

A Study on the Disposal Safety of Radioactive Waste Containing Organic Complexing Agents

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Introduction

- Organic complexing agents (chelating agents and cellulose), contained in radioactive waste, are generated during the operating and decommissioning of nuclear power plants (NPPs), and these agents form organic complexing compounds that accelerate the movement of radionuclides.
- Chelating agents and cellulose are representative substances that cause the formation of organic complexing compounds. In the current situation, standards to regulate the organic complexing agents are insufficient in Korea and there are no regulatory standards and current status of radioactive waste containing cellulose, unlike chelating agents.
- Considering the disposal safety, management of radioactive waste is essential especially, which is containing organic complexing agents. Therefore, to raise the efficiency of the treatment and the disposal of the organic complexing agents, it is necessary to analyze the behavior of the organic complexing agent and the generation of radioactive waste which is containing chelating agents and cellulose. Also based on these analyzes, it is necessary as well to develop a technology for evaluating the treatment and disposal of radioactive waste containing organic complexing agents.

Characteristics and generation of radioactive waste which is containing chelating agents

- Chemical decontamination is performed to improve worker's safety and to prevent the spread of radioactive-contamination when maintaining, repairing and decommissioning of NPPs. During chemical decontamination, chelating agents such as Ethylenediaminetetraacetic acid (EDTA), Nitritriacetic acid (NTA), and citric acid, which cause the formation of organic complexing compounds, are used as decontamination chemicals.
- Most of the drums of radioactive wastes, generated during operation at the NPPs, are being stored in the storage facility on the site of the NPPs. Among them, the number of drums, that are assumed to contain chelating agents, is 20,015 drums (concentrated waste liquid) and 13,376 drums (waste resin) on March 20, 2020. Also, it is predicted that a larger amount of radioactive waste containing chelating agents will be generated when the NPPs are decommissioned.

Table 1. Current products, containing chelating agents, and their usage used in NPP.

NPP	Type	Amount (L)	Period (year)
Kori #1	LA / AT	400 ~ 1,000 /	'03 ~ '06
		1,200 ~ 1,800	
Kori #2	LA / AT	800 ~ 1,800 /	'05 ~ '07
		400 ~ 1,600	
Hanbit #1	GP100, LA, AT, PWT	800 ~ 3,000	'93 ~ '06
Hanbit #2	LA / AT	780 ~ 2,500 /	'03 ~ '07
		460 ~ 2,660	

Characteristics and generation of radioactive waste which is containing cellulose

- Cotton, paper and wood, which are largely composed of cellulose, are generated as low- and intermediate-level wastes (LILW). In domestic, the current status of radioactive waste, containing cellulose, has not been identified yet.
- This cellulose is decomposed by isosaccharinic acid (ISA) under strong alkali conditions (pH 12.4) formed by the hydration reaction of cement. ISA combines with radionuclides to form organic complexing compounds. Like chelating agents, these organic complexing compounds lower the absorbability of the engineering barrier to radionuclides and dissolves in groundwater, accelerating its migration. Eventually, whole this process causes a negative impact in terms of safety.
- According to the data published by SKB in Sweden, various concentrations of ISA occurred according to the reaction conditions (a type of DAW, pH, presence of oxygen, etc.), and it was reported that the maximum concentration of 0.1 M occurred.

Behavioral characteristics of organic complexing compounds

- ISA is generated from chelating agent and cellulose, contained in cement solidification or dry active waste (DAW). This ISA is combined with radionuclide and forms organic complexing compounds.
- The formed organic complexing compounds interfere with the adsorption of radionuclide at barriers (engineering and natural) in the disposal facility. Thereafter, this is likely to leak to the near-field and the far-field along with the groundwater.

