No. 17A4, 18A4, 19A4

Utilization of Bromine in Seawater by Redox Reaction with Fine Bubble Supply and Application to Water Purification

Yoshinari Wada[1], Kaoru Onoue[2]

[1]College of Industrial Technology, Nihon University, [2]Faculty of Engineering, Chiba Institute of Technology

Summary

N To create the comprehensive utilization system of seawater resources based on the salt production process, the utilization method of dissolved bromine (Br) in the discharge concentrated brine of salt manufactory in Japan was developed. In this study, we focused on the production of Br oxyacid as an upgrading method for Br using O_3 fine bubbles, which has a high oxidation potential, and developed a technique for water purification. When O_3 fine bubbles is introduced into the liquid phase, the gas absorption of O_3 is accelerated by the increases in gas–liquid interfacial area and residence time of the bubbles and the hydroxyl radical (OH•) generation is enhanced by the increase in contact probability between the dissolved O_3 and accumulated OH^- at the minute gas–liquid interfaces. Moreover, when O_3 fine bubbles are supplied into a liquid phase with coexisting Cl^- or Br^- as halogen ions, further improvement in oxidation potential in the liquid phase can be expected by the acceleration of the Br oxyacid generation with OH•.

In the case where O_3 fine bubbles with an average diameter of 50 μm were continuously supplied into the simulated seawater or ion-exchanged water, the concentration of active oxygen species (C_{OS}) in the simulated seawater increased to 1.4 times greater than that in the ion-exchanged water. Additionally, when O_3 fine bubbles were fed into a solution of NaCl, $MgCl_2$, $CaCl_2$, KCl, or NaBr to condirm the factor of C_{OS} increment, the tendency of C_{OS} to increase with the bubble injection time in the NaBr solution was more pronounced than those in the ion-exchanged water and other salt solutions, because oxyacids of Br such as HOBr/BrO^- were generated by the selective oxidation of Br^- during the O_3 fine bubble injection into the NaBr solution.

Further, to evaluate the effects of the Br^- concentration on the degradation of methylene blue (MB) as an organic compound, MB was degraded by O_3 fine bubble injection into NaBr/MB solutions with different initial NaBr concentrations ($(C_{NaBr})_0$). The formation of Br oxyacids owing to the acceleration of the reaction between OH• and Br^- during the O_3 fine bubble injection led to an enhancement in MB degradation. Furthermore, the degradation of *tert*-butyl alcohol (TBA) by O_3 fine bubble injection at different $(C_{NaBr})_0$ values was carried out. Consequently, the rate constant of TBA degradation exhibited a maximum value at C_{OS} of 0.54 mmol/L because of the conversion of HOBr/BrO^- with higher oxidation potential to BrO_3^- with lower oxidation potential caused by the excess oxidation of Br^-. Hence, the generation of HOBr/BrO^- with O_3 fine bubble injection and bromide addition is effective for achieving enhanced degradation of refractory organic compounds.