Topic number

Decomposition of Acetic Acid Solution by Dielectric Barrier Discharge

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This study deals with the decomposition of an acetic acid solution by a water treatment reactor based on a dielectric barrier discharge (DBD) with a parallel plate electrode configuration. The treat water is supplied onto an electrode surface as a water film and exposed to the DBD. The total organic carbon of the solution is estimated to evaluate the decomposition of acetic acid by the DBD.

1. Introduction

Water treatment by discharge plasma is promising technology to decompose persistent organic pollutants by chemically active species produced in the plasma. Although a great deal of the water treatment reactor using discharge plasma has been actively developed with various configurations [1], [2], the authors have developed the water treatment reactor based on a dielectric barrier discharge (DBD) produced on a treat water surface [3]. In this work, an acetic acid solution, commonly used as an indicator of persistent organic pollutants, is treated by our reactor and the total organic carbon (TOC) concentration of the solution is measured.

2. Experimental setup

The water treatment reactor used in this study was previously presented in [3], of which the several parts were modified. The reactor has a parallel plate electrode configuration, consisting of a dielectric barrier, a ring-shaped metallic back electrode and a lower metal electrode. The dielectric barrier is a borosilicate glass plate with 75 mm in diameter and 1.1 mm in thickness. It has a hole at its centre for supplying the treat water. The ring-shaped metal electrode applying a high voltage is made of a copper tape with the inner and outer diameters of 28 and 51 mm, respectively. It is adhered on one side of dielectric barrier. The lower electrode is made of stainless steel whose diameter of the planer surface is 52 mm. It is movable in the vertical direction using a micrometer gauge and a stepper motor, which is capable of adjusting the gap distance automatically and precisely. With forming the water film on the lower electrode surface, the DBD is generated between the dielectric barrier and the treat water surface. An acetic acid solution of 20 mg/L in concentration is prepared as the treat water by dissolving a guaranteed reagent of acetic acid with pure water. Total amount of the treat water is 0.5 L, which is circulated by a water pump with a flow rate of 1.5 L/min. The TOC concentration is measured by a TOC analyser (TOC-L$_{CSN}$, Shimadzu Corp.) to evaluate the decomposition of acetic acid. Although the TOC concentration of the 20-mg/L acetic acid solution should be 8 mg$_{TOC}$/L, the TOC concentration before the plasma treatment become around 7.04–7.25 mg$_{TOC}$/L.

3. Experimental results and discussions

The acetic acid solution is treated for 2 hours with different gap distances of 1–2.5 mm. The results are shown in Fig. 1. Argon gas is fed into the reactor with a flow rate of 1.0 L/min. The initial discharge powers adjusted in an effort to be 1.7 W for all gap distances were within the range of 1.57–1.75 W. By 2 hours' treatment, the TOC concentration decreases for all gap distances. The consumption energy for 2 hours estimated from discharge power and treatment time is also indicated in Fig. 1. The consumption energy slightly becomes large with longer gap distance. However, the higher TOC reduction is observed with the shorter gap distance. These results indicate that the shorter gap distance is expected to effectively decompose the persistent organic pollutants.

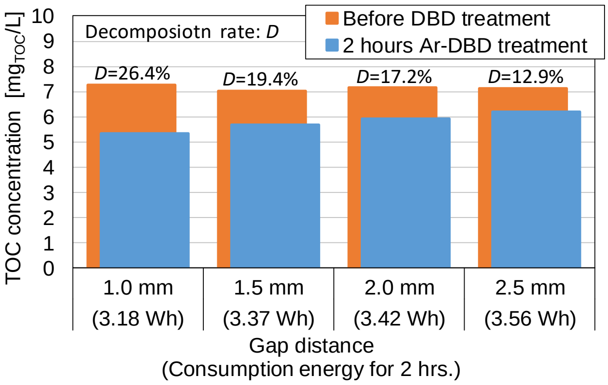

Fig. 1 TOC concentration of acetic acid before and after Ar-DBD plasma treatment for 2 hrs.

3. References

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