Effects of Hydrazine and Cu on Fe dissolution

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1.Introduction

In all kind of nuclear reactors, radioactive filed build up around the primary coolant system due to the radioactive deposition. Mainly, the radioactive contamination build up for the corrosion products through the reactor core[1]. Magnetite is the major corrosion product in PHWR as the primary heat transport system has made up of carbon steel. The dissolution of the host magnetite is achieved by some chemical formulations for getting rid of the radioactivity trapped in the oxide[2]. To dissolve this oxide surface full chemical decontamination is needful. Several kind of organic acids or chelating agents can be able to dissolve the oxide layer but that is the main reason of organic waste generation, which is difficult to decompose. Such oxides can be dissolved with a combination of reducing agent like hydrazine hydrate. Hydrazine not only acts as a reducing agent of metal ions but also forms a coordination compound whereas, hydrazine is decomposed easily into nitrogen and water by hydrogen peroxide[3]. Copper ion has acted as catalyst which increase the dissolution rate of Fe ion in the solution. The optimized concentration of hydrazine and copper to get high rate of Fe dissolution has been studied here.

2. Methods and Results

2.1 Effects of Hydrazine on Fe dissolution

Experiment has followed by using different concentrations of hydrazine in HyBRID solution, in 6hours and analyzed the dissolved concentration of Fe in the solution. In the solution Cu has been added for acting as a catalyst in the aim of dissolving the Fe ion, so the concentration of Cu was fixed in the solution. As hydrazine is an alkali reagent so H_2SO_4 has been added to this solution for keeping the pH of the solution 2.5-3. The amount of H_2SO_4 in the solution has been increased with the concentrations of hydrazine added. Afterwards, Fe powder (Fe_2O_3, 36ppm) has been added in the solution and kept it in a water bath in 95℃ for 6hours. After 6hours reaction the concentration of dissolved ion has been analyzed by using Atomic Absorption Spectrophotometer.

The result has showed that 30mM and 50mM hydrazine concentrations shows maximum Fe dissolution in the solution. The dissolution of iron ion has been increased with the increasing concentrations of hydrazine in the solution.

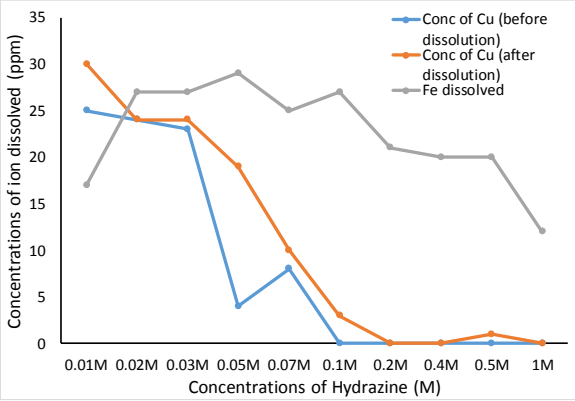

Fig 1 Concentrations of dissolved Fe ion and Copper (before and after dissolution) in the solution with the changes of hydrazine concentration added in the solution

2.2 Effects of Copper on Fe dissolution

Experiment has followed by using different concentrations of copper in HyBRID solution, with fixed concentrations of hydrazine for 6hours. Analyzed the concentration of Fe dissolved in the solution and concentrations of dissolved copper in the solution (before and after the dissolution). The experiment has been carried with 50mM of hydrazine and five different concentrations of copper ion ($CuSO_4$). To fix the pH of the solution in between 2.5-3, H_2SO_4 has been added to this solution. Fe powder (Fe_2O_3, 36ppm) has been added in the solution and kept it in a water bath in 95℃ for 6hours. After 6hours reaction the concentration of dissolved

ion (iron and copper) has been analyzed by using Atomic Absorption Spectrophotometer.

The concentrations of iron dissolved in the solution showed almost same for 0.2mM, 0.5mM, 1mM, 2mM Cu added in the solution. At higher concentration of Cu in the solution made less dissolution of Cu and Fe ion in the solution.

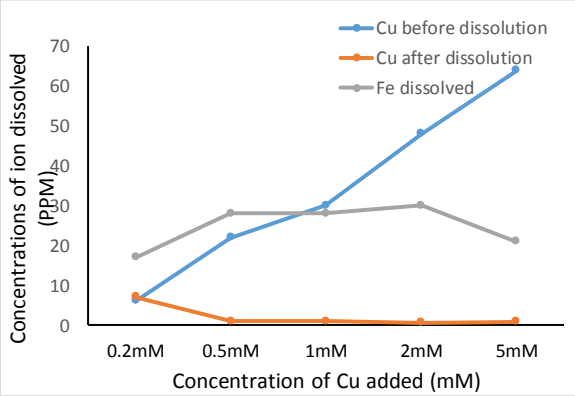

Fig 2 Changes of concentrations of dissolved Fe in the solution and Copper (before and after dissolution) with the changes of Copper concentrations added in the solution.

3. Conclusion

Hydrazine hydrate is a reducing agent which has the potentiality to reduce ions at high temperature. But, the dissolution of magnetite is a complicated process as it depends on several conditions like concentrations of hydrazine, temperature, particle size, etc. Also, it is important to know the characteristic of Fe ion, either it's Fe^{2+} or Fe^{3+}. The primary function of reducers is to reduce a part of Fe^{2+} to Fe^{3+}[4]. The addition of Cu ion into the solution makes a new mechanism towards the dissolution of magnetite. Cu is highly reactive when hydrazine concentration is high and high amount of H_2SO_4 in the solution may cause the formation of $CuSO_4$ from elemental Cu. So, using hydrazine and Cu ion as catalytic reagent in the solution can make a conventional pathway to reduce magnetite without generating high volume of organic wastes.

4. References

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