Study on Decomposition Characteristics of Oxalic Acid and Hydrazine by Electron Beam Irradiation

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1. Introduction

In the nuclear industry, organic acids (oxalic acid, citric acid, formic acid, etc.)

Various organic solvents such as ascorbic acid, di-2ethylhexylphosphoric acid (HDEHP), and tributyl phosphate (TBP) have been used.[2)]

Of the above organic solvents, oxalic acid ($C_2H_2O_4$) Sedimentation agents for sedimentation, extraction agents for decontamination of radioactive materials, and general decontamination agents.[2)]

In addition, in nuclear power plants, oxalic acid is used to remove the oxide film formed on the internal surfaces of various facilities such as piping, pumps, heat exchangers, etc. related to power generation.[1)]

It is combined with the oxidized precipitate and is present in water in complex form.

As the removal process of oxalic acid, various methods such as a method using an oxidizing agent such as KMnO4, chromic acid, and an ion exchange method are suggested.3)

However, the conventional methods have a problem that the metal ions remain in the final treatment liquid, the treatment chemicals are consumed excessively, and the waste liquid and waste are excessively generated.

Hydrazine(N_2H_4) is a weak base and is a strong reducing agent and is mainly used for rocket propellants, reactants for military fuel cells, plating, polymerization, and removal of dissolved oxygen from boiler feedwater causing corrosion.

Hydrazine solution is used in water treatment process of boiler because it suppresses oxidation of metal in low or high pressure steam environment and maintains weak reduction state.

It is used in applications such as metal corrosion inhibition, dissolved oxygen removal, etc. in addition to oxalic acid in nuclear power plant, and it is mainly used in the first system cooling water.

Recently, new elimination methods such as advanced oxidation have been actively studied.

In this study, we compared the treatment effects of excess hydrazine and oxalic acid in the waste and waste through electron beam irradiation.

2. Main subject

2.1 Materials and Methods, Analysis

2.1.1 Sample Preparation. The initial concentration of oxalic acid (Oxalic Acid, 99 +%, 144-62-7, Aldrich Chemical Company, Inc.) were set at 2, 5, 10 and 20 mM.

The initial concentration of hydrazine(Hydrazine monohydrate 98%, N_2H_4 64-65%, Lot#BCBX7481, Sigma-Aldrich Chemical company, Inc.) was set at 20 mM.

2.2 Radiation (Electron Beam) Irradiation

All the irradiation experiments were carried out with the electron beams of the electron beam accelerator units 2 of EB-Tech (170-9, Techno 2-ro, Yuseong-gu, Daejeon, 34028, KOREA). The maximum electron energy is 2.5 MeV(19 mA, 100kW).

All investigations were carried out at room temperature. The absorbed dose of radiation was 5, 10, 30, 50 kGy. The sample was allowed to have a depth of 0.7 cm in a beaker so that the electron beam could be irradiated uniformly.

2.3 Experimental Apparatus and Analysis Apparatus

The concentration of oxalic acid was analyzed using High Performance Liquid Chromatography (HPLC) (Agilent Technologies, 1200 series). Rezex ROA-Organic Acid H + (8%) (300 × 7.8 mm) was used as the column. The mobile phase used 20 mM $KHPO_4$. TOC-VCSN TOC analyzer (Shimazu, kyoto, Japan) was used to measure total organic carbon.

The concentration of hydrazine was measured by UV-VIS (DR-5000, HACH).

3. Result

Fig. 1 shows the degradation of oxalic acid by concentration.

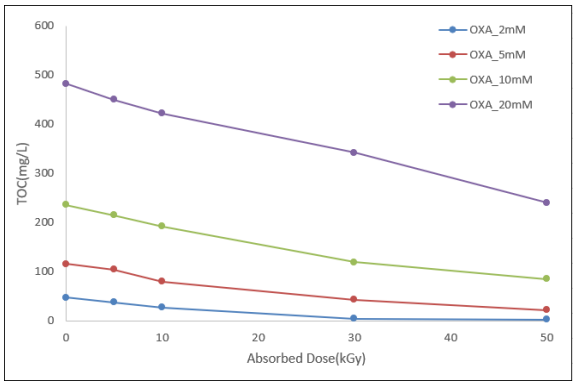

Fig. 1. Degradation of oxalic acid by electron beam irradiation (by concentration).

Fig. 2 shows decomposition of hydrazine by electron beam irradiation.

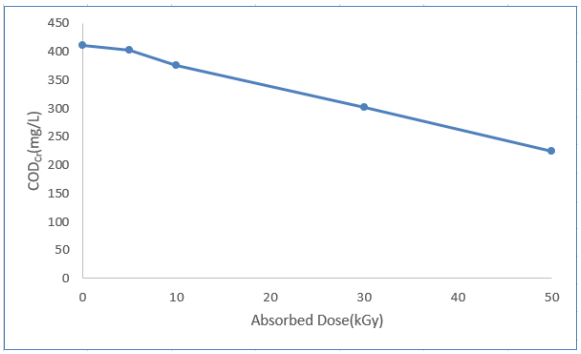

Fig. 2. Decomposition of hydrazine by electron beam irradiation (= 20 mM).

4. Conclusion

The decomposition characteristics of oxalic acid and hydrazine were investigated using electron beam, which is one of the advanced oxidation methods. In the case of oxalic acid, the decomposition efficiency was decreased as the concentration increased. Hydrazine also had the same results as oxalic acid. It is necessary to further decompose organic materials by promoting the generation of OH radicals in water through irradiation with an electron beam after using an oxidizing agent.

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