Study on the Precipitation Behavior of Metal Ions in the Chemical Decontamination Waste by Using Carbonates

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1. Introduction

The accumulation of radioactive materials in the corrosion oxide film on the surface of the NPP system causes worker's exposure to radioactivity during maintenance or decommission of NPP, and decontamination is done through chemical methods or physical methods to reduce worker's exposure. Especially, in the case of chemical decontamination, chemicals are used to dissolve the corrosion oxide film, from which various metal ions are dissolved. The HP/CORD is widely used for the decontamination of NPP system and it consists of oxidation by $HMnO_4$, reduction by oxalic acid and decomposition by UV/H_2O_2.

Kim et al. [1] simulated the corrosion oxide film in NPP system, and through comparison with other literature [2,3] confirmed that the simulation was similar to actual corrosion oxide film of NPP.

In this study, we investigated the precipitation behavior of metal ions that can be retained after decontamination of the corrosion oxide film and the metal precipitate was formed through pH control. The remaining metal ions were selected as Fe, Cr and Mn by reference to study on simulation of the corrosion oxide film. Na_2CO_3 was used for pH control, and the precipitation behavior of each metal ion was evaluated depending on pH.

2. Experiments

In this study, 1 mM Fe^{2+}, Fe^{3+}, Cr^{3+}, Mn^{2+} were selected as metal ion targets for the precipitation, and for this , $Fe(NH_4)_2(SO_4)_2$, $FeCl_3$, $CrCl_3$ and $MnCl_2$ were used, respectively. Na_2CO_3 was injected into the initial solution to set pH to 4, 5, 6, 7, 9, 11 and the precipitation behavior was evaluated by measuring the metal ions concentration using ICP-OES, after filtering.

3. Results

3.1 Precipitation of Fe^{2+} and Fe^{3+}

The Precipitation behavior of Fe^{2+} and Fe^{3+} depending on pH condition is shown in Fig. 1. The result shows that Fe^{2+} was completely removed in pH 4 to pH 5 range and Fe^{3+} in pH 5 to pH 6 range.

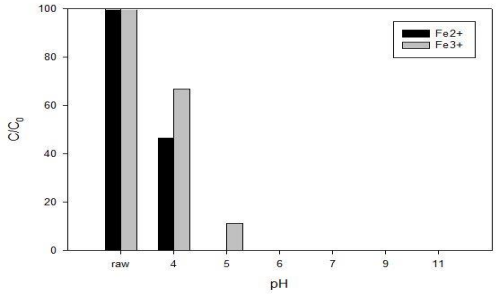

Fig. 1. Precipitation of Fe^{2+} and Fe^{3+} depending on pH.

3.2 Precipitation of Cr^{3+}

The Precipitation behavior of Cr^{3+} depending on pH condition is shown in Fig. 2. The result shows that most of Cr^{3+} was removed in pH 6 region.

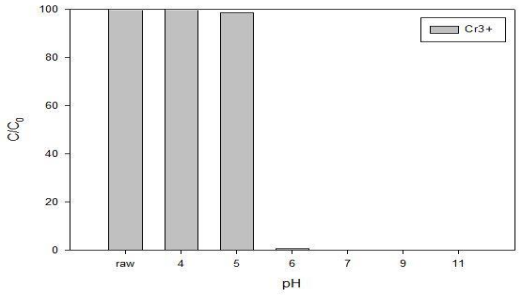

Fig. 2. Precipitation of Cr^{3+} depending on pH.

3.3 Precipitation of Mn^{2+}

The Precipitation behavior of Mn^{2+} depending on pH condition is shown in Fig. 3. The result shows that Mn^{2+} was completely removed in pH 9 to pH11 range.

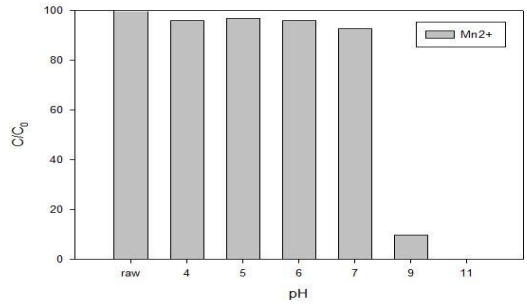

Fig. 3. Precipitation of Mn^{2+} depending on pH.

4. Conclusion

The following conclusion was obtained about the precipitation behavior of metal ions from the NPP chemical decontamination in the experimental ranges: The pH control by carbonates is the key factor to precipitate the metal ions in the form of metal carbonates or hydroxide and the increase of pH up to 11 is necessary to precipitate Mn^{2+} ions.

5. Acknowledgement

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