CO10-1 Possibility of Suppression of Cs Elution from Incineration Fly Ash by Adding Soil

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INTRODUCTION: The procedure to the final disposal of the waste polluted with radioactive Cs in Fukushima is far from well established. In carrying out a middle storage of the polluted waste and its final disposal, it is necessary that behaviors of radioactive Cs in the wastes are clarified and a realistic method is suggested to prevent leakage of radioactive Cs to the environment in future to establish the safe disposal method of the waste. This study examines the effectiveness of the method to mix the soil which had strong adsorption ability of the Cs with incineration fly ash as elution suppression measures.

EXPERIMENTS: At first, behavior of stable Cs-133 of the concentration of 500μg/kg and radioactive Cs-134 of the concentration of 125,000Bq/kg (2.6ng/kg) is compared when they are added to heat treated forest soil as a decontamination waste. Here, heat treated forest soil means that the soil is heated for 30min at 500 degree Celsius by muffle kiln. Soil of experiment forest of Iwate University is used, because it is thought to be similar to forest soil in Fukushima. Then, the elution rate to water of Cs from the mixture of a simulated incineration fly ash and heated or unheated forest soil is examined by the method of elution test of Soil Contamination Countermeasure Law considering the quantity of K as a competitive adsorption element contained in the mixture. Table 1 shows the components of the simulated fly ash. Stable Cs-133 is used if there is no clear difference in the elusion rate from soil between Cs-133 and Cs-134.

Table 1. Components of simulated incineration fly ash.

fly ash A		fly ash B	
component	ratio (%)	component	ratio (%)
activated C	3.0	activated C	3.0
KCl	10.0	KCl	4.0
SiO_2	86.8	NaCl	4.0
metals	0.2	$CaCl_2 \cdot 2H_2O$	2.0
		SiO_2	29.0
		Al_2O_3	29.0
		$CaCO_3$	29.0

RESULTS: Although the concentration of Cs-133 and Cs-134 are 5 order of the magnitude different, there was no clear difference between in the elution rate of Cs-133 and in that of Cs-134 from heated soil. The elution rate of Cs from heated forest soil was less than 1%. However, the drop of the elution rate from incineration ash by adding heated or unheated forest soil was not so effective as we expected. Fig.1 shows the elution rate of Cs from the mixture of the simulated fly ash and heated or unheated forest soil. It was necessary to mix the soil of the quantity of a little less than 10 times of fly ash to drop the elution rate to around several percent. When the soil and fly ash was mixed, the concentration of $[K^+]$ (meq/mL) in the solution of the elution test would be approximately estimated by the contents of element K of the simulated fly ash, if the content of K was much bigger than the cation exchange capacity (CEC) of the soil in each mixture. We found that we could estimate the elution rate of Cs by the equation (1) based on Langmuir type competition adsorption theory when we mixed soil and fly ash.

$$\text{elution rate (\%)} = 100/(1+ 0.05/ [K^+]) \qquad (1)$$

When quantity of K in the mixture of soil and fly ash is larger enough than quantity of CEC, $[K^+]$ can be approximately estimated as total K minus CEC of the mixture solved in the solution. It was possible to estimate each observed Cs elution rate with around 10% of errors by the equation (1). Therefore, it means that it is necessary to suppress $[K^+]$ less than 0.5×10^{-3} (meq/mL), or the contents of Cs in each mixture less than around 0.5×10^{-2} mmol/g to control each elution rate of Cs less than 1%. In addition, it was expected that the behavior of Cs in the mixture would be greatly change if the contents of Cs exceeded the contents of frayed edge site where Cs is preferentially sorbed. Because the amount of frayed edge site of the soil used in this study was around 0.0002 (meq/g), behavior of Cs in the soil would not be different if the amount of Cs added to the soil is less than 27mg/kg. It was also found that when the amount of Cs was more than the amount of frayed edge site, the elution rate could be estimated based on the competition adsorption theory of the Freundlich type, though the effect of the difference of soil parameters was great.

