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酸素プラズマによる水中溶存亜鉛イオンの除去特性

Effect of oxygen plasmas on the removal of zinc ion from water

九大総理工[1] ○(D)サイマ カノム[1], 林 信哉[1]

Kyushu Univ.[1], ○Sayma Khanom[1], Nobuya Hayashi[1]

Abstract

Zinc ion dissolved in water is attempted to be removed by generating the zinc oxide (ZnO) using the ozone oxidation treatment system. The amount of ZnO production were measured at different treatment periods of the oxygen plasma irradiation on water. The amount of the deposit increases initially up to 3 min, and then decreases with the irradiation period. The maximum removal rate of zinc from water is achieved at the treatment period of 1 min.

1. Introduction

Excess amount of heavy metal ions dissolved in tap water induces many serious problems on the health of living bodies including human. As contamination in water has been a serious issue in some countries. However, there is not an effective and reasonable technique to remove heavy ions from the water.

Oxidation of the heavy metal ions sometime produces deposits of metal oxide after oxidation of the heavy metal ions. These metal oxide deposits can be removed from the water easily. The ozone treatment of the tap water, which has been developed and put to practical use, is also effective for the removal heavy ions from the water. The simultaneous treatment for the disinfection of tap water and heavy ion removal from water would be realized using the oxygen plasma. In this experiment, the zinc ion dissolved in water is attempted to be removed generating the zinc oxide (ZnO) using the ozone oxidation treatment system.

2. Experimental procedure

The ozone oxidation of the dissolved zinc ion is performed by the simple ozone bubbling in the water containing the ions, as shown in Fig. 1. The amount of water is 380 ml and there is no water flow in the water vessel. The ozone is generated by the torch type dielectric barrier discharge (DBD) plasma using the pure oxygen gas with the flow rate of 1.0 L/min and the discharge voltage is approximately 5 kV.

Effect of the oxidation of the zinc is evaluated by the generation amount of zinc oxide, which deposits on the bottom of the water. After the ozone or oxygen plasma treatment, the water filled in a conical tube with the capacity of 15 mL is centrifuged, then the deposit accumulates on the bottom. The deposit is extracted from the water and dried up. The weight of the dried deposit is measured using the precision measure. In order to specify the composition of the deposit, IR absorbance spectra of the deposit is measured using the FTIR, and the obtained spectra are compared with the typical spectra of zinc oxide.

3. Results and Discussion

The concentration of the gaseous ozone that is injected into the water is varied from 100 to 800 ppm.

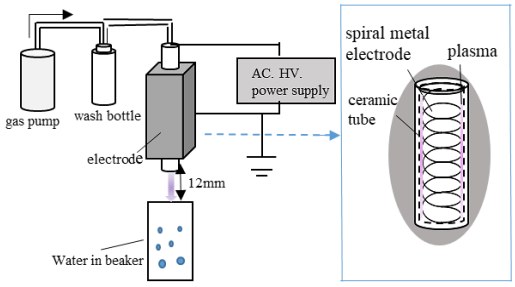

Fig. 1 Schematic diagram of experimental apparatus.

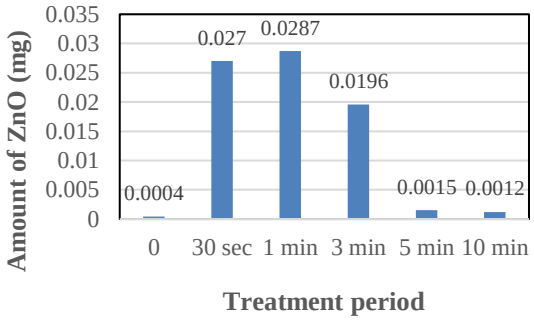

Fig. 2 Production amount of ZnO in water varying the ozone treatment period.

This concentration range is almost same as that used for the practical ozone treatment of the tap water.

The treatment irradiation period dependence of the production amount of the zinc oxide deposit in water is shown in Fig. 2. The amount of the deposit increases initially up to 3 min, and then decreases with the irradiation period. When the treatment period is longer than 5 min, the pH of the water becomes higher than 5. Thereafter, the zinc oxide dissolve in the acidity water and the precipitate would disappear. The solubility of zinc oxide in water is investigated varying the pH value of the water. Other possibility of the decrease tendency of zinc oxide is the production of zinc hydrate from zinc oxide owing to the discharge of H_2O molecule.

4. Conclusions

Removal of zinc ion from water was attempted. The maximum removal rate of zinc from water is achieved at the treatment period of 1 min.