A Study on the Sludge Solubilization by Alkaline Treatment and Electron Beam Irradiation

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1. Introduction

Sludge is a major product in the wastewater treatment operations. The disposal of wastewater sludge which contains mainly microbial pathogens and organic compounds remains a critical problem in the world. The sludge solubilization reduces the amount of sludge for the final disposal. Moreover, it makes possible to utilize recovered organic acids from the sludge as an external carbon source in the denitrification process. In this study, we studied the sludge solubilization and E. coli sterilization by an alkaline treatment and electron beam irradiation.

2. Materials and methods

2.1 Alkaline Treatment

The sludge pH was adjusted to 12.5 using a 10 N sodium hydroxide solution. The reaction time was fixed to 3 hr.

2.2 Electron Beam Irradiation

The radiation experiments were done using an electron accelerator made by EB-Tech. Co. (Model ELV-4, 1.5 MeV). The experimental apparatus is shown on the Figure 1. About 250 ml of samples in Pyrex vessels were irradiated at room temperature, within the dose range up to 50 kGy.

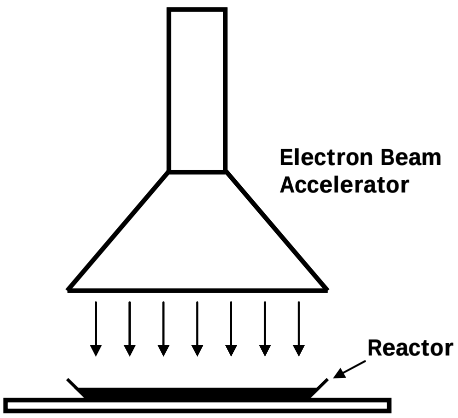

Figure 1. Experimental apparatus used for EB radiation.

2.3 Analysis

The pH, solids, COD_{Cr} and E. coli were measured according to Standard Methods.

3. Results and discussion

As a result of the three-hour reaction, the initial sludge pH of 12.51 was decreased to 10.12 and SCOD/ TCOD ratio was increased to 0.35 from 0.04 (Fig. 1 and 2). This was due to the sludge hydrolysis at strong alkaline pH; pH was decreased and SCOD/TCOD ratio was increased by organic acids produced from hydrolysis process of sludge.

Raw and alkaline treated sludge were irradiated with doses of 10 kGy and 50 kGy, and then SCOD/TCOD ratio, the degree of sludge disintegration and VSS/TSS ratio were measured (Fig. 3-5).

The SCOD/TCOD ratio was increased as the irradiation dose increases and increased much higher when sludge was irradiated after an alkaline treatment. This was due to the destruction of sludge cells by an alkaline treatment and electron beam irradiation and the consequent release of proteins and carbohydrates which exist in sludge cells. The electron beam irradiation after an alkaline treatment was more effective on the cell destruction than sole electron beam irradiation. The concentrations of soluble carbohydrates and proteins were increased in the samples as the irradiation dose increases (data not shown). The degree of sludge cell disintegration was increased as the irradiation dose increases. Electron beam irradiation after an alkaline treatment was more effective than sole electron beam irradiation on the sludge disintegration. When dose of 50 kGy was applied to sludge, the degrees of sludge disintegration which were treated by electron beam irradiation and electron beam irradiation after an alkaline treatment were 26.1and 76.7%, respectively.

The VSS/TS ratio was decreased as the irradiation dose increases and its decrease was higher when electron beam irradiation after an alkaline treatment was applied compared to sole electron beam irradiation application. It is also an indirect evidence indicating organic components such as proteins and carbohydrates were released from sludge cells by disintegration.

Table 1 shows that the reduction of the colony forming unit of E. coli after treatments.

E. coli was removed over 99% and it was removed completely when the dose of 10 kGy was irradiated after an alkaline treatment.

