Determination of Reduction Yield of Lithium Metal Reduction Process

In Kyu Choi, Young Hwan Cho, Taek Jin, Kim, Kwang Young Jee
Korea Atomic Energy Research Institute
Kyu11@kaeri.re.kr

1. Introduction

Metal reduction of spent oxide fuel is the first step for the effective storage of spent fuel in Korea as well as transmutation purpose of long-lived radio-nuclides.[1,2] During the reduction of uranium oxide by lithium metal to uranium metal, lithium oxide is stoichiometrically produced. By determining the concentration of lithium oxide in lithium chloride, we can estimate that how much uranium oxide is converted to uranium metal. Previous method to determine the lithium oxide concentration in lithium chloride is tedious and timing consuming.[3] This paper describe the on-line monitoring method of lithium oxide during the reduction process

2. Experimental and Results

Lithium metal reduction process of uranium oxide in lithium chloride molten salt at 650℃ gives lithium oxide and uranium metal as following equation:

$$U_3O_8 + Li \rightarrow U + LiO_2 \quad (1)$$

Determining the reduction yield there two methods. One method is that uranium powder in reaction vesseel is sampled and analyzed to determine the oxygen content, but uranium sampling is not convenient from the vessel. The other method is that molten salt is sampled from the vessel and analyzed the lithium oxide content which is dissolved in lithium chloride up to 8.7wt% at 650℃.

Of convenience molten salt sampling has been preferred. However, analytical procedure of lithium oxide measurement is quite complex and tedious as followings: sampling the molten salt during the reduction process, weighing the sample, dissolving the sample in distilled water and measuring the hydrogen volume to compensate lithium metal and titrating the final solution by hydrochloric acid. Total volume of hydrochloric acid consumed is due to the small amount of lithium metal and lithium oxide. The amount of lithium metal is obtained from the hydrogen evolution volume and is subtracted from the total volume of hydrochloric acid.

The method described in this paper is very simple and able to measure the lithium oxide contents in the reaction vessel by measuring the current due to the reduction of lithium ion dissociated from lithium oxide. Lithium metal dissolved in lithium chloride molten salt doses not interfere the measurement, while it interferes the previous sampling method.

Without using a reference electrode, two-electrode system was used to measure the current (shown in Fig. 1).

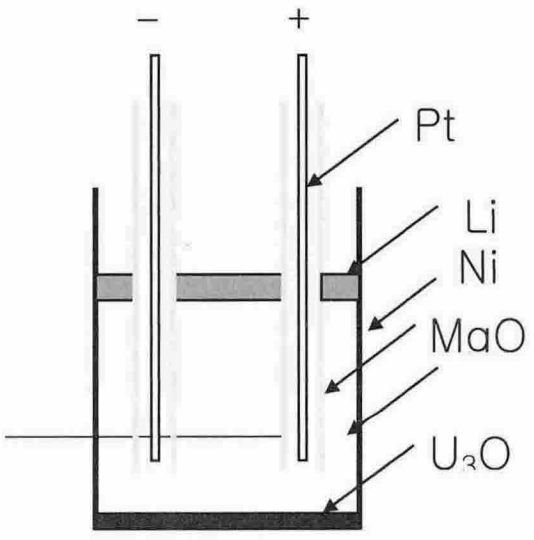

Fig. 1. Schematic diagram of current measurement system (U_3O_8 : 31.6g, Li metal : 7g in LiCl at 650℃)

During the current measurement, molten salt were sampled to analyze the lithium oxide content with previous method and compared with the result from the current measurement. Fig. 2 shows that both results give similar trend.

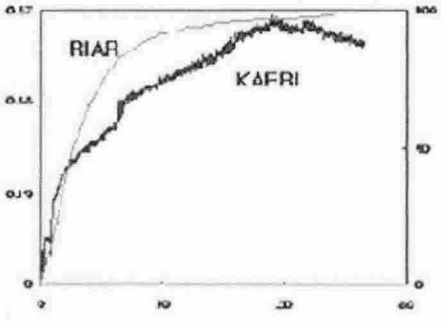

Fig. 2. Comparison of current measurement result with RIAR results.

REFERENCES

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