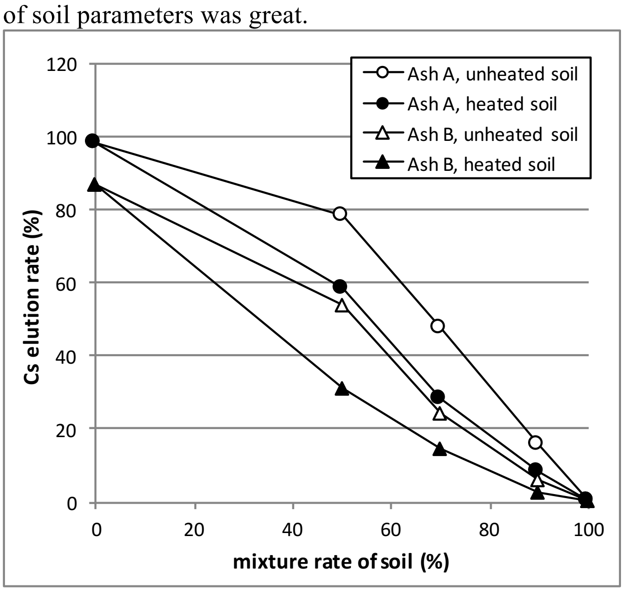

Fig. 1. Elution rate of Cs from mixture of simulated incineration fly ash and soil.

CO10-2 Ethnographic Study on Nuclear Reactor
- Safety and Relief in *Fukushima*, post 3.11. -

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At the end of March 2017, after the seventh year of the earthquake disaster, governmental order for evacuation was mostly terminated except for Nagadoro where radiation levels are still high. The radiation level in the living zone of Iitate village has decreased to less than 0.3 μSv/hr and it is about 1 μSv/hr even when going to worship deep in the mountain of Yamazumi shrine that worships the local mountain gods (Figure 1). The form of life style of villagers is varied, after the evacuation order for them is terminated. Villagers trying to return home in Iitate immediately will be less than 20%. Most of them are elderly people with little risk of radiation damage, and it is difficult to regenerate the community. The only clinic that has restarted at Iitate manages the outpatient clinic only twice a week in the morning.

Figure 1. GPS-mapping of environmental radiation distribution on Google around the central Iitate. Radiation dose of almost all living areas are less than 0.3μSv/hr (3.16, 2017).

1. Nuclear bio-politics
Is there any justification of the scientific basis for the political evacuation direction against the disaster area? Unfortunately, it must be said that the scientific basis of regulation was lacking. Safety standards extrapolated from model experiments of radiation safety management and regulation standards in the field are considerably divergent. It can be said that it is rather a different concept. Experimental condition setting does not reflect the current situation in the field. Sciences (eg, radiobiology) were ineffective and impossible to regulate the field based on their experimental results. Nonetheless, the importance of scientific advice for political administration is recognized as an issue to be discussed more and more after 3.11 disaster (1). How can scientific advices [scientifically] reflect on political administration? Despite the necessity of politically neutral think tanks and scientific brains of politicians, etc. have been advocated, why did not they work in this 3.11 disaster? I believe that there was already a problem in the planning and establishment process of Japanese Basic Nuclear Energy Law (196th December 19th Act No. 186).

2. Engine called law to drive bio-politics
Since there is a legal system of nuclear energy policy starting with the Basic Law of Nuclear Energy, bureaucrats can not "take a step" within the low, and will promote nuclear power politics endlessly along the law. It is difficult to change the bureaucratic mind for safety regulation unless the law will be changed (2). Bureaucrats are robots that run by law. Since nuclear power administration consists of inevitable incorporation of plutonium cycle from the beginning, abandoning nuclear reactors at the present time is a politically incompatible choice. In creating safety regulations, science that fills the gap between the scientific safety and the relief of victims should be established (for example, regulation anthropology). Many villagers can not return home safely even if evacuation regulation is terminated. It is not a simple matter of radiation dose in the field. It is a problem that there are significant estrangement between environmental safety and victim's feeling for relief.

Case study in which occupational prompt resuming was reliably connected to victim's relief: Mr. K was 54 years old (at the time of the disaster), a public officer, has worked with side jobs for Turkey bellflower, rice and honey, but after the disaster early retired from officer and evacuated temporarily, but immediately after July 2011 Later, leaving his family at refuge and seeking new farmland in the neighboring prefecture to start his life work as a house farmer mainly for Turkey bellflower. However, there was no administrative support in entrepreneurship in other prefectures, and in the situation that there was no subsidy payment immediately after the disaster, they were forced to start their own business without any administrative supports.
「*From the officers in Iitate village, I was treated as a traitor. But I got into this place with a strong mind that I could not live any more without resume of my life work. Initially I had difficulty with village ostracism, harassment etc. But I am now contributing to the rebuilding of the village for my success in bussiness.*」 Regional administration that does not support diaspora-like reconstruction in order to enclose villagers in the village, as a result, it can not escape from the driving force of the national nuclear power administration. On the other hand, is the unconscious resistance of the vulnerable people who are not bound by administrative districts and bricolages even farmlands might become a sustainable reconstruction power? (3). Many of the villagers were cultivation pioneers from 2 to 3 generations ancestors (Iitate Son-Shi, 1979), culture inherited from ancient times has become one of the bricolagic driving force through the network for their recovery. As seen in the Nanohana project (hybrid plant of radiation pollution and nature) in radiation contaminated environments in Fukushima, the driving force of reconstruction can be found even in the hybrid structure with pollution, so in order to fit Latour's scientific theory into a low-level radioactive environment, we should rethink the real nature and the progress of science in his theory.

