Control Measures for Water Leaked from the H4 Area Tank

— Status of the Consideration of the Applicability of the Collecting Method for Strontium Present in the Soil —

March 27, 2014
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1. Overview of the Consideration

• In considering the applicability, an laboratory test and a field test are to be carried out, and the effectiveness of related measures.

Laboratory test: Sr-collecting effect of the collecting material and soil conditioner※1(apatite + crushed stones) is to be confirmed.

Field test: Confirm the effect of collection※3 as a supplementary purpose in addition to the main purposes of confirming workability and quality※2.

※1 The soil conditioner is a material made by mixing hydroxy-apatite ［$Ca_{10}(PO_4)_6(OH)_2$］ with crushed stones.
※2 The main purpose of the field test is to confirm the mixing method of soil conditioner and the workability according to the specified compounding ratio etc.
※3 The effect of collection is determined from the result of the laboratory test. The result of the field test is to be reflected in the construction/installation as needed.

[Laboratory Test]

The following tests are conducted in the laboratory:
• Batch test (Capability test of the collecting material)
• Column test (Simulation test of the soil conditioner)

(Polypropylene container)

[Column test]

⇩ Reflect the result

[Field Test]

A full-scale verification test is conducted on site.
• Confirmation of workability and quality (Main purposes)
• Confirmation of the effect of collecting Sr (Supplementary)

(Tube rotator)

[Batch test]

2. Laboratory Test (1)　Batch Test　① Test Results

- The batch test is intended to confirm the distribution coefficient , removal ratio※1, and Ca substitution ratio※2 of apatite in relation to Sr.

[Test Results]

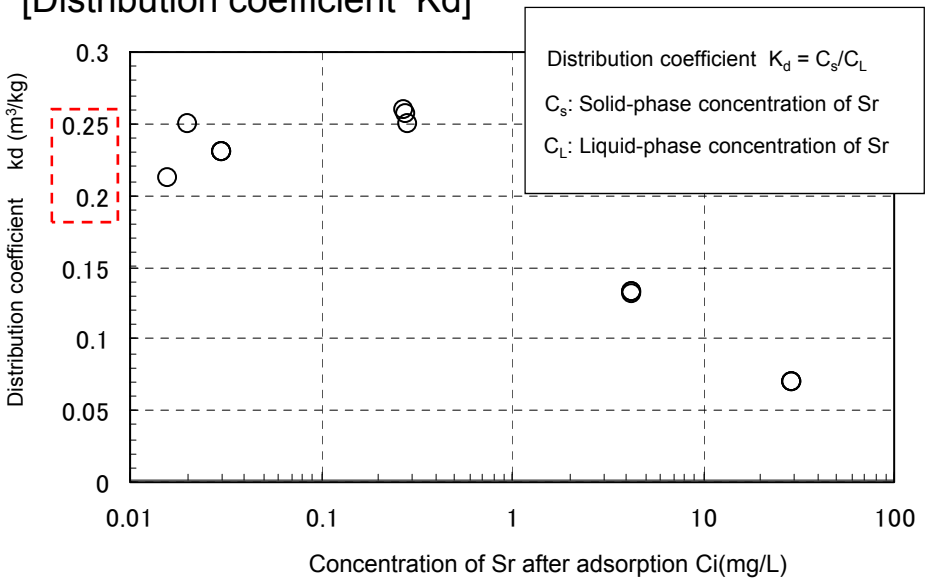
Distribution coefficient : 0.2 to 0.25m^3/kg (200 to 250ml/g)

Removal ratio: 60% to 70% (decontamination factor DF※3: 3 to 3.5)

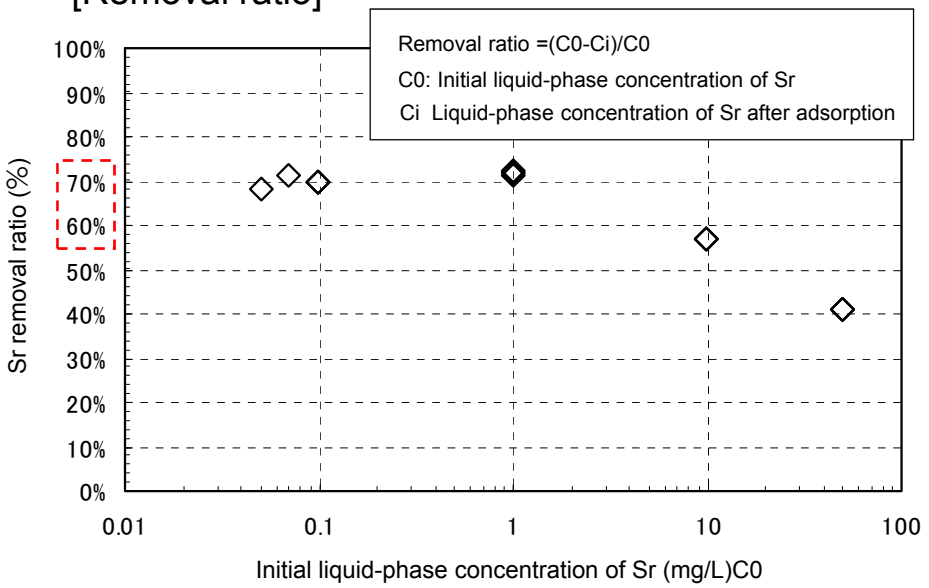
Ca substitution ratio: 0.07%※4

※1 Relative values in proportion to apatite (1g), with the solid-liquid ratio being 1/100
※2 On the assumption that all the amount of adsorbed Sr has been substituted
※3 DF=(Initial liquid-phase concentration of Sr)/(Liquid-phase concentration of Sr after adsorption)
※4 Final values of the amount of remaining adsorbed Sr after the desorption test

