with low concentration was used as the model water. The best performance occurred in the improved method where gas and water were simultaneously induced and mixed by the pump, and dispersed through the rotating-flow microbubble generator.

Ozone is a popular oxidant and disinfectant in advanced water treatment. However, the

application of ozone has been limited by its low utilization efficiency because the ozone mass transfer rate from the gas phase to the liquid phase is relatively low. Microbubbles, with high specific interfacial area, large residence time and high inner pressure, are thought to be excellent in ozone gas mass transfer. However, the lack of knowledge about mass transfer using microbubbles causes many difficulties in the ozone reactor design. The author evaluates the mass transfer efficiency of microbubbles under different conditions. The volumetric mass transfer coefficient increases with increasing both induced-gas and water flow rates. The $k_{L,O_3}a$ obtained in the present study was also compared to those from other researchers. A similar level of $k_{L,O_3}a$ was achieved at low gas flow rates when microbubbles were employed.

A further research on the removal of organic contaminants in water was carried out. Demethyle Sulfoxide (DMSO) was selected as the model contaminant because it makes much odor trouble for the traditional waste water treatment. Experimental results indicate that the ozonation of DMSO is a first-order mass-transfer controlled reaction. Ozone utilization ratio increases with a decrease in gas flow rate. The ratio of DMSO removed to ozone dissolved can be raised to as high as 0.8 or higher with proper gas and water flow rates. It was also proved that no free radicals were yield by air microbubbles in the microbubble generation system.

It is expected that the specific data in the present study could provide valuable information for the design of water treatment processes using microbubbles.