Degradation of Polyvinyl Alcohol using a Radiation Treatment

C.K. Park[a], D.H. Yoo[a], J.K. Lee[a], B.J. Lee[a], M.J. Lee[a], J.S. Choi[b], S.J. Ahn[b], B.S. Han[c], J.K. Kim[c]
a Division of Radiation Application, Korea Atomic Energy Research Institute, 150 Deokjin-dong, Yuseong-gu, Daejeon, KOREA,
b Team of Environmental Research, Korea Dyeing Technology Center, 404-7, Pyongri-6Dong, Seo-gu, Daegu, KOREA.
c EB Tech, Yongsan-dong Yuseong-gu, Daejeon, 305-500 KOREA

Corresponding E-mail Address : qkrclrbs@korea.com

1. Introduction

The release of polyvinyl alcohol (PVA) from industrial plants, especially from the textile industry causes many ecological problems, which still need to be solved [1].

Unfortunately, sizing agents in these wastewaters are very difficult to break down biologically, and they are known as the dominant contributor of COD in the textile wastewater. Conventional treatment technologies do not satisfactorily reduce PVA concentration in the wastewaters [2, 3].

Although, PVA in wastewater can be effectively destroyed by wet oxidation, advanced chemical oxidation such as Fenton oxidation [4], UV, O_3 and RuO_2/TiO_2 process [5], the costs of these methods are relatively high because of additional chemical requirements.

Especially, positive effects of gamma-rays irradiation for purification of wastewater are well known.

Therefore, objective of this work is to examine the applicability of gamma–rays irradiation to the treatment of wastewater containing PVA.

2. Methods

2.1 Chemicals

PVA was purchased from Yakuri pure chemicals. Co. Ltd. (Osaka Japan). It was prepared by dilution with deionized water at the concentration of 50, 100, 150, 200 and 250 mg/l, respectively.

2.2 Gamma-rays Irradiation

Gamma-rays irradiation was done by using high level gamma-rays experiment equipment of Cobalt-60 in Korea atomic energy research institute.

2.3 Analysis

The concentration of residual PVA in solution was determined by UV-vis spectrophotometer at 690nm using the colorimetric method. The COD_{Mn} was determined by the standard method and BOD_5 was assessed by standard BOD_5 tests using sludge from a local sewage treatment plant. The TOC content was measured using a Shimatzu TOC-5000A.

3. Results

3.1 Degradation of PVA by radiation

The irradiation dose range was varied from 0.3 kGy to 2.0 kGy. The effect of initial PVA concentrations on degradation rate was shown in Figure. 1. PVA with the initial concentration of 50 mg/l was removed over 99% by irradiated at 1 kGy. It was provided evidences that the chains were broken during the gamma-rays irradiation.

Consequently, hydroxyl radicals would attack PVA by hydrogen abstraction hence leading to the formation of carbonyl bonds.

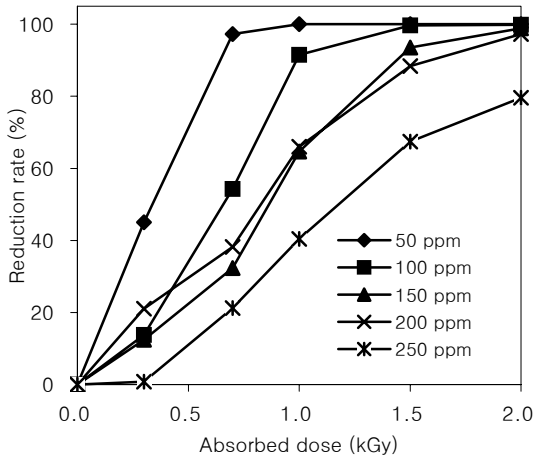

Figure 1. Reduction of PVA by gamma-rays irradiation.

3.2 Reduction of COM_{Mn} by gamma-rays irradiation

Reduction of COD_{Mn} are illustrated in Figure. 2 as a function of dose rate for five different PVA concentration. As expected the COD removal rate increased with the dose rate, showing a trend similar to that for PVA decay. This is due to the formation of intermediate products such as acetic acid.

3.3 Reduction of TOC by Gamma-rays irradiation.

Figure. 3 showed the concentration change of TOC with dose rate in degradation. PVA was removed by 39.2% when its initial concentration was 50 mg/l. But reduction of TOC could not make reduction of COD.

This was due presumably to the formation of intermediates in the first oxidation stage. After the initial PVA had been all degraded, the mineralization stages took place.

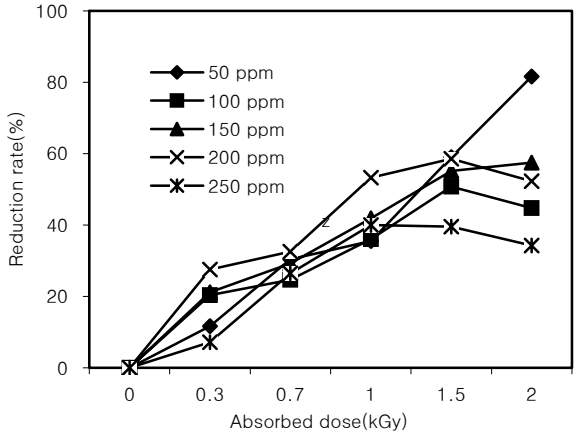

Figure 2. Reduction of COD_{Mn} by Gamma-rays irradiation.

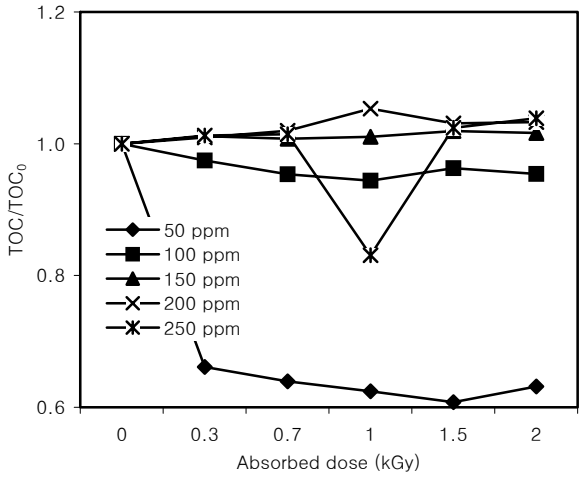

Figure 3. Reduction of TOC by Gamma-rays irradiation.

4. Conclusion

The gamma-rays irradiation was found to have a significant effect on the decomposition of PVA. The decomposition of PVA by the gamma-rays irradiation was affected by the operating conditions such as dose rate and PVA concentration. PVA was removed over 99% at the dose rate of 1 kGy. When it's initial concentration was 50 mg/l, while it was decomposed by 39.2% when it's initial concentration was 250 mg/l.

When the concentration of the initial PVA was low, the gamma-rays irradiation was especially effective.

Therefore, an integrated chemical-biological process, using gamma-rays irradiation as a pretreatment step, could provide an attractive alternative to conventional biological treatment of PVA.

5. Acknowledgments

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