[Distribution coefficient Kd]



[Removal ratio]



2. Laboratory Test (2)　Batch Test　②Evaluation of the Test Results

[Distribution coefficient]

- The distribution coefficient can be defined as the sum of electrical surface adsorption and adsorption by ion exchange between Ca and Sr.
- The distribution coefficient obtained from the test results was in the range from 0.2 to 0.25m^3/kg (200 to 250ml/g), and the removal ratio was between 60 to 70%.
- When compared in terms of the distribution coefficient, the above values are smaller than those of zeolites※1 such as Zeolite A (790ml/g), Zeolite X (790ml/g) and clinoptilolite (560ml/g) etc.

[Ca substitution ratio]

- It is the ratio of the adsorbed amount of Sr to the amount of Ca present in 1 gram of apatite (8.8mmol/g)(100% if all the Ca content of the apatite※2 substitutes Sr).
- The substitution ratio calculated from the final remaining amount of Sr after the desorption test shows the amount of Ca which contributed to the ion exchange.
- According to the test results, the final substitution ratio was 0.07%, showing the substitution ratio of Sr by Ca present in the apatite was very small. (This ratio was designed to be 10% at the Hanford Site)

※1 The Data Collection of the Atomic Energy Society of Japan, with seawater content of 1%
※2 Chemical formula: $Ca_{10}(PO_4)_6(OH)_2$

2. Laboratory Test (3)　Additional Consideration

- As the Ca-substitution ratio of the apatite used for this test was low, we used other materials and carried out additional tests.

[Additional Consideration]

- A study on (natural and synthetic apatite) powder-type apatite, confirmation of the effect and selection of adequate materials
- Confirmation of the effect of solution-type apatite (refer to the specification for the Hanford Site)
- A study on (natural and synthetic) zeolites, confirmation of the effect and selection of adequate materials

[The specification for the Hanford Site]
Target of reduction in Sr concentration: By 90% of the maximum concentration
(Solution-type)
- Main works: Synthetic apatite → On-site collection effect: About 90%

(Powder-type)
- Field test: Natural apatite (calcination temperature※: 350° C) → On-site collection effect: About 90%
- Main works: Natural apatite (calcination temperature: 1000 – 1100° C)→ On-site collection effect: Not yet conducted

[The specification for this test]
(Powder-type)
- Field test: Natural apatite (calcination temperature: 1100° C)

※The higher calcination temperature enhances the crystalline property of apatite, and decreases the reactivity (substitution ratio) between Ca and Sr.

2. Laboratory Test (4)　A List of Considered Materials

Types of materials		Calcination temperature	Remarks	Availability	Testing status	Analysis/Evaluation
Natural apatites	Apatite ①: Beef bone	1100℃	K_d =0.2m^3/kg	Already used	Already used	Already used
	Bone char (coarse grain): Beef bone	1000 - 1100℃	Used at the Hanford Site	Available	Completed	Now being carried out
	APATITE Ⅱ®(fine grain): Fish bone	350℃	Used at the Hanford Site	Available	Completed	Now being carried out
	Apatite ②: Beef bone	850 - 900℃		Available	Now being carried out	Not yet conducted
	Steamed bone meal: Pork bone	Steamed at 180℃		Available	Completed	Now being carried out
Synthetic apatites	Hydroxy-apatite	Non-calcinated		Available	Completed	Now being carried out
	Tribasic calcium phosphate①	Non-calcinated		Available	Completed	Now being carried out
	Hydroxy-apatite　slurry	Non-calcinated		Available	Completed	Now being carried out
	Tribasic calcium phosphate②	Non-calcinated		Available	Completed	Now being carried out
	Solution-type $CaCl_2$+(Na^2HPO_4+Na_3PO_4+NH_4NO_3)	-	Refer to the specification for the Hanford Site	Available	Completed	Now being carried out
Natural zeolites	Clinoptilolite (produced in Shimane)	-		Available	Completed	Now being carried out
	Clinoptilolite (produced in Futatsui)	-		Available	Completed	Now being carried out
	Zeophyllite #1424 (Mordenite)	-		Available	Now being carried out	Not yet conducted
	Nitto Zeolite No.2 (Mordenite)	-		Available	Now being carried out	Not yet conducted
Synthetic zeolites	P-type zeolite (synthetic)	-		Available	Completed	Now being carried out
	X-type zeolite	-		Available	Completed	Now being carried out

3. Implementation Processes

- Implementation processes have been changed due to additional tests etc. (Black→Red)
- The implementation of the main works will be determined in a comprehensive manner on the basis of the results of additional laboratory test etc.