Management of Radioactive Organic Wastes Generated during Decontamination and Decommissioning Activities

Young-Gerl Ryue, Kyung-Kil Kwak, Ki-.Hong Kim
Whan-Gyeong Je*, Dong-Ho Kim*
Korea Atomic Energy Research Institute, 150 Deokjin-dong, Yuseong-gu, Daejeon
*Hanil Nuclear Co., Ltd., 3F, Dongyoung Venturestel, 202-4, Anyang7-dong, Manan-gu, Anyang
ryuyg@kaeri.re.kr

During the decontamination and decommissioning activities of nuclear installations and facilities, a large amount of organic wastes including EDTA, citric acid, oxalic acidwhich contain metal ions and radionuclides are generated. These complex compounds present a difficulty for a solidification, a possibility of a gas evolution due to a decomposition of the organic matter and a promotion of an underground migration of radionuclides.

The treatment process for organic wastes must have options such as a complete destruction, reduction of the offgas volume and associated contaminants and dioxin, free toxic gas, and a low operating time [1, 2]. So we decided on the MEO (Mediated Electrochemical Oxidationusing Ce(IV), Ag(II) as a catalyst) system as an alternative for an incineration process(Fig. 1)[3 ~ 6].

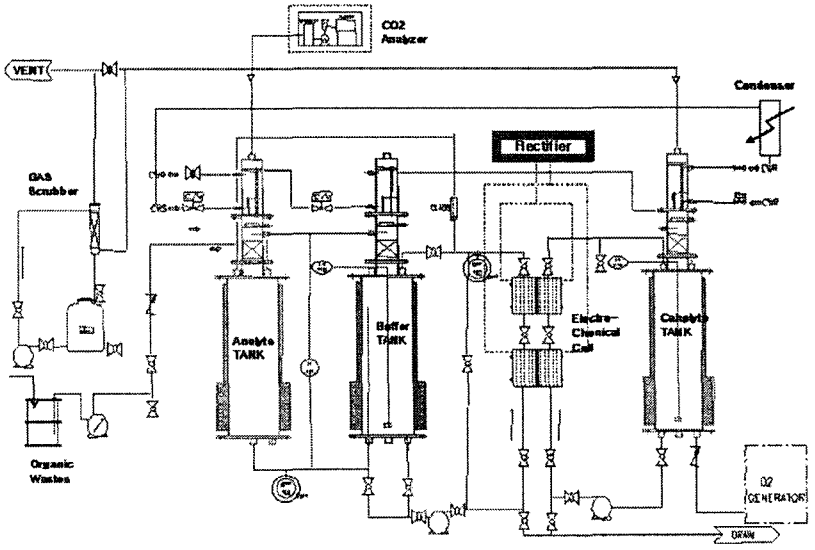

Fig. 1. Schematic diagram of MEO where using a catalyst Ce(IV), Ag(II)

- The concentration of EDTA generated during a decontamination of the nuclear installations of a Nuclear Power Plant was 16 wt.%, its solid contents(ash) of which the main metals were Fe, Cu, Mn, and Ni, was 3 wt.%, and its activity was very low(Co; 1.24 x 10^{-1}, Cs; 1.14 10^{-3} Bq/ml).

To establish the operating conditions of the pilot-scale system, under a constant concentration of Ce(0.1 M) and HNO_3(3 M), some experiments by changing the operating temperature and current density were carried out. The EDTA wastes were transported into the reactor at a constant rate for 40 minutes. The dissolved organic carbons instead of the EDTA concentrations during the oxidation were analyzed by a TOC analyzer (LACHAT IL500 TOC-TN).

It is necessary to decrease their concentrations due to a high concentration of EDTA for a treatment by the MEO system, so decreased concentrations of EDTA by changing the mole of HNO_3 by considering the concentration of HNO_3 in anolyte were studied.

