Studies on the Decomposition Behavior of Oxalate Organic Waste by UV-photo-Fenton AOP Using a Medium Pressure UV Lamp

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1. Introduction

Oxalic acid($H_2C_2O_4$) is used as reagent for reductive dissolution of metal oxide such as Fe_3O_4. After the dissolution process, it is necessary to decompose oxalic acid into CO_2 and H_2O to reduce waste volume. In order to decompose the oxalic acid, photo-Fenton reaction, which decomposes organics by the combination of H_2O_2, Fe^{2+} and UV, could be applied [1]. In the photo-Fenton reaction, the type of UV lamp and the irradiation density are important factors determining decomposition performance. Especially, the medium pressure UV lamp has UVA, UVB and UVC with a wavelength of 200~400 nm. [2]. In this study, the decomposition behavior of oxalic acid depending on the energy irradiation density was investigated using a medium pressure lamp. Moreover, we tried to confirm that the decomposition behavior of oxalic acid by the medium pressure lamp can be represented as a first-order reaction to the UV irradiation density.

2. Experiments

2.1 Decomposition process of oxalic acid depending on energy irradiation density

This experiment was confirmed the decomposition rate according to energy irradiation density using a medium pressure lamp. The solution was prepared by mixing 2 mM ferrous chloride and 30 mM oxalic acid. For the Photo Fenton treatment, 1500 W medium pressure lamp was used. After injection of 30 mM H_2O_2, the UV lamp was operated with 1700 mL/min circulation using the peristaltic pump. Comparing the volume of 17 L with the volume of 8.5 L, the decomposition behavior with time was investigated. Expt-1 was sampled at 0, 2, 4, 6, 8, 10, 15, 20 and 25 minutes, Expt-2 was sampled at 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 15 minutes. After sampling and dilution, to investigate decomposition behavior of oxalic acid, Total Organic Carbon was measured using TOC analyzer.

Table 1. Experimental Conditions of oxalic acid decomposition of medium pressure lamp

Exp. No	Volume [L]			Q [L/min]	E [kW]
	Reactor	Tank	Total		
Expt-1	1.7	15.3	17	1.7	1.5
Expt-2	1.7	6.8	8.5	1.7	1.5

3. Results

Fig. 1 shows the residual rate of oxalic acid over time. Experimental results show that the decomposition rate was higher when the volume of oxalic acid waste was smaller (8.5 L). It was confirmed that 99% decomposition of 8.5 L took 25 minutes, and that of 17 L took 15 minutes. In this study, to identify the factors involved in decomposition behavior The energy irradiation density was calculated as follows. We also confirmed whether it fitting the first-order reaction model.

$$X = \frac{C}{Co} \times 100[\%] \quad (1)$$

$$-\frac{dX}{dt} = kX \quad (2)$$

$$X(t) = 100 \times \exp(-kt) \quad (3)$$

$$E_{\_UV} = P_{\_UV} \times t/V_W \quad (4)$$

[$E_{\_UV}$: Energy density, $P_{\_UV}$: Lamp, t : UV irradiation time, V_W : Volume of the oxalic acid waste]

Therefore, This can be represented as shown in eq.(5)

$$X(E_{\_UV}) = 100 \times \exp(-k' E_{\_UV}) \quad (5)$$

Fig. 2 shows the result of fitting the residual rate to the UV irradiation density to the first-order reaction model equation. It was confirmed that the decomposition behavior in both experiments can be fitted well by a single graph. Therefore, it can be confirmed that the graph of the decomposition behavior of oxalic acid according to the energy irradiation density is well fitted when the first-order reaction model equation is applied.

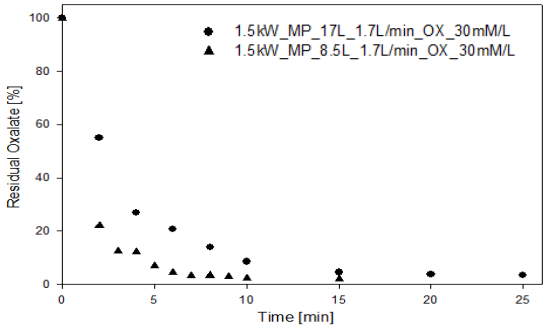

Fig. 1. Fraction of oxalic acid residual depending on time.

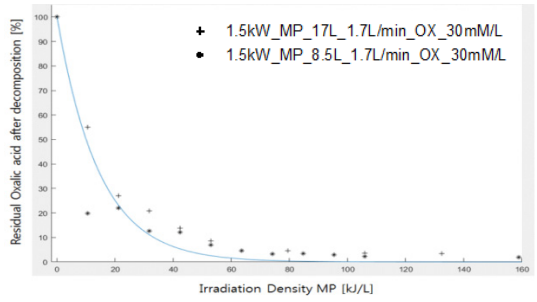

Fig. 2. Fraction of oxalic acid residual depending on energy irradiation density.

4. Conclusion

The decomposition behavior of oxalic acid by a UV-photo-Fenton AOP was investigated using a medium pressure lamp. The following conclusions were obtained within the experimental ranges.

1. The oxalate decomposition behavior by the Photo-Fenton AOP using a medium pressure lamp follows a first-order reaction.
2. The oxalate decomposition behavior is dependent on the UV energy irradiation density[kJ/L] regardless of the recirculation speed and quantities.

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