

KNF-
FUEL-08

Nuclear fuel material HANA

NUCLEAR FUEL TECHNOLOGY DEPT. Jae Ik Kim
T. 042-868-1147 E. jkim@knfc.co.kr

HANA is a nuclear fuel material for which ‘KEPCO Nuclear Fuel(KNF)’ has independent technology ownership. It is a new zirconium-based alloy material with high burnup performance of over 70,000 MWd/MTU. It is planned to be supplied to domestic nuclear power plants starting in 2028.

※ HANA :

High-performance Alloy for
Nuclear Application

Description

● Background

- The performance of nuclear power plants is continuously improving. However, it has led to more severe core and nuclear fuel operating conditions, such as high burnup, longer cycle operation, and power increases. Accordingly, to secure safety under these conditions, the fuel rod cladding was developed from the 1st generation Zircaloy-4 to the 2nd generation improved Zircaloy-4 and to the 3rd generation Zr-Nb series ZIRLO and M5 cladding, developed by foreign companies, and it has been supplied to domestic nuclear power plants.
- KNF has a tube manufacturing facility(TSA) but imports ZIRLO TREX, owned by WEC, to manufacture and supply tubes to domestic and overseas nuclear power plants.

● Purpose and Necessity

- Developed cladding with a high burnup performance of over 70,000 MWd/MTU. KNF’s technology ownership was secured, and it commercially supplied the cladding to domestic nuclear power plants.
- Resolved export restrictions by securing independent technology ownership.

● Technology composition

- Nuclear fuel material HANA cladding tube, HANA guide tube and HANA grid assembly
 - Zr-Nb series alloy composition and manufacturing technology
- Out-of-pile and in-pile test of HANA material and various out-of-pile and In-pile performance data
 - Different thermal and mechanical property test of HANA materials and test result data
 - Halden In-Reactor Test for HANA material and its test results data
 - Test results data of Lead Test Rod(LTR) program(Hanbit Units 1/5) and PSE(Poolside Examination)/PIE(Post Irradiation Examination) for HANA material
 - Test results data of Lead Test Assmby(LTA) program(Hanul Unit 6 HIPER16 LTA and Hanbit Unit 2 HIPER17 LTA) and PSE for HANA material
 - Test Results data of high burnup LTA(~65,000 MWd/MTU) and PSE/PIE(~2023.12) for HANA material
- HANA cladding tube irradiation performance and its performance model reports

Hot Cell Test	Results of HANA material performance test			Results of HANA material performance test in Hot-cell
	Design requirement	Performance level for Commercial Nuclear fuel	World Best Performance level	
Corrosion Resistance (Oxide Thickness)	Under 100 μm	60 ~ 70 μm	under 20 μm	10 ~ 20 μm
Hydrogen Ingress	600 ppm	500 ppm	100 ppm under	100 ppm
Irradiation Growth	1%	0.6~0.8%	0.4~0.6%	0.5~0.6%
Mechanical Properties	-----			Test in progress
Safety	-----			Test in progress

- Application of HANA cladding tube irradiation performance model to KNF fuel performance code and preparation for approval

Distinctiveness

- **The performance of cladding tube has proven to be the world's best through the hot cell test.**
- **Benefit**
 - Supply nuclear fuel to commercial nuclear power plants in Korea through achieving self-reliance in nuclear fuel materials/parts
 - Resolve restrictions on nuclear power plant exports and secure export competitiveness through localization of nuclear fuel materials and parts
 - Use as nuclear fuel components(fuel rod, guide tube, grid assembly) of SMART nuclear power plant
 - Expect to increase in nuclear power plant utilization rate by 2% and decrease the emission of spent fuel due to an increase in licensing burnup limit(~62,000 MWd/MTU)

Experience

- **HIPER16(HANA cladding tube, HANA guide tube, HANA grid assembly)**
 - Completed in-pile test and hot cell test in progress
 - Preparing for licensing for domestic commercial supply
- **HIPER17(HANA cladding tube, HANA guide tube, HANA grid assembly)**
 - Completed in-pile test and PSE
 - Undecided KHNP policy for domestic commercial supply

Deliverables

- PWR KSNP fuel(HIPER16 fuel cladding tube/guide tube/grid assembly)
- PWR Westinghouse 17-type fuel(HIPER17 fuel cladding tube/guide tube/grid assembly)
- PWR Westinghouse 16-type fuel cladding tube
- SMART Nuclear Power Plant fuel cladding tube/guide tube/grid assembly)
- Accident tolerant fuel cladding tube(base material)

Technology Readiness Level (TRL)

Field demonstration of Prototype

Business Model

Technology Transfer

Licensing

Joint Search

Service Execution

Others