The Radioactivity of ^{3}H and ^{14}C in the Sludge Samples of a Nuclear Power Plant

Hee-Reyoung Kim, Wanno Lee, Kun Ho Chung, Geun Sik Choi and Chang Woo Lee

Korea Atomic Energy Research Institute, Yuseong Daejeon 305-353, Korea

INTRODUCTION

Stable radioisotopes of hydrogen (H) and carbon (C) are contained in a sludge which is used for nuclear power plants. Tritium (^{3}H) and carbon fourteen (^{14}C) are produced by a nuclear reaction from these stable isotopes. Therefore, ^{3}H and ^{14}C can be found in radioactive wastes of an intermediate/low level. In fact, a radioactivity analysis of ^{3}H and ^{14}C is required to monitor the environment of a disposal site for radioactive wastes of an intermediate/low level or to self-dispose of the radioactive waste from nuclear power plants. In the present study, the radioactivity of ^{3}H and ^{14}C in the sludge samples used in nuclear power plants (NPP) is analyzed by using a commercialized high temperature furnace and a LSC. Also, it is determined whether the sludge can be self-disposed of or not.

THE EXPERIMENT

Fig.1 shows the experimental system for measuring the radioactivity.

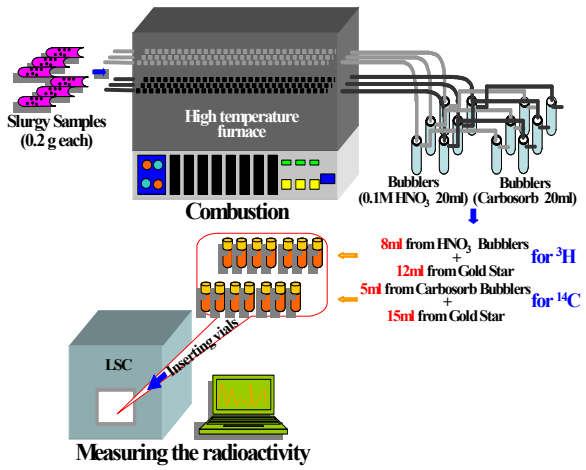

Fig.1. The experimental system with a commercialized furnace and a LSC for measuring the radioactivity

A pre-treatment by using a chemical procedure and a combustion of a sample is carried out to analyze these radioisotopes [1]. First of all, a nitric acid solution with a concentration of 0.1M and a carbosorb are pipeted at 20 ml each and they are placed into the corresponding bubblers. And then, the bubblers are connected to the quartz pipe of the combustion furnace by using rubber tubes as seen in the Fig. 2 .

Fig. 2. The combustion furnace with auxiliaries for oxidizing the samples

A sludge sample with a constant quantity is burned at a maximum temperature of 800 ^{o}C in the combustion furnace of the quartz tube with a catalyst. Then the heating cylcle for the sludge is given in the Fig. 3.

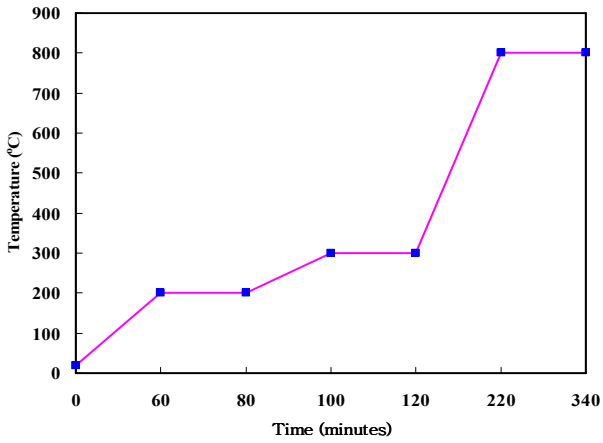

Fig. 3. Furnace heating cycle for sludge

The ^{3}H and ^{14}C which are generated from this process are trapped in a nitric acid solution and a carbosorb respectively. The ^{3}H trapped in the nitric acid solution is mixed with a scintillation solution (Gold star) in a vial and the ^{14}C trapped in the carbosorb is also mixed with a

scintillation solution (Gold star) in another vial. Finally, their radioactivity is measured by a low level liquid scintillation counter (LSC, Quantlus 1220, Walac). The efficiencies of the measurement of ^{3}H and ^{14}C for all the samples are calculated by measuring the standard solutions. The relation between the standard quenching parameter (SQP(E)) and the measurement efficiency for ^{3}H and ^{14}C can be seen in Fig. 4.

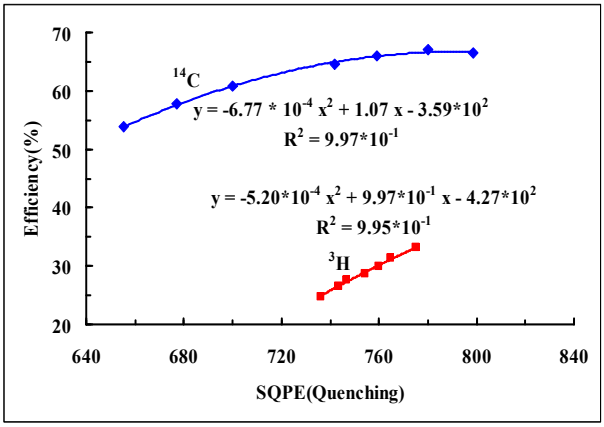

Fig. 4. The quenching curve for ^{3}H and ^{14}C

ANALYSIS RESULTS

The specific activities of ^{3}H and ^{14}C were less than a minimum detectable activity (MDA), respectively [2]. They are much less than the limit of a concentration available for a self-disposal of ^{3}H and ^{14}C. The MDA was calculated by using the following equation.

$$MDA = \frac{(2.71+4.65\sqrt{N_b})}{t_b m \varepsilon}$$

N_b : Background count

t_b : Background counting time

m : Mass of the sample

ε : Efficiency

The background count rates were 1.34 cpm for Tritium and 3.39 cpm for C-14.

CONCLUSION

The radioactivity of ^{3}H and ^{14}C of the sludge used in a nuclear power plant was simultaneously analyzed by using a high temperature combustion furnace and the LSC method. It is suggested that the sludge can be self-disposed of from the analysis result.

The procedure of the present study will be continuously applied to an analysis of the ^{3}H and ^{14}C for an environmental monitoring and for determining a self-disposal.

REFERENCES

1. Ian Croudace and Jung-Suk Oh, **"**Analysis of total tritium and ^{14}C in solid samples**"**, GAU/RC/2022 (2005).
2. IAEA, **"**Measurement of Radionuclides in Food and the Environment**"**, Technical Report Series No. 295, Vienna (1989).