The treatment process of wood waste for Regulatory Clearance level deregulation

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1. Introduction

A large amount of wood waste is stored in waste storage facility in the radiation management area of the Korea Atomic Energy Research Institute. The amount of wood waste is approximately 27 tons, it accounts for 17% of the total waste stored in the waste storage facility. The Radwaste Management Center is planning to reduce waste through its own disposal method to improve the fire resistance performance of waste storage facility, secure storage facility space, and reduce waste disposal costs. In order to self-disposal wood waste through deregulation, it is necessary to meet the self-disposal acceptance standards stipulated in the Domestic Nuclear Act and the disposal standards of the Waste Management Act. Surface contamination tests, nuclides concentration analysis, and dose assessment were performed to confirm the criteria for allowing self-disposal. After confirming the criteria for allowing self-disposal, it was finally approved by the regulatory agency. In this study, it is confirmed that the effective treatment method, radioactivity concentration analysis, dose assessment according to the characteristics of wood waste can improve the understanding of workers by process and maximize work efficiency when treating similar waste in the future.

2. Methods and Results

In this section, classification by type of wood waste, waste contamination test, collection of representative samples, nuclide concentration analysis, and dose evaluation are described.

2.1. Classification by type of wood waste

Wood waste was classified by type. And size and weight of each type were measured.

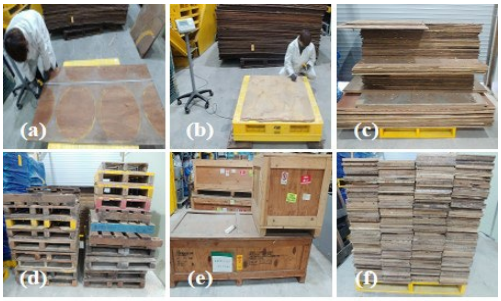

Fig. 1. (a) Size measurement, (b) Weight measurement, (c) Plywood, (d) Pallet, (e) Box, (f) Filter case

2.2. Surface dose rate and surface contamination measurement

To confirm the surface contamination of wood waste, direct and indirect measurement methods were performed. In case of direct method, dose rate measurement was performed by using gamma survey meter. In case of indirect method, surface contamination measurement was performed by using smear filter paper and low background alpha/beta counting system.

Indirect measurement value was calculated by equation 1. The results of the analysis of the smear sample of total alpha and beta nuclide radioactivity were less than MDA.

$$(1)\quad A_s = \frac{R_{s+b} - R_b}{e_i e_s F s}$$

R_{s+b} : Gross count rate
R_b : Background
e_i : Instrument efficiency
e_s : Source or surface efficiency
F : Removal fraction
S : Surface area

Fig 2. (a) Dose rate test, (b) Surface contamination measurement (Direct method), (c) Surface contamination measurement (Indirect method), (d) Low background alpha/beta counting system

2.3. Collection of Representative Samples

Wood waste was drilled, including points with high dose rates and random points. After homogenizing the sample using a mixer, the sample was placed in 1L Marinelli beaker. When collecting samples, 1kg per 200kg of waste was collected. The order of representative sample collection is shown in Figure 3.

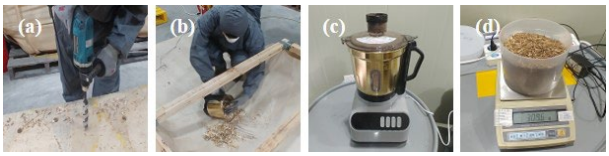

Fig 3. (a) Drilling a hole, (b) Collecting wood sample (c) Sample homogenization, (d) Weighing the sample

2.4. Radioactivity Concentration Analysis

Radioactivity concentrations were analyzed by nondestructive method and destructive method. U-238, U-235, U-234, Co-60, Cs-137, gross alpha, gross beta, Sr-90, Tc-99, Ni-63, H-3, C-14 were selected as representative nuclides.

a) Nondestructive method

U-238, Co-60, Cs-137 were analyzed by Gamma spectroscopy. The measurement time of the sample was selected considering 1/10 value of MDA. U-235, U-234 were calculated by using equation. In the following order, the concentration of radionuclides is determined.

1) Using HPGe detector for analysis samples
2) Measure the nuclide Th-234 that is secular equilibrium with U-238
3) Calculation of enrichment using radioactive concentrations of U-238 and U-235 [1]
4) Calculation of U-234 enrichment using equation [2]
5) Calculation of alpha activity ratio using specific activity

The summary results of the analyzed each nuclide are shown in table I.

Table I : Representative radioactivity concentration

Radionuclide	U-238	U-235	U-234	Co-60	Cs-137
Radioactivity concentration (Bq/g)	0.594	0.037	0.975	0.030	0.081
Allowable concentration (Bq/g)	-	-	-	0.1	0.1

b) Destructive method

Among the results of gamma nuclide analysis, samples with the highest concentrations of U-238, U-235, U-234, Co-60, and Cs-137 were selected. And gross alpha, gross beta, Sr-90, Tc-99, Ni-63, H-3, C-14 analysis were performed. The selected representative samples and radionuclides were analyzed using LSC and GPC equipment through the pretreatment process. The summary results of the analyzed each nuclide are shown in table II.

Table II : Representative radioactivity concentration

Radio nuclide	Sr-90	Tc-99	Ni-63	H-3	C-14
Radioactivity concentration (Bq/g)	0.341	0.027	0.044	2.54	0.072
Allowable concentration (Bq/g)	1	1	100	100	1

2.5. Dose assessment

Dose assessment was performed to obtain approval for clearance of radioactive waste. The method of self-disposal wood waste is to landfill incineration ash generated after incineration of waste. Dose assessment was performed in the incineration scenario and the landfill scenario, respectively.

a) Incineration scenario

In the case of incineration of wood waste, the expected maximum individual exposure dose and collective exposure dose were evaluated. NRCDose code was used to assess the incineration scenario [3]. Input values were based on the concentration of representative radionuclide, the guidelines of the KINS/RR-144 [4], KINS/RG-N02.02 [5] and registration population status. Four groups divided with ages were calculated and the result of assessment were satisfied with domestic regulations on the classification and self-disposal of radioactive waste.

b) Landfill scenario

RESRAD onsite was used to assess the landfill scenario [6]. The representative nuclides applied to the program used the same nuclides as the incineration scenario. Input values were based on the concentration of representative radionuclide, the guidelines of the KINS/RR-144, registration population status and Meteorological Agency Data. Six groups divided with ages were calculated and it was confirmed that dose of individuals and groups criteria for clearance regulation.

2.6. Storage of wastes to disposal

Wood waste satisfied disposal acceptance criteria through nuclide concentration analysis and dose evaluation was stored in a waste storage separately from radioactive waste.

Fig 4. Waste in storage facility

2.7. Application for self-disposal plan

Based on results, Radioactive Waste Management Center submitted the report on wood waste self-disposal plan to obtain approval. After final approval from KINS, wood waste is to be incinerated and incineration ash is to be landfilled in the designated place.

3. Conclusion

Surface contamination tests, nuclides concentration analysis, and dose assessment were performed to dispose of wood waste. The results of the analysis and dose assessment were satisfied with domestic regulations on the classification and self-disposal of radioactive wastes. After obtaining approval for self-disposal from the regulatory agency, the wood waste was self-disposed. Storage space was secured through self-disposal of wood waste stored in waste storage facility and disposal costs were reduced. When applying for self-disposal of similar waste stored in the institute in the future, it is judged that this procedure and method can improve the understanding of workers by detailed process and maximize work efficiency.

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