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CO10-3 Characteristics Measurement in High Gamma Ray dose Environments for a Neutron Detector and Amplifier Used in an Active Neutron Method

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INTRODUCTION:
We have been working on the development of a non-destructive assay (NDA) of nuclear materials by using the fast neutron direct interrogation (FNDI) method that is one of active neutron methods. Now we are proceeding with studies for NDA methods in high gamma ray dose environments, and then it is significant to investigate the influence of high gamma ray dose on a neutron detector. An amplifier of the neutron detector for the FNDI system requires fast pulse shaping to prevent counting loss. Furthermore, it is important to keep the base line stable in order to reduce the pile-up due to the high count rate. We have produced amplifiers with the double delay-line shaping function to satisfy the requirements. The purpose of this experiment is to evaluate the performance of the amplifiers under high dose-rate gamma ray environments. Note that the irradiation object in this experiment is not the amplifier but a neutron detector.

EXPERIMENTS:
The experiment was carried out in the Co-60 gamma -ray irradiation facility. Figure 1 shows an amplifier, which is 18 cm in length, 4 cm in width and 3 cm in depth. The experimental setup is shown in Figure 2. We utilized He-3 neutron detector (proportional counter) that was 1 m in length and its pressure was 4 atm. The amplifier was mounted in close proximity to the detector. Lead blocks were set in front of the amplifier in order to reduce gamma rays. Since neutron signal from the detector was necessary, a neutron source (Cf-252) with polyethylene moderator was attached on the detector. The gamma ray dose-rate was varied from 1.3 Gy/h to 8.0 Gy/h by changing the distance between the gamma ray source and neutron source. We measured neutron counts at gamma ray irradiations.

RESULTS:
Table 1 shows relative neutron counts compared to counts at 0 Gy/h. It was found that the ratio was reduced by 25 % at 2.0 Gy/h and 50 % at 4.0 Gy/h though the ratio at 1.3 Gy/h was almost constant. These results will give us important information to develop a new measurement system in high gamma ray dose environments. In the future, we will examine other neutron detectors for use in such severe environments. It may enable us to achieve further improvements.

Fig. 1 Amplifier for a neutron detector

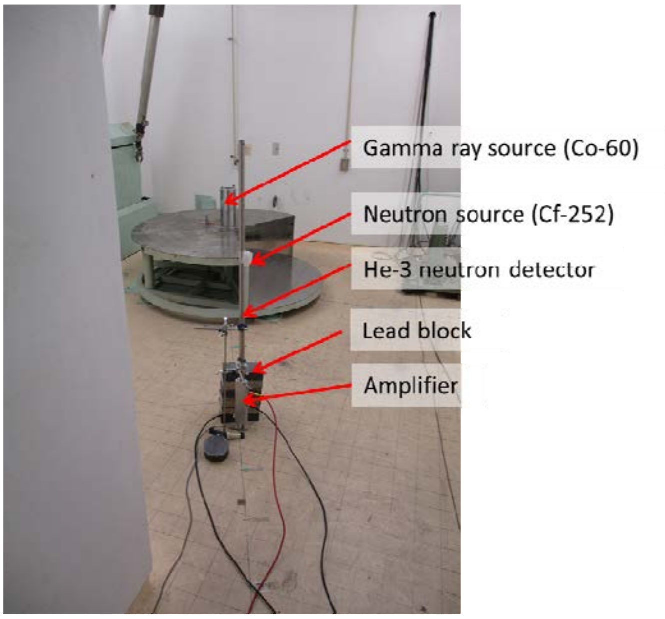

Fig. 2 The experimental setup

Table 1 Relative neutron counts

Gamma ray dose-rate (Gy/h)	1.3	2.0	4.0	8.0
Neutron counts	1.06	0.75	0.50	0.26