

Capability Development of Determination on Oxygen/uranium Ratio of U Pellet by Gravimetric Analysis at KINAC

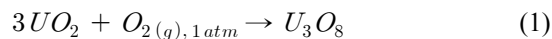
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1. Introduction

Destructive analysis is used to verify that protracted diversion of safeguard nuclear materials has not occurred[1]. According to IAEA report, Thermo gravimetric analysis (TGA, Ignition gravimetry) has been used in analyzing uranium and plutonium compound for element concentration measurements for safeguard purpose[2]. In the case of uranium compound, It is generally accepted that the oxidation of uranium pellet at temperatures below 900°C was a reaction, as proposed in 2004 by International Standard (ISO-12795.) [3,4].



The sample is perfectly changed from UO_2 to U_3O_8 under 900°C and the U_3O_8 formation due to UO_2 oxidation leads to a 36% volume increase[3].

Although KINAC is the only organization for nuclear materials management, but has not been able to verify O/U ratio independently, which is a key factor to estimate the amount of uranium in the nuclear fuel. This year, for the first time, thermo gravimetric analysis was performed in order to check its own analysis capacity in the following manner.

2. Methods

2.1 Samples

The uranium pellet specimens used in this study were provided by Korea Electric Power Corporation-Nuclear Fuel (KEPCO-NF). The pellets whose stoichiometry is close to UO_2 .

2.2 Experiment

The oxidation curves using uranium pellet were obtained under isothermal conditions with a

thermo-gravimetry SETARAM TGA (SETSYS evolution), in pure oxygen gas(99.999%) flowing at 0.03 L/min and at temperatures ranging from 25 to 900°C. The equipment of TGA and the graph of the temperature condition is shown in Fig. 1 and 2.



Fig. 1. TGA.

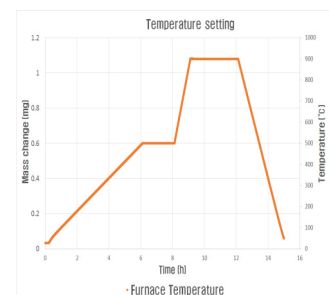


Fig. 2. Temperature condition of experiment.

2.3 Blank test for buoyancy correction

The buoyancy of the pure oxygen gas itself decreases when the gas in the system is heated. Therefore, the sample/crucible appears to gain weight. Table. 1 represents the results of blank test and Fig. 3 shows weight gain curves as a function of time recording with Pt crucible in pure oxygen gas. The average value of variation was 0.050 mg.

Table 1. Blank test results of weight change

Test number	1	2	3	4	5	6	7	Mean
Initial mass -								
final mass (mg)	0.11	0.073	0.077	0.085	0.069	-0.041	-0.029	0.050

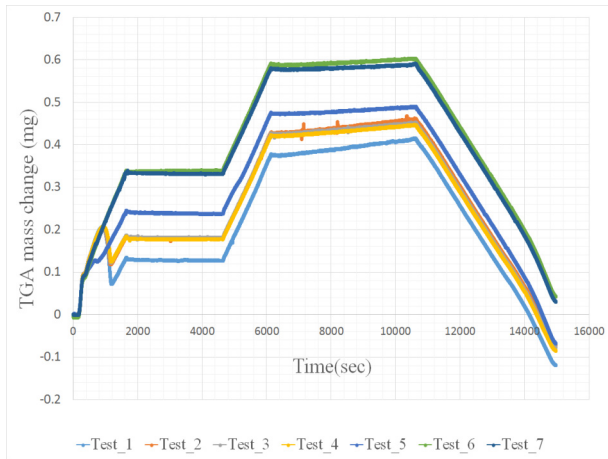


Fig. 3. Blank test results as a function of time.

2.4 Calculation

The formula applied to calculate the U/O ratio using uranium pellet is as follows[4]:

$$W_u = 100 \times F_s \times W_2 - (W_2 \times I) / W_1 (\%) \quad (2)$$

Where:

W_u = weight fraction of uranium, in percent

W_1 = original sample weight, in grams

W_2 = sample weight (in gram, after oxidation) -
Buoyancy correction value (0.050)

I = weight fraction of all non-volatile impurities
in oxide form in U_3O_8 (0.000076)

F_s = stoichiometric factor for the conversion of
grams of U_3O_8 to grams of U.

Base on the eq. (2), the O/U ratio is obtained as

$$(100\% - W_u) \times A_u / W_u \times A_o \quad (3)$$

Where:

A_u = uranium atomic weight(Enrichment : 4.5%)
(237.9156)

A_o = oxygen atomic weight (15.9994)

3. Results & Conclusion

Fig. 4 shows the weight gain curve, obtained from thermo gravimetric experiment. The initial weight and final weight was 163.499, 170.025 mg individually. The weight fraction of uranium (in percent) was 88.152% after correcting the buoyancy effect and O/U ratio was 2.000.

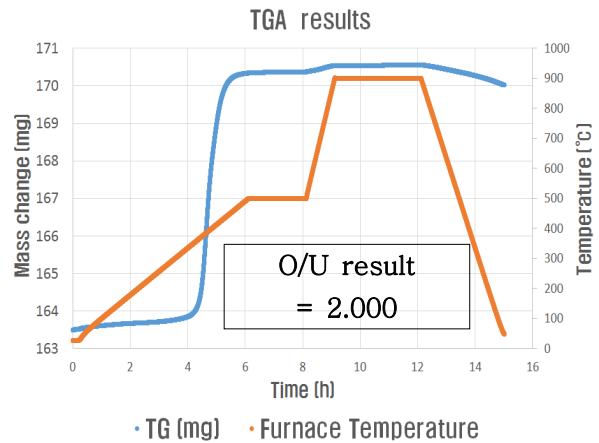


Fig. 4. Weight gain curve of uranium pellet oxidised from 25 to 900°C in pure oxygen gas flowing at 0.03 L/min..

KINAC obtained these results in the first experiment and established the ability to accurately verify the uranium contents. To sustain this accurate results for TGA in future, it is necessary to study the effects of various factors(gas velocity effects, thermal effects on the balance mechanism, etc.) on weight changes.

4. REFERENCES

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