4. Conclusion

The combined process of an alkaline treatment and an electron beam irradiation was very effective on sludge solubilization and E. coli disinfection. The application of a combined process of an alkaline treatment and an electron beam irradiation into the sludge treatment will be able to reduce the volume of sludge digester and the generation of sludge which should be disposed. In addition, economical effects were also expected by using treated sludge for a carbon source in the denitrification process.

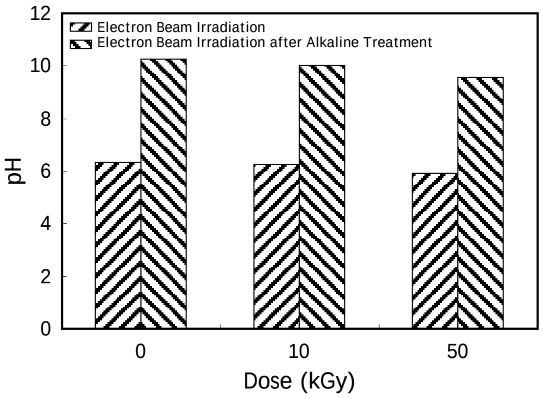

Figure 2. The change of pH with an irradiation dose increase.

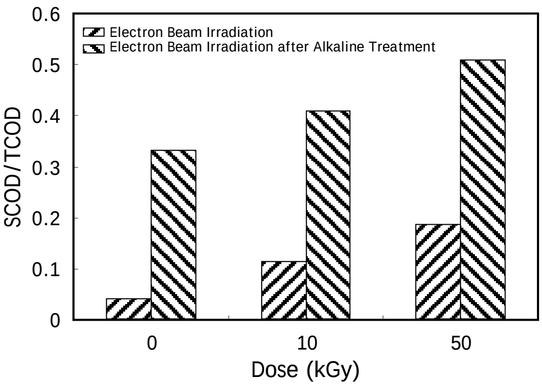

Figure 3. The change of SCOD/TCOD ratio with an irradiation dose increase.

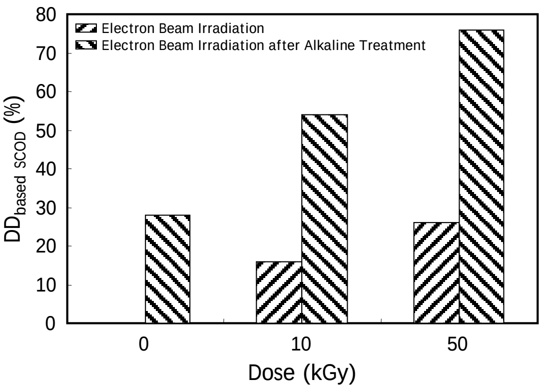

Figure 4. The degree of sludge disintegration with an irradiation dose increase.

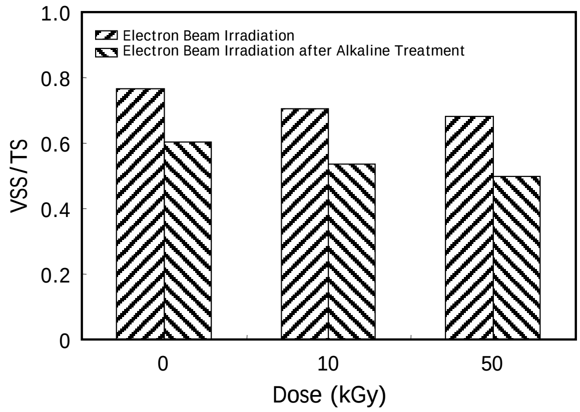

Figure 5. The change of VSS/TS ratio with an irradiation dose increase.

Table 1. Reduction of the colony forming unit of E. coli after irradiation

Dose (kGy)	CFU/mL	
	EB*	AT+EB**
0	4,500,000	3,600
10	720	< 1
50	< 1	< 1

* Electron beam irradiation
** Electron beam irradiation after alkaline treatment

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