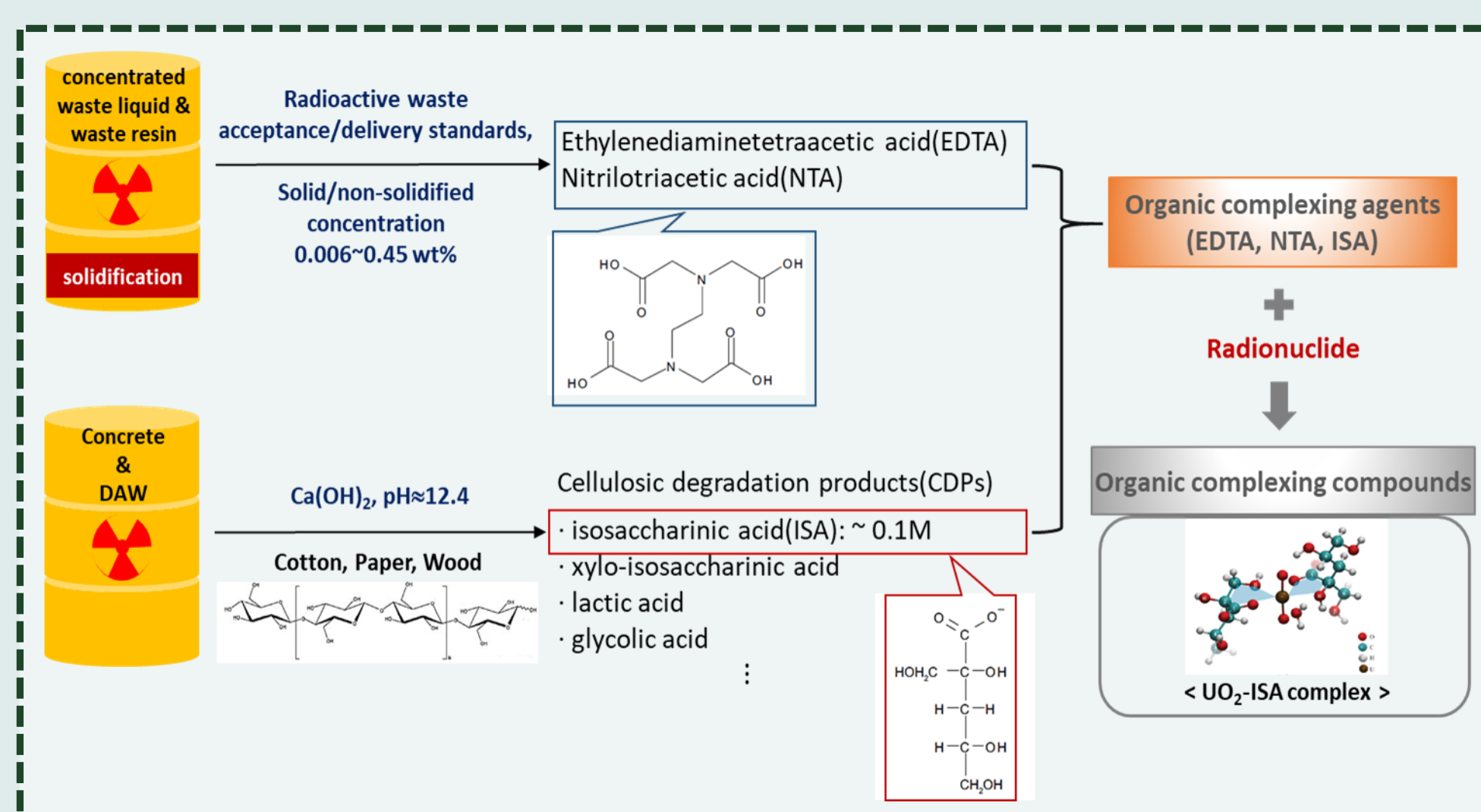


Fig. 1. Generation of organic complexing agents and formation of organic complexing compounds.