- Fig. 2 and Fig. 3 show the concentration of TOC (total organic carbon) remaining in the solution (EDTA + anolyte) during the oxidation of the EDTA. The initial concentration of EDTA as a TOC was 254,000 ppm. The figures show that the EDTA was destroyed at the same time as its' supply, and after a completion of the EDTA supply the destruction rate of the EDTA (or other organic materials)

decreased slowly. In Fig. 2, according to an increase of the operating temperature with a constant current density (3 A), the oxidation of the EDTA progressed rapidly. The conversion ratio from EDTA to an inorganic at 60 ℃, 80 ℃ and 90 ℃ was 76.5 %, 86.8 % and 85.6 %, respectively. Also, according to an increase of the current density with a constant operating temperature (80 ℃), the oxidation of the EDTA progressed rapidly. The conversion ratio from the EDTA to an inorganic in 3 A, 5A and 10A was 86.8 %, 85.6 % and 90.2 %. As a result, the current density was more important than the temperature for the destruction of the organic wastes because of the production of oxidants.

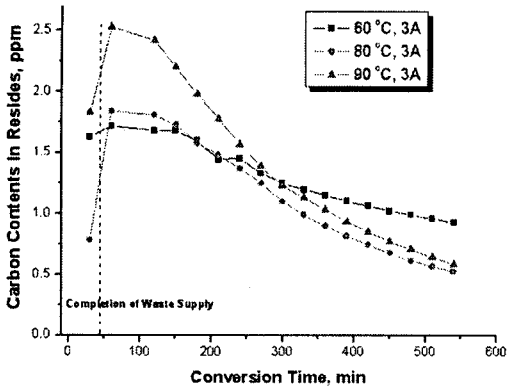

Fig. 2. Concentration (TOC) of the residues as a function of the destruction time according to the temperature

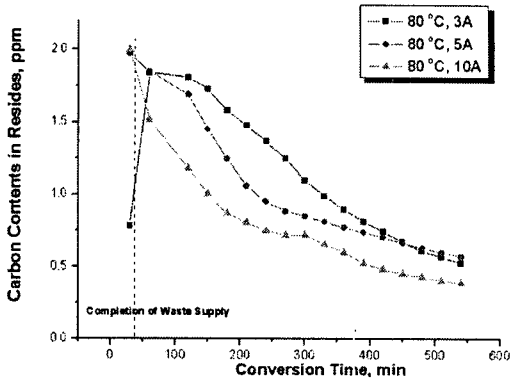

Fig. 3. Concentration (TOC) of the residues as a function of the destruction time according to the current density

On the other hand, it would take a long time to destruct 16 wt.% of the EDTA of which the concentration is too high for the MEO system. So the concentration of the EDTA by using 3.5 ~ 7.5 M-HNO_3 could be lowered from 16 wt.% to 2.4 ~ 2.1 wt.%. This means that we could reduce the treatment time by 1/6 times.

- A waste treatment system by using an electrochemical oxidation (MEO, Mediated Electrochemical Oxidation) was installed at KAERI(Korea Atomic Energy Research Institute) for a treatment of the radioactive organic wastes (EDTA, TBP/Dodecane, etc.) generated during the decontamination activity of the nuclear installations in a Nuclear Power Plant.

As a results, by analyzing the dissolved organic carbons with a TOC analyzer, the conversion ratio of the EDTA to an inorganic and CO_2 was 76.5 % at 60 ℃ and 3 A, and 90.2 % at 80 ℃ and 10 A, respectively. It was found that we could lower the concentration of EDTA from 16 wt.% to 2.4 ~ 2.1 wt.% by using 3.5 ~ 7.5 M-HNO_3 to reduce the treatment time by 1/6 times.

References

1. IAEA Technical report Series No. 427, Predisposal management of Organic Waste, 2004.
2. Alternative Nonflame Technologies for Destruction of Hazardous Organic Waste, INEL/EXT-97-00123, April 1997.
3. N.Nelson, et al., The ceRox process: New Technology for Organic Hazardous Waste Destruction, the Symposium on Emerging Technology: Management in the 21st centry, 2000.
4. N. Nelson, Electrochemical Destruction of organic Hazardous Wastes, Platinum Metals rev., 2002, 46, (1), 18-23.
5. A.D.Turner, Mediated Electrochemical Oxidation – Silver II, National Pesticide Stewardship Alliance Conference 2001, Memphis, November 27-30, 2001.
6. Z.Chiba, B.Schumacher, P.Lewis, and L.Murguia, Electrochemical Oxidation as an Alternative to Incineration for Mixed Wastes, UCRL-JC-119133, 1995