applied sciences

Article

Comparison between OCl^--Injection and In Situ Electrochlorination in the Formation of Chlorate and Perchlorate in Seawater

Jongchan Yi [1], Yongtae Ahn [1], Moongi Hong [2], Gi-Hyeon Kim [1], Nisha Shabnam [1], Byongsueng Jeon [2], Byoung-In Sang [2] and Hyunook Kim [1,*]

[1] Department of Environmental Engineering, University of Seoul, 163 Seoulsiripdaero, Dongdaemun-gu, Seoul 02504, Korea; jcyi1989@gmail.com (J.Y.); walker34@naver.com (Y.A.); bluemelon33@gmail.com (G.-H.K.); shabnam251@gmail.com (N.S.)

[2] Department of Chemical Engineering, Hanyang University, 222, Wangsimni-ro, Seongdong-gu, Seoul 04763, Korea; hmg3433@naver.com (M.H.); a1trust@hanmail.net (B.J.); biosang@hanyang.ac.kr (B.-I.S.)

* Correspondence: h_kim@uos.ac.kr; Tel.: +82-2-6490-2871, Fax: +82-2-6490-2859

1. Seawater Sampling Site

Seawater samples were collected from the west coast (Yeonggwang, Korea, 35°23′27′′N, 126°24′25′′E) of the Korean peninsula and the east coast (Uljin, Korea, 37°01′53′′N, 129°24′54′′E) (Figure S1).

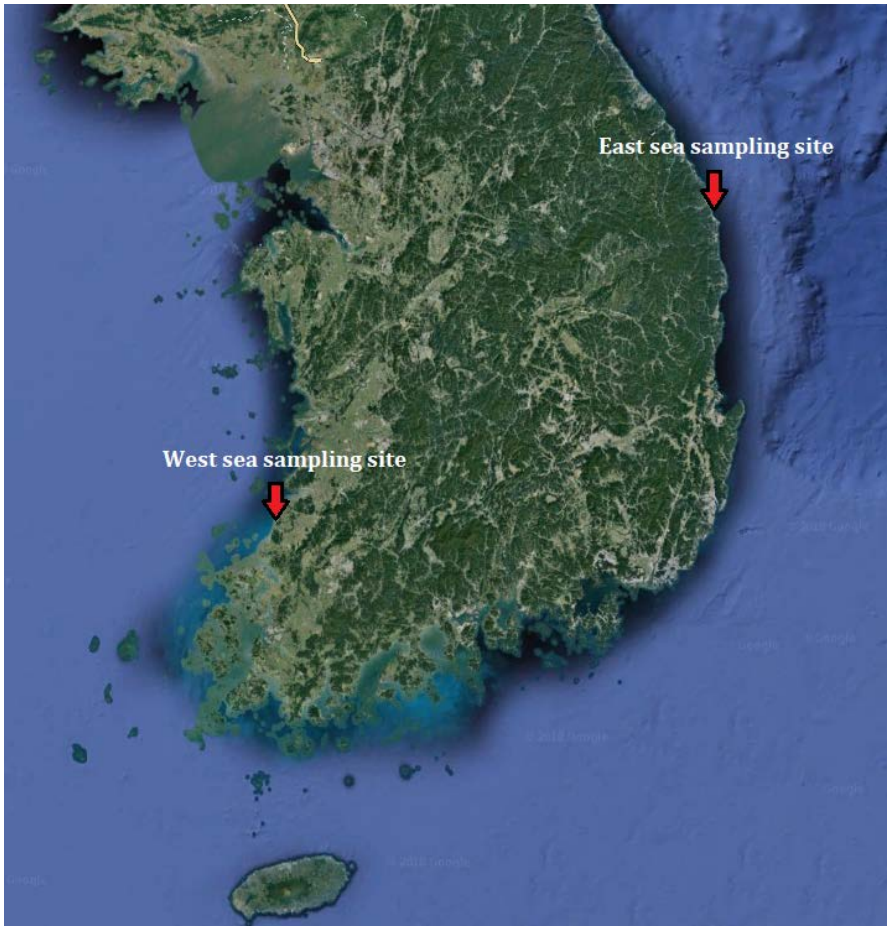

Figure S1. Seawater sampling site; the west sea and the east sea.

2. Effects of Bromine Ions during Chlorination

The electrochemical processes for generating residual oxidants, including hyperbromous acid (HOBr/OBr^{-}) from bromine (Br^{-}) are well known (Equations (1)–(3)) [1–5]:

$$2Br^{-} \leftrightarrow Br_2 + 2e^{-} \ (E_o = 1.09 \text{ V}) \quad (1)$$

$$Br^{-} + H_2O \leftrightarrow HOBr + H^{+} + 2e^{-} \ (E_o = 1.34 \text{ V}) \quad (2)$$

$$HBrO \leftrightarrow BrO^{-} + H^{+} \ (pK_a = 8.8 \text{ at } 25\ ^{\circ}C). \quad (3)$$

If bromine ions exist in the water, chlorine quickly changes to hyperbromous acid and ion, as in the following reactions (Equations (4),(5)):

$$HOCl + Br^{-} \rightarrow HOBr + Cl^{-}, \ k = 2.95 \times 10^{3} \ M^{-1}S^{-1} \quad (4)$$

$$OCl^{-} + Br^{-} \rightarrow OBr^{-} + Cl^{-}, \ k = 9.0 \times 10^{-4} \ M^{-1}S^{-1}. \quad (5)$$

Since seawater contains a high concentration of bromine ion, chlorine is changed quickly to hyperbromous acid during seawater electrolysis. Thus, the main TRO formed during electrolysis is hyperbromous acid, despite the formation of chlorine and hyperbromous acid at the same time [6]. In that case, the hyperbromous acid could be the active form of biocide in seawater [7].

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