The Current Status of HANARO Driver Fuels Fabrication in KAERI

Kyuhong Lee[a*], Ki Nam Kim[a], Wonjae So[a], Jonghwan Kim[a], Yoon-Sang Lee[a],
Yong Jin Jeong[a], Sunghwan Kim[a], Jong Man Park[a]
[a]*Korea Atomic Energy Research Institute, 111, Daedeok-daero 989Beon-gil, Yuseong-gu, Daejeon*
[*]*leekh79@kaeri.re.kr*

1. Introduction

The HANARO (**H**igh-flux **A**dvanced **N**eutron **A**pplication **R**eact**O**r) driver fuels were designed by ACEL and KAERI on the basis of the driver fuel for the NRU reactor in Canada [1]. The fuel is a high density (3.15 gU/cm^3) uranium-silicide/aluminum dispersion rod-type fuel. At the beginning of reactor operation, ACEL had supplied the driver fuels to HANARO. In 2005, KAERI successfully localized the HANARO fuels and supplied the first fuel assembly which was fabricated at the Advanced Fuel Science Building to the HANARO.

Fig. 1. The photograph of the Advanced Fuel Science Building

2. Description of HANARO Fuel

Fuel meat of the HANARO fuel consists of low enriched U_3Si powder and aluminum matrix as shown in figure 2. Two types of fuel element are used, standard core and reduced core fuel elements having a core diameter of 6.35 and 5.49 mm, respectively. The rod-type fuel core is co-extruded with finned aluminum cladding and is sealed with end plugs by electron beam welding.

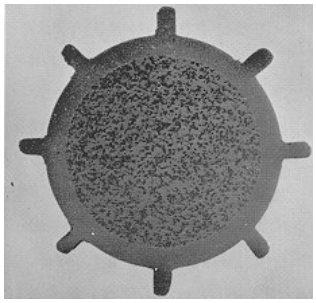

Fig. 2. Cross-sectional macro-graph of HANARO fuel rod. Dark particles are U_3Si fuel powders and the gray area is aluminum matrix. The fuel core is surrounded by the aluminum cladding with 8 pins.

The fuel elements are assembled with assembly components which are composed of a central rod, end plates, a grapple head, spacer plates/tubes, and spring, etc. There are two type of fuel assemblies. 36-elements fuel assembly is a hexagonal shape which are arranged in two inner hexagonal arrays with the standard core elements and outermost array with the reduced ones. On the other hand, the fuel elements of 18-elements fuel assembly are arranged in two concentric ring, 6 in the inner ring and 12 in the outer ring. Figure 3 shows the photographs of the fuel assemblies.

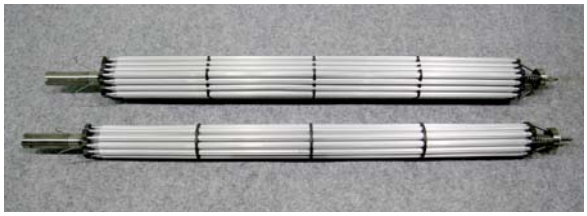

Fig. 3. The photograph of HANARO fuel assemblies, 36-element fuel assembly at the upper side and 18-element fuel assembly at the lower side.

3. Localization of HANARO fuel

KAERI launched a localization program of the HANARO driver fuels at 1987 with the rotating-disk centrifugal atomization technology [2, 3]. ACEL fabricated uranium silicide powder by mechanical comminution of casting master alloy [4]. The centrifugal atomization method can simplify the fuel powder fabrication process compared to comminution method. Since the centrifugal atomization is a kind of the rapid solidification process, it has several advantages such as spherical powder shape and narrow particle size distribution. Figure 4 shows the centrifugal atomization process and fuel powder.

Also, all of the fabrication process of fuel element and assembling process were developed with establishing the fabrication equipments at the advanced fuel science building in KAERI. A vertical extrusion process applied to fabrication of fuel core. The spherical atomization powder improves the plastic flowability and do not have any preferred orientation after extrusion. The aluminum was clad on the fuel core by co-extrusion method [5]. To prevent the leaking of fissile materials at the reactor core, the fuel elements were sealed with end plugs by electron beam welding.

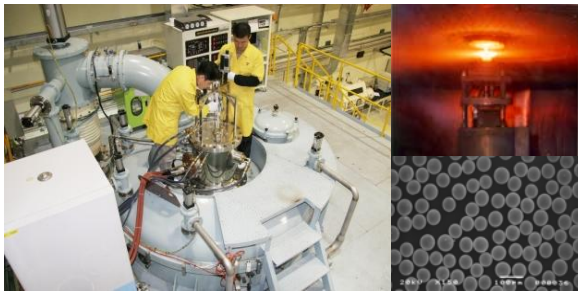

Fig. 4. The centrifugal atomization process and the fuel powder. A melting of uranium and silicon mixing is poured on the rotating disk. The fuel powder is a near-perfect spherical shape.

At 2004, KAERI got permission for the fabrication of the HANARO fuels. The lead bundle (KFC-001), the first research reactor fuel fabricated in Korea, was loaded in the HANARO reactor core in March 2005. The reactor core has been filled by the domestic fuels since November 2007.

Fig. 5. HANARO fuel fabrication facilities at the advanced fuel science building in KAERI.

Up to now, total 348 fuel assemblies which contains 10,206 fuel rods were fabricated at the domestic facilities.

4. Conclusion

The HANARO driver fuels were successfully localized with our own technology. The centrifugal atomization method was the key technology for the localization and fabrication of the fuels. The experience of the HANARO fuel localization is spreading to the other projects related to fuel fabrication such as a plate-type research reactor fuel, SFR fuels, and other metallic fuels.

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