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# Preparation of Tracing Source Layer in Simulation Test of Nuclide Migration

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## Abstract

In cooperative research between CIRP and JAERI on safety assessment for shallow land disposal of low level radioactive waste, a laboratory simulation test of nuclide migration was carried out, in which the undisturbed loess soil column sampled from CIRP' s field test site was used as testing material , three nuclides, Sr—85, Cs—137 and Co—60 were used as tracers. Special experiment on tracing method was carried out, which included measuring pH value of quartz sand in HCl solution, determining the eligible water content of quartz sand as tracer carrier, measuring distribution uniformity of nuclides in the tracing quartz sand, determining elution rate of nuclides from the tracing quartz sand and detecting activity uniformity of tracing source layer. The experiment results showed that the tracing source layer, in which fine quartz sand was used as tracer carrier, satisfied expected requirement.

## Introduction

For environmental safety assessment of radioactive waste disposal, it is one of necessary work to study migration characters of nuclides in stratum medium. The one of importent ways for above studying is laboratory simulation test for nuclide migration. In recent years a lot of works on simulation test of nuclide migration were done in Germany, Japan and China, and several tracing ways were used, for example, radionuclide solution was sprinkled to testing soil column, a thin ice film made of radionuclide solution was put onto the testing soil column, after melting the tracing layer was formed, besides, the tracing source layer was made by mixing nuclide solution with fine grain solid material. In above methods, the tracing way which is similar to the release of nuclides from waste form and convenient for modeling is the last one. For this method the key problem is selecting a suitable fine grain solid material as carrier of nuclide tracers. The carrier material should have following properties:

(1) chemical reaction with nuclide solution does not take place.

(2) physics—chemical properties are stable.

(3) it is easy for nuclides to be eluted from the carrier.

(4) The carrier material should be cheap and gained easily.

In cooperative research between CIRP and JAERI on safety assessment for shallow land disposal of low level radioactive waste, a laboratory simulation test of nuclide migration was carried out, in which the undisturbed loess soil column sampled from CIRP's field test site was used as testing material, three nuclides, Sr—85, Cs—137 and Co—60 were used as tracers. Special experiment on tracing method was carried out.

1. Experimental works

(1) *Measurement of pH value of quartz sand.*

Five samples of fine quartz sand were weighed out by 25 g for each and put into five plastic cups (50 ml), respectively. Then 1.8 ml of 0.0001 N, 0.001 N, 0.01 N, 0.5 N of HCl and 23.2 ml of distilled water were added into these cups, respectively. After mixing, the solutions allowed to rest for 5 minutes and the pH value was measured.

(2) Determination of the eligible water content for the quartz sand

About 70 g of fine quartz sand were dried and weighed, after this some water was added in the quartz sand, mixing by stirring. The amount of water added in quartz sand increased time—by—time until all quartz sand was moistened but keeping its loose status. At this time the water content of the sand was the eligible water content which can be determined by repeated tests. The fine quartz sand was mixed with tracer solution under the condition of eligible water content when preparing the tracing quartz sand.

(3) Measurement of the uniformity of radionuclides in the tracing quartz sand

Ten samples of tracing quartz sand were weighed and detected for their activities by using a gamma—spectrometer and then the concentration of each radionuclide in the quartz sand was calculated.

(4) Determination of elution rate of radionuclides from the tracing quartz sand

3 samples of the tracing quartz sand with weight of 5.64, 5.41 and 5.63 g were taken and put in three plastic cups (50 ml), respectively. These three samples of sand were then immersed separately in 10 ml of water taken from the well of the field test site, or distilled water, or 0.01 N HCl. After taking their weight, the three kinds of fluid for immersion were poured into three flasks respectively for detecting activities of radionuclides in various fluid. Such procedure was repeated for 11 times in total, and a elution rate was calculated based on the detection results.

(5) Detection for activity uniformity of tracing source layer

First, the upper surface of the testing soil column was made be level and smooth by using " scraper for spreading sample", then tracing quartz sand was put on it and made be level and uniform. The thickness of the sand layer was 3 mm.

After spreading tracing source layer, making the γ detector aim at the tracing source layer and the activity in the layer was detected from four direction (0°, 90°, 180°, 270°) by rotating the testing soil column, then the activity uniformity was examined.

## 2. Results

(1) pH values of quartz sand

Fig. 1 shows that the curve of pH of quartz sand in HCl solution with different concentrations is parallel to the curve of pH value of different concentration of HCl solution. This means that quartz sand hardly react with HCl, and can be used as an ideal radiotracer carrier.

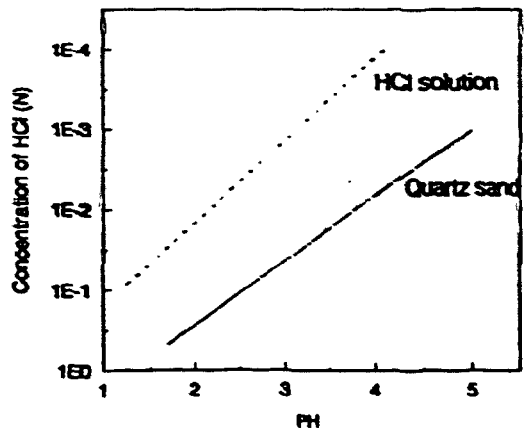


Fig. 1 Relationship between pH of quartz sand and concentration of HCl solution

(2) Eligible water content for the quartsz sand

The eligible water content for the quartz sand was determined about 4%, under which all quartz sand particles were moistened but keeping its loose status, that is, the quartz sand can not only contain the tracer nuclides fully but also be spread easily.

(3) The uniformity of the distribution of nuclides in tracing sand layer

The radioactivities of ten quartz sand samples which were used to determine the uniformity of radionuclide distribution were detected with multi—channel spectrometer. The standard deviations of measurement results were rather small, so it was indicated that the nuclides were distributed in tracing quartz sand layer homogeneously.

(4) Elution rate of nuclides from quartz sand

The elution rates of Sr—85 and Co—60 were over 99%, but Cs—137 little low (92%). The measurements indicated that tracing nuclides can be fully eluted from quartz sand under reaction of water flow.

(5) Uniformity of activity in the tracing source layer

By comparising of detection result from each direction with the mean value of detection results from four directions, it can be seen that all deviations are less than 5%. This indicated the tracing source layer had good uniformity.

## 3. Conclusions

From above results, following conclusions may be obtained:

(1) In process of mixing quartz sand with acid tracer nuclide solution, no chemical reaction took place basically. The nuclides were easily eluted from the quartz sand, this made tracer nuclides fully be desorbed from sand carrier and migrate into soil.

(2) Under water content of about 4%, the quartz sand can both fully contain nuclide solution and remain loose status advantageous to spreading. So this water content may be considered as eligible water content for preparing tracing quartz sand.

(3) The results of detection to actual tracing source layer of the tested soil column showed the activity uniformity was good.

To sum up, the tracing source layer using quartz sand as carrier of tracer nuclides, may satisfy requirement of simulation test for nuclide migration. This tracing method is feasible.