Performance Test of the Salt transfer and Pellet fabrication of UCl3 Making Equipment for Electrorefining

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1. Introduction

Uranium electrorefinning process is to recover pure uranium from LiCl-KCl eutectic salt include crude uranium by electrochemical method. In the process, the reactor of an electrorefiner consists of the two electrodes and the molten chloride salt which is LiCl-KCl-UCl_3. The role of uranium chloride salt (UCl_3) is to stabilize the initial cell voltage between electrodes in the electrorefining reactor. The process to produce a uranium chloride salt includes two steps: a reaction process of gaseous chlorine with liquid cadmium to form the $CdCl_2$ occurring in a Cd layer, followed by a process to produce UCl_3 by the reaction of U in the LiCl-KCl eutectic salt and $CdCl_2$ [1]. Chemical reaction is next chlorination reaction;

- Cd chlorination : Cd + Cl2 → CdCl2
- U chlorination : 3CdCl2 + 2U → 3Cd + 2UCl3

The apparatus for producing UCl_3 consists of a chlorine gas generator, a uranium chlorinator, a Cd distiller, the pelletizer, a off-gas wet scrubber and a dry scrubber. Salt transfer system set among reactors to transfer salt at 500℃. The temperature of the reactants is maintained at about 600 ℃. After the reaction is completed in the uranium chlorinator, The Salt product is transferred to the Cd distiller to decrease residual Cd concentration in the salts, and then salt is transferred to the mould of pelletizer by a transfer system to fabricate pellet type salt. Performance test of the salt transfer and pellet fabrication of its equipment was tested in this work.

2. Experimental

The reactor of equipment for making pellet type UCl3 salt consists of a uranium chlorinator, a Cd distiller, a pelletizer. Salt transfer equipment coupling to among reactors and salt transfer system was heated by electric heating at 500℃as shown in Fig.1. Material and size of transfer tube is stainless steel 316, 3/8 inch. Argon gas was supplied into the reactor and transfer tube to control argon atmosphere in the reactor. Heating rate of transfer tube was 5℃/min. Salt transfer was carried out under pressurization at 3bar and reduced pressure at 76tor. Pressurization rate was control by argon gas flowmeter. A eutectic salt (59 LiCl – 41 KCl mol %) of 15kg per batch was melted at 600℃ by heating rate 5℃/min. Salt was fed two time each 5 kg-salt because bulk density of ingot type salt is low density. Cd distillation did not carry vacuum distillation at 600℃ because there is no Cd in reactor. And then pellet type salt was fabricated by mold of the pelletizer in the argon atmosphere at 90~200℃. And pellet type salt was removed from mold at room temperature. Salt moving in the salt transfer tube was checked by thermocouple.

Fig.1. Salt transfer equipment heated by electrical control.

3. Results and discussion

Test of the salt transfer and the pellet fabrication of salt carried out by 15kg-salt/batch UCl3 making equipment as shown in Fig. 2. Melting salt at 600℃ in uranium chlorinator reactor was moved successively to next reactors by the salt transfer system. When velocity of salt transfer was controlled under reduce pressure, velocity of salt transfer was difficult to control. But when velocity of salt transfer was controlled by pressurization, velocity of salt transfer is easy to control by argon ball flowmeter. When melted salt is moving in transfer tube by pressurization, temperature of tube inside rises up to 600℃ from 500℃. The pellet type salt was fabricated in mold of pelletizer. When mold of pelletizer heated at 90℃, pellet size, OD90 x H 115mm, fabricated as shown in Fig. 3.

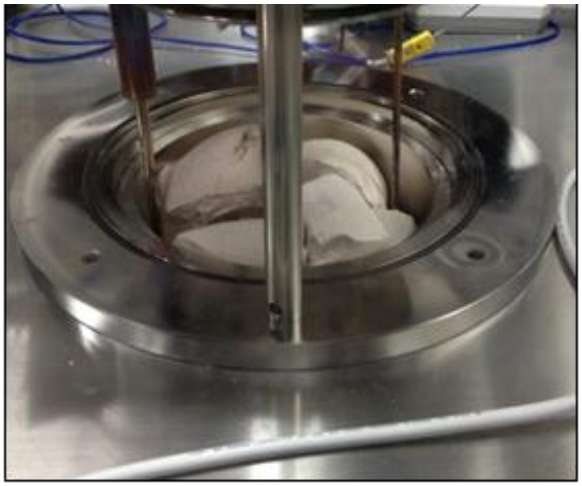

Fig.2. LiCl-KCl salt before melting in the reactor

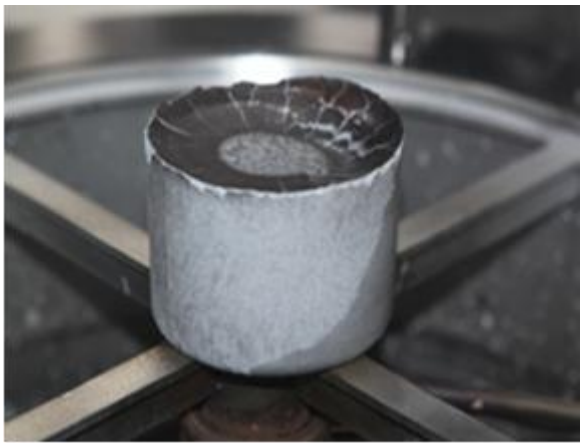

Fig.3. Fabricated salt by mold of pelletizer

But when mold of pelletizer heated at 200℃, pellet fabricated is about half size smaller than fabricated pellet at 90℃ as shown in Fig. 4. Because melted salt leaked from mold.

Fig.4. Fabricated salt by mold of pelletizer at 200℃

So that we need reducing of heating temperature of mold at about 90℃. To separate fabricated pellet from mold need cooling time about over-night in room temperature.

3. Conclusions

Performance test of the salt transfer and pellet fabrication of UCl3 making equipment for Electrorefining carried out in this work. The result of equipment test is that melted salt at 600℃ was easy transferred by salt transfer equipment heated at 500℃. In this time, salt transfer was carried out by argon gas pressurization at 3bar. When velocity of salt transfer was controlled under reduce pressure, velocity of salt transfer was difficult to control. And when salt pellet was fabricated by the mold of pelletizer heated at 90℃ better than mold of pelletizer heated at 200℃ because salt melted prevent leakage from mold of pelletizer.

REFERENCES

[1] Miller et al, “Method for Making a Uranium Chloride Salt Product” Patent No.: US 6,800,262B1, Date of Patent: Oct.5, 2004