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論　文　内　容　要　旨

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学位論文題目	Study of Water Treatment Method with Nanosecond Pulsed Power System (ナノ秒パルスパワーシステムを用いた水処理方法の研究)		

内容要旨

Recently, environmental problems such as water pollution and atmosphere pollution have been serious locally and globally. In order to resolve the water pollution, measures as preparation of law have been adopted against industrial wastewater and water treatment technologies have been studied around the world. As one of water treatment technologies, advanced oxidation processes (AOPs) and biological treatment by microorganisms have been introduced to sewage system. However, there were problems that efficiency of ozone production to perform the AOPs was low and it was difficult for microorganisms to decompose persistent substances during biological treatment. In order to generate ozone and treat wastewater more efficiently, nanosecond pulsed power system of water treatment using electric discharges was studied.

Firstly, the developed water treatment system was evaluated in performance with treatment of indigo carmine solution. The decoloration of indigo carmine using oxygen gas as working gas was faster than that using nitrogen gas. Active species generated from oxygen, such as ozone and OH radical, caused strong decomposition of indigo carmine, because oxidation-reduction potential (ORP) of ozone and OH radical are higher than that of compounds resulted from nitrogen. Moreover, treatment of surfactants which were one of domestic wastewater was performed. Height of foaming which was characteristic of surfactant reduced by 100 minutes' pulse application. In order to investigate advantageous effects of electric discharges, surfactant treatment using nanosecond pulsed power system was compared with that using an external ozonizer. Foaming height in using the pulsed power system decreased faster than that in using the ozonizer, although OH radical production was approximately same in both treatment methods. It would be indicated that the surfactants were not be decomposed sufficiently by ozone and OH radical. Therefore, the electric discharges would promote chemical reactions between OH radical and surfactant. In order to generate a large amount of OH radical with high efficiency, nanosecond pulsed power system should be applied in water treatment for organic compounds.

For faster water treatment, more ozone and OH radical were needed. In order to produce dense ozone more efficiently, electric discharges in coaxial reactor for ozone production were studied. It was found that inner wire electrode of the coaxial reactor was curving at high pulse frequency especially and spark discharges occurred around the part of narrowing of electrodes. Then, ozone concentration decreased at high pulse frequency because uniformity of streamer discharges was lost. Ozone concentration with high pulse frequency was stable without the decreasing by preventing the curving of inner wire electrode. As well as ozone production experiment, the removal ratio of NOx, which caused air pollution, decreased by curving of inner wire electrode. When coaxial reactor with tensed inner wire electrode was also applied to treatment of NOx, NOx treatment efficiency increased.

In a newly developed water treatment device, in order to increase treatment volume of water treatment device, inner diameter of outer electrode became larger. In addition, for an aim to increase direct effects of electric discharges such as UV rays and ion wind, the number of inner wire electrode increased. Surfactant treatment became faster with increasing the number of inner wire electrodes. It was suggested that direct effects of electric discharges which UV rays promoted active species production and ion wind pushed the active species into target solution promoted

surfactant treatment. In addition, in order to investigate necessity of electric discharges, surfactant treatment using the nanosecond pulsed power system was compared with water treatment using an external ozonizer. The foaming height in using the external ozonizer decrease slower than that in using the pulsed power system even when ozone concentration in reactor in using the ozonizer was higher than that in using the pulsed power system. It was found that, with treatment using the pulsed power system, electric discharges under the condition of lower ozone concentration could promote chemical reactions between OH radical and surfactant. As improvement of surfactant treatment, surfactant treatment with a combination system using both the pulsed power system and the ozonizer was performed. The surfactant treatment using the combination system was faster than that using only pulsed power system, while surfactant treatment using only ozonizer was slower than that using only pulsed power system. Because more active species with the combination system were generated than that with only pulsed power system, it was suggested that more active species and electric discharges near the target solution could contribute to surfactant decomposition.

Consequently, streamer discharges generated near target solution using the nanosecond pulsed power system should be applied for water treatment, because the direct effect of the streamer discharges such as UV rays and ion wind pushed the active species toward target solution, so that faster water treatment could be obtained.