Evaluation of Remote Injection Casting Integrated Process

Hoon Song[a*], Yoon-Myung Woo[a], Sang-Gyu Park[a], and Jeong-Yong Park[a]
[a]*Korea Atomic Energy Research Institute, 1045 Daedeokdaero, Yuseong, Daejeon, Korea, 305-353*
[*]*Corresponding author: hsong@kaeri.re.kr*

1. Introduction

In order to secure the remote manufacturing technology of metal fuel slug to produce and supply the recycling core fuel slug required for SFR, we developed a recycling metal fuel manufacturing technology for SFR fuel after spent fuel reprocessing. It is possible to maximize utilization of high-level waste disposal space using spent fuel by securing SFR cycling metal fuel manufacturing technology. Because of the high radiation content of the recycled fuel, it is important to develop a process for remotely manufacturing, since the entire manufacturing process performed in the hot cell facility for safety. In this study, the remote injection casting process used to identify the feasibility of the fuel slug remotely was evaluated using an engineering-scale metal fuel slug remote manufacturing system for the purpose of manufacturing a recycling metal fuel slug in a hot cell [1,2].

2. Methods and Results

In this section, experimental methods and results described.

2.1 Experiment Procedure

Injection molding technology is a method in which a molten metal pushed into an injection mold with an inert gas to cast. The process of injection casting classified as remote and non-remote operation, and the related process such as fuel loading, crucible and mold assembly transportation and mold assembly disassembly accompanied by metal fuel fabrication apparatus and injection molding evaluated.

Remote injection casting process divided into the preparation process of the metal fuel slug, metal fuel material melting process, and process after injection casting. Engineering-scale injection casting equipment shown in Fig. 1. The preparation process of the metal fuel slug is a step of preparing for casting before the metal fuel melting process. It is consisted of the process of inserting the crucible into which the fuel core melting material is loaded into the melting chamber and a process of positioning the mold assembly inside the chamber.

A crucible hanger is required to carry out remotely the process of inserting crucible for moving the crucible. A NW flange joining process is required to connect the upper chamber and the lower chamber to open and close the upper chamber. A docking post is required to place the mold assembly in the holding device in order to position the mold assembly inside the chamber, and the mold assembly that has seated raised as much as possible using a mold drift device, and then the upper chamber rotated toward the lower chamber. To align and position, a master-slave manipulator (MSM) mechanism is necessary remotely to perform this operation. A crucible hanger and docking post shown in Fig. 2.

After the crucible and the mold assembly prepared, the upper chamber and the lower chamber bound together, and then the inside of the chamber evacuated by using a vacuum pump. The melting process begins by starting the melting oscillator. When the target melting temperature reached, the mold-drifting device descends the mold to produce the fuel slug. The preparation process for remote activity summarized in the Table 1.

After the melt casting, post-casting process performed. The bundled NW flange released using an air lock device. After the upper chamber lifted, the upper chamber rotated to place the mold assembly in the mold transfer case, and then the mold assembly placed on the mold transfer case. Using a crucible hanger, the crucible moved out of the lower chamber and placed on the table to complete the process. MSM and crane used to perform remotely these processes such as NW flange opening, top chamber rotation, crucible hangers.

Table 1. Preparation process remote summary

Action	Item	Remote action	Gain visibility
Crucible insertion	Crucible hanger	MSM, Crane	Window, camera
Upper chamber rotation		MSM	Window
Mold bind	Docking post	MSM	Window
Bind upper chamber with bottom chamber	NW flange binding	MSM, Air lock	Window
Mold disassembly	Docking post	MSM	Window
Crucible disassembly	Crucible hanger	MSM. crane	Window, camera

2.2 Results

Preliminary injection casting tests of metal fuel manufacturing equipment were performed remotely using pure metal Cu, which has a similar melting temperature to uranium metal.

Test result shows that the injection casting process that excludes the risk that may occur during the

injection casting process established and confirmed by the remote casting test that it performed remotely and soundly.

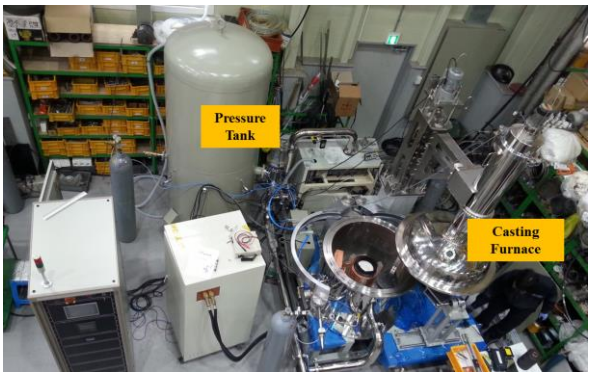

Fig. 1. Engineering-scale injection casting equipment (Max. U-Zr charge: 20kg, installed at KAERI

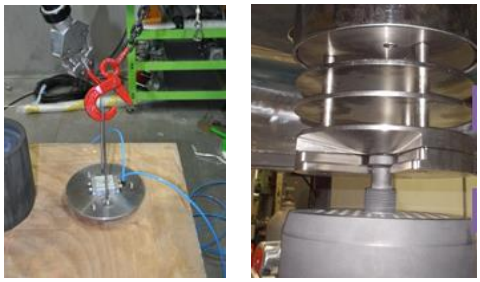

Fig. 2. Crucible hanger (left) and Docking post (right)

3. Conclusions

For manufacturing a recycling metal fuel slug in a hot cell, the injection casting process performed to identify the feasibility of fuel slug remotely as engineering scale. The injection casting evaluated by dividing as remote and non-remote using an engineering scale remote metal fuel fabrication equipment. As a result, it confirmed that the injection casting process that minimizes the risk during casting performed soundly by remote casting test.

REFERENCES

[1] C.L. Trybus, J.E. Sanki, S.P. Henslee, Journal of Nuclear Materials, Vol.204, pp.50, 1993.
[2] H.F. Jelinek, G.M. Iverson, Equipment for Remote Injection Casting of EBR-II Fuel, Nucl. Sci. Eng., Vol.12, p.405, 1962.