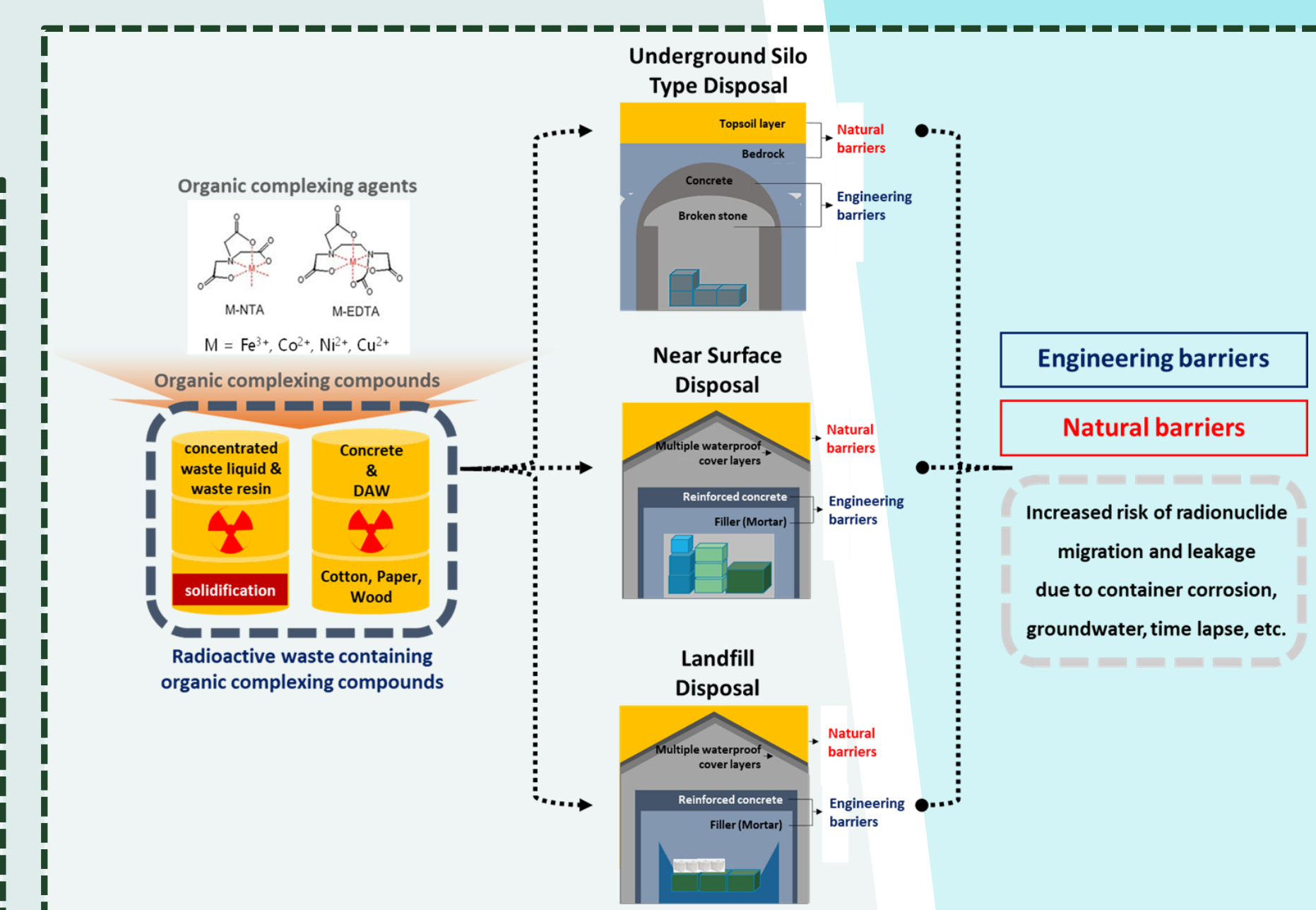


Fig. 2. Radionuclide migration and leakage by organic complexing compounds.

Regulatory standards related to organic complexing compounds

Table 2. Acceptance inspection of radioactive waste in domestic.

Inspection item	Criteria	Inspection method
Chelating agents	- If chelating agent contains more than 0.1% of the weight of radioactive waste, the chemical name and content must be specified. - If chelating agent contains more than 1%, the waste must be solidified. - If chelating agent contains more than 8%, the waste should not be disposed of.	Document inspection (Follow the preliminary inspection procedure at the origin place)
Cellulose	None	

→ **Chelating agents**
: the Nuclear Safety and Security Commission (NSSC) Notice No. 2017-60 『Delivery Regulations of Medium/Low-Level Radioactive Waste』

→ **Cellulose**
: there are no specified notices

Conclusions

- To improve the safety and reliability of disposal of radioactive waste which is containing organic complexing agents, the following studies are required continuously.
 - Assessment of characteristics about the generation of organic complexing agents
 - Establishment of reduction measures about organic complexing agents
 - Draw of methods for confirming suitability for disposal of organic complexing agents
 - Deriving improvement plan for acceptance criteria related to organic complexing agents
 - Construction of the DB by experimental analysis of the influence (solubility, adsorption distribution coefficient) of organic complexing compounds according to external reaction conditions for each radionuclide
 - Establishment of a model for radionuclide migration by organic complexing compounds and development of an evaluation system for the safety of disposal

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