

Fabrication of preliminary fuel rods for SFR

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1. Introduction

Metal fuels was selected for fueling many of the first reactors in the US, including the Experimental Breeder Reactor-I (EBR-I) and the Experimental Breeder Reactor-II (EBR-II) in Idaho, the FERMI-I reactor, and the Dounreay Fast Reactor (DFR) in the UK [1, 2]. Metallic U-Pu-Zr alloys were the reference fuel for the US Integral Fast Reactor (IFR) program. Metallic fuel has advantages such as simple fabrication procedures, good neutron economy, high thermal conductivity, excellent compatibility with a Na coolant and inherent passive safety [3]. U-Zr-Pu alloy fuels have been used for SFR (sodium-cooled fast reactor) related to the closed fuel cycle for managing minor actinides and reducing a high radioactivity levels since the 1980s. Fabrication technology of metallic fuel for SFR has been in development in Korea as a national nuclear R&D program since 2007 [4-7]. For the final goal of SFR fuel rod fabrication with good performance, recently, three preliminary fuel rods were fabricated. In this paper, the preliminary fuel rods were fabricated, and then the inspection for QC(quality control) of the fuel rods was performed.

2. Fabrication of fuel rod

Fig. 1 shows the fuel slug fabrication equipment melted under Ar inert atmosphere. Elemental lumps of low-enrichment uranium (LEU), zirconium, and Mn, and RE(rare earth) were used to fabricate the fuel slugs. Graphite crucible plasma-spray coated with Y_2O_3 was

used. Graphite and quartz were used as mold materials. After casting the metal fuel slugs, the fuel slugs were machined into the pin of 5.0mm in diameter



Fig. 1. Gravity casting furnace

The chemical compositions of the fuel slugs were shown in Table 1.

Table 1. Chemical compositions of the fuel rods

Chemical Composition	Number of Rod
U-10wt.Zr	1
U-10wt.Zr-RE	1
U-10wt.Zr-Mn-RE	1

3. Inspection for QC of the fuel rods

Quality control for the metallic fuel slug, cladding, and fuel rod were performed. For quality control of the fabricated metallic fuel, cladding, and fuel rod, 9 kinds of inspections were performed. The inspection items were tabulated in the Table 2. Whether pass or not for all the inspection items was based on the design document and its permissible tolerance.

Table 2. Inspection items for QC of the fuel rod

Item	Inspection Item
1	Chemical composition of metallic fuel
2	Defect of metallic fuel : surface defect, internal defect, microstructure
3	Dimension of metallic fuel : mass, length, density
4	Dimension of cladding : outer diameter, thickness, length
5	Sodium melting : quantity, level
6	Dimension of fuel rod plug : top plug, bottom plug
7	Welding of fuel rod : visual inspection, RT
8	Dimension and mass of fuel rod : total length of fuel rod, mass
9	He leakage of fuel rod

4. Summary

The three preliminary fuel rods for SFR, U-10wt.Zr, U-10wt.Zr-RE, U-10wt.Zr-Mn-RE were fabricated, and then the inspection for QC(quality control) of the fuel rods was performed. The inspection result for QC the three fuel rods shows that the fuel rods was fabricated according to the design criteria.

References

- [1] L. C. Walters, B. R. Seidel, J. H. Kittel, *Nuclear Technology*, 65, p. 179, 1984.
- [2] J. H. Kittel, B. R. T. Frost, J. P. Mustellier, K. Q. Bagley, G. C. Crittenden, J. Van Dievoet, *Journal of Nuclear Materials*, 204, p.1, 1993.
- [3] G.L. Hofman, L.C. Walters, T.H. Bauer, "Metallic Fast Reactor Fuels", *Progress in Nuclear Energy*, Vol.31, p.83, 1997.
- [4] C.B. Lee, B.O. Lee, S.J. Oh, S.H. Kim, "Status of Metallic Fuel Development for Sodium-cooled Fast Reactor", *Proceedings of Global-2009*, Paris, France, 2009.
- [5] C.T. Lee, S.J. Oh, H.J. Ryu, K.H. Kim, Y.S. Lee, S.K. Kim, S.J. Jang, Y.M. Woo, Y.M. Ko, C.B. Lee, "Casting Technology Development for SFR Metallic Fuel", *Proceedings of Global-2009*, Paris, France, 2008.
- [6] S.J. Oh, K.H. Kim, C.B. Lee, C.T. Lee, S.J. Jang, "Effects of Ce Element Addition on the Characteristics of U-Zr Alloys", *Proceedings of Nuclear Fuels and Structural Materials for the Next Generation Nuclear Reactors (NFSM-II)*, Anaheim, USA, 2008.
- [7] K.H. Kim, S.J. Oh, J. T. Lee, Y. S. Lee, C.B. Lee, "Feasibility Study of Advanced U-Mo-X Metallic Fuel System for SFR", *Proceedings of KNS Spring Meeting*, Gyeongju, Korea, 2008.