

Chemical Decontamination of Metallic Waste from Uranium Conversion Plant Dismantling

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1. Introduction

Korea Atomic Energy Research Institute (KAERI) started a decommissioning program of the uranium conversion plant. Pre-work was carried as follows; installation of the access control facility, installation of a changing room and shower room, designation of an emergency exit way and indicating signs, installation of a radiation management facility, preparation of a storage area for tools and equipments, inspection and load test of crane, distribution and packaging of existing waste, and pre-decontamination of the equipment surface and the interior. First, decommissioning work was performed in kiln room, which will be used for temporary radioactive waste storage room. Kiln room housed hydro fluorination rotary kiln for production of uranium tetra-fluoride. The kiln is about 0.8 m in diameter and 5.5 m long. The total dismantled waste was 6,690 kg, 73 % of which was metallic waste and 27 % the others such as cable, asbestos, concrete, secondary waste, etc. And effluent treatment room and filtration room were dismantled for installation of decontamination equipment and lagoon sludge treatment equipment. There were tanks and square mixer in these rooms. The total dismantled waste was 17,250 kg, 67% of which was metallic waste and 33% the others. These dismantled metallic wastes consist of stainless and carbon steel. In this paper, the stainless steel plate and pipe were decontaminated by the chemical decontamination with ultrasonic.

2. Experimental

Samples were taken from tanks and pipes as a property of uranium conversion process. The chemical composition of uranium was uranium dioxide, ammonium uranyl carbonate (AUC), and uranyl nitrate hexahydrate (UNH) as the process. The plate samples were cut by using a nibbler as a size of 20 by 20 cm and the pipes were cut by a pipe cutter as a size of 20 cm. Experimental equipment consists of decontamination tanks and ultrasonic generator and shows in figure 1. The tank size is 500 L. 10 wt% of nitric acid was used as a decontamination chemical and was circulated in the tank through a filtration system. Decontamination was performed at 60 °C with time and residual impurity was rinsed out with steam after chemical decontamination. Contamination was analyzed by a low background alpha beta counter (Canberra XLB).



Figure 1. Experimental equipment

3. Results and discussion

Table 1 shows a contamination of plate contaminated with UNH after decontamination with time. The plate contaminated with UNH can be decontaminated less than 0.2 Bq/cm² of alpha in 10 minutes. The decontamination goal is that alpha is 0.2 Bq/cm² (0.04 Bq/g) and beta, gamma are 2.0 Bq/cm² or 2.0 Bq/g. It is estimated that the plate contaminated with UNH can be decontaminated easily and initial contamination degree before decontamination don't affect a result of decontamination.

Table 1. Decontamination of plate contaminated with UNH

Sample	Contamination before decontamination		Time, min	Contamination After decontamination	
	α , Bq/cm ²	β , Bq/cm ²		α , Bq/cm ²	β , Bq/cm ²
1	36.4	2.23	10	0.1153	0.0123
2	47.1	3.41	20	0.0523	0.0072
3	69.7	4.49	30	0.0353	0.0053
4	38.2	3.52	60	<MDA	<MDA
5	14.9	1.39	90	0.0185	<MDA

MDA; α 0.0145 Bq/cm², β 0.00485 Bq/cm²

Table 2 shows a contamination of plate contaminated with AUC after decontamination with time. The plate contaminated with AUC can be decontaminated less than 0.2 Bq/cm² of alpha in 10 minutes as the plate contaminated with UNH.

Table 2. Decontamination of plate contaminated with AUC

Sample	Contamination before decontamination		Time, min	Contamination After decontamination	
	α, Bq/cm ²	β, Bq/cm ²		α, Bq/cm ²	β, Bq/cm ²
1	15.0	5.43	10	0.1350	0.0190
2	12.1	6.12	20	0.1290	0.1273
3	12.1	3.51	30	0.0857	0.0283
4	20.3	12.2	60	0.0678	0.0198
5	23.0	11.9	90	0.0689	0.0121

Table 3 shows a contamination of plate contaminated with uranium dioxide after decontamination with time. The plate contaminated with uranium dioxide can be decontaminated less than 0.2 Bq/cm² of alpha in 60 minutes. Uranium dioxide doesn't dissolve easily in a low concentration nitric acid other than UNH and AUC. So, it is estimated that the decontamination of plate contaminated with uranium dioxide need a time over 30 minutes.

Table 3. Decontamination of plate contaminated with UO₂

Sample	Contamination before decontamination		Time, min	Contamination After decontamination	
	α, Bq/cm ²	β, Bq/cm ²		α, Bq/cm ²	β, Bq/cm ²
1	5.03	1.753	10	1.586	0.7340
2	4.23	2.26	20	1.109	0.2692
3	4.14	1.424	30	0.370	0.2152
4	3.85	1.303	60	0.169	0.0839
5	3.31	1.183	90	0.1266	0.0284

Table 4 shows a contamination of pipe contaminated with AUC after decontamination with time. The pipe can be decontaminated less than 0.2 Bq/cm² of alpha in 30 minutes. Although the length of pipe is 20 cm, decontamination agent didn't circulate inside the pipe. So, contamination after decontamination was measured after

cutting in half the pipe. It is confirmed that the pipe also can be easily decontaminated as the plate.

Table 4. Decontamination of pipe contaminated with AUC

Sample	Contamination before decontamination		Time, min	Contamination After decontamination	
	α, Bq/cm ²	β, Bq/cm ²		α, Bq/cm ²	β, Bq/cm ²
1	13.4	3.92	10	0.2361	0.0488
2	11.9	6.70	20	0.0185	0.0210
3	48.3	8.66	30	0.0353	0.0053
4	15.8	5.20	60	<MDA	0.0180
5	25.8	2.85	90	0.0185	<MDA

Therefore the metallic wastes from the uranium conversion plant dismantling can be decontamination by using the chemical decontamination with ultrasonic. It will be predicted to minimize the volume of radioactive wastes through the decontamination.