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Study of Electrolyte for Electrochemical Decontamination

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1. Introduction

Removal of metallic surface contamination by anodic dissolution in an electrochemical has pervaded in industrial use for many years. The removal of radioactive contaminations by this same technique has more recently attracted attention. Allen and Arrowsmith have reported extensive work with phosphoric acid as the electrolyte[1]. Phosphoric acid is very efficient electrolyte for removing radioactive contaminations and does furnish an electro-polished surface that is quite smooth. But inadequate processes for the spent electrolyte caused unwanted waste. Such unwanted waste is also caused in other acidic electrolytes (for example, nitric acid or sulfuric acid). Most of the radioactivity is assumed to be localized in about ten micron thickness on the surface: therefore, a surface decontamination method should be useful as a decontamination technique. In particular, electrolytic decontamination is considered to be the most useful method because of a high volume reduction factor and easy application on metal waste of diverse shapes.

In this paper, we consider that $NaNO_3$ solution is suitable for electrochemical decontamination.

2. Experiment

A schematic diagram of electrochemical decontamination device is showed in Fig.1, which is being manufactured. The positive and negative direct currents from a rectifier were charged to the anodic and cathodic electrodes. The charge current density was maintained 500 ㎃/㎠ during the operation. The experimental conditions are summarized in Table 1.

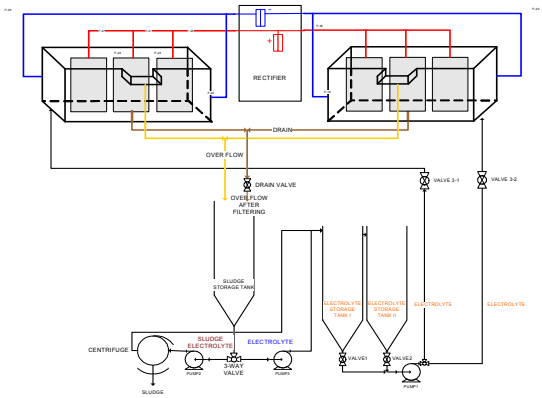

Fig.1. Schematic diagram of electrochemical decontamination device

Carbon steel, galvanized steel and stainless steel were used as anode and copper was used as counter electrode.

Table 1. Experimental condition

Electrolyte	NaNo3 (0.5 M)
Target	carbon steel galvanized steel stainless steel
Current density	500 ㎃/㎠
Voltage	10 to 12 V
Counter electrode	Copper
Operation time	10 min.

3. Result and discussion

After electrochemical decontamination most of radioactivity is removed from surface. Result of decontamination is described in J.S. An's report [2].

3.1 Stability of electrolyte

The nitrate in the electrolyte appeared to be stable. The only decomposition product detected was ammonia by its odor over the surface of an operating cell [3].

3.2 Metal accumulation

Most of metal ion generated during anodic dissolution process is precipitated as a form of metal hydroxides. All of uranium is also precipitated. But chromium accumulation in the electrolyte with increased process time. All of the chromium in electrolyte is in a hexavalent state. As the chromium accumulates in electrolyte, the process of the anodic dissolution diminishes. So the silver nitrate is added to the oxidation of the hexavalent chromium to the trivalent chromium. As a result (table 2) hexavalent chromium is precipitated as silver chromate.

3.3 Separation of metal hydroxide

As a result of PSA(Particle Size Analysis) to sludge, SMD (Sauter Mean Diameter) is 14.46 ㎛. To separate this sludge, 15,000 rpm centrifuge was tested with 80 ℓ electrolyte after decontamination. The results of these tests are described in Table 2. After centrifuge silver nitrate was added. Most of chromium is successfully removed from electrolyte. 99% particles were removed.

Table 2. Contents of metal ion in electrolyte and sludge: ICP-MS

	U(㎎)	Cr(㎎)	Al(㎎)	Zn(㎎)	Ag(㎎)
1*	N.D	0.0046	0.0070	0.0078	N.D
2*	N.D	0.0007	0.20	0.0023	0.21
3*	0.0045	0.50	0.64	277.20	0.0011
4*	1.10	3.35	0.031	0.14	272.37

* 1 electrolyte after centrifuge
2 electrolyte after adding silver nitrate
3 sludge after centrifuge
4 sludge after adding silver nitrate

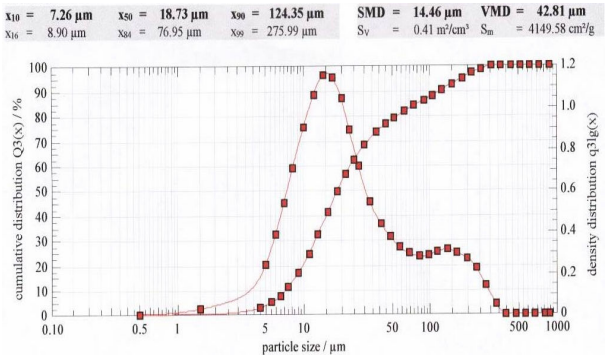

Figure 2. PSD (Particle Size Distribution) of sludge

4. Conclusion

The electrochemical decontamination of carbon steel, galvanized steel and stainless steel from uranium contaminated using a $NaNO_3$ solution electrolyte has been demonstrated. This process has the following advantages.

1. The second waste (sludge) can be separated from the electrolyte through use of centrifuge.
2. The process can achieve background level of contamination.
3. The $NaNO_3$ solution is effective, stable, and suitable electrolyte for the electrochemical decontamination.

The NaNO3 solution is effective for electrochemical decontamination, but problems still remain as criticality and disadvantage in this surface oxidation film (radioactive corrosion product) cannot be effectively removed from the metal surface.

REFERENCES

[1] R. P. Allen, H. W. Arrowsmith, “Radioactive Decontamination of Metal Surface by Electropolishing”, Mater. Perform., 18, 11, 21, 1979

[2] J. S. An, “Electrochemical Decontamination of Radioactive Metal Waste using Neutron Salt Electrolyte”, Ajou University, pp 39~49, 2004.

[3] E. L. Childs and J. L. Long, “Electrolytic Decontamination of Stainless Steel Using a Basic Electrolyte”, Nucl. Technol., 54, pp 208, 1981.