1-2 Improvement in Environmental Burden Reduction of Advanced FBR
—Core and Fuel Design Study for Minor Actinide Containing Oxide Fuel—

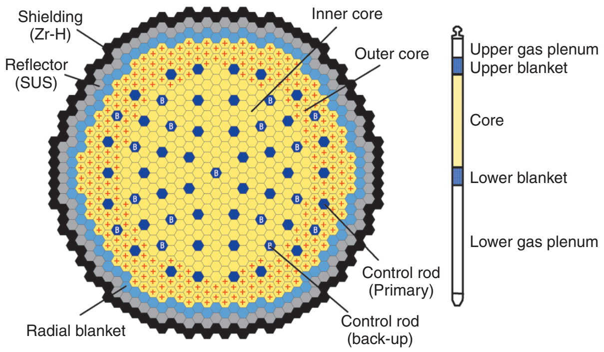

Fig.1-4 Configuration of core and fuel pin for commercial JSFR

Table 1-1 Major specification and design targets of commercial JSFR

Specification	Core power	1500MWe
	Core outlet/inlet coolant temperature	823/668K
Design target	Average Burn-up	150GWd/t
	Breeding ratio	~1.1
	Cycle length	> 24months
	Na void reactivity	< 6$

Table 1-2 Major characteristics of commercial JSFR for two fuel compositions of multiple-recycled FBR and LWR spent fuels

	FBR multiple-recycled SF composition	LWR SF composition
MA content (wt%)	0.9 (IC) 1.0 (OC)	3.0 (IC) 3.0 (OC)
Pu enrichment (wt%)	18.3 (IC) 20.9 (OC)	19.6 (IC) 22.1 (OC)
Core height (cm)	100	100
Axial blanket length (m)	20 (upper) 20 (lower)	15 (upper) 20 (lower)
Na void reactivity ($)	5.3	5.9
Doppler coefficient (Tdk/dT)	-0.0057	-0.0045
Max. linear heat rate (W/cm)	398 (IC) 396 (OC)	411 (IC) 395 (OC)
Max. linear heat rate limitation (W/cm)	442 (IC) 438 (OC)	435 (IC) 433 (OC)
Lower gas plenum length (cm)	110	115

SF : Spent fuel, IC : Inner core, OC : Outer core

We are developing an advanced FBR named “Japan Sodium-cooled Fast Reactor (JSFR)”, with development targets on safety and reliability, sustainability (environmental burden reduction, efficient utilization of resources, etc.), economic competitiveness and nuclear non-proliferation. The core and fuel design studies of JSFR with oxide fuel containing minor actinide (MA) have been performed.

JSFR is required to burn MA mainly from the viewpoint of reduction of environmental burden. The amount of MA contained in the fuel changes depending on the number of years after the introduction of FBR. When all the reactors are replaced by FBR many years after the FBR introduction, spent fuels from FBRs will be recycled, and MA content of the fuel is estimated to become around 1wt% after multiple recycling in FBRs. On the other hand, during the period when the light water reactors (LWRs) are in operation along with FBRs, spent fuels from LWRs, which contain much more MA, will be recycled and tend to increase the MA content in the fuel. Therefore, the core and fuel of JSFR must be designed to be able to accept MA-containing fuel with a certain variation range in content.

Although it is known that MA has influence on the core and fuel design, necessary information such as the material properties of MA-containing fuel is limited, and hence, relatively large design margins were taken corresponding to this situation. Therefore, we have tried to accumulate necessary fuel data, and by fully utilizing them the core and fuel design of the commercial JSFR has been performed, as presented in Fig.1-4 and Table 1-1. On the MA content, a fuel composition case for LWR spent fuel with the MA content of 3wt% is tentatively considered as well as a case for the multiple-recycled FBR.

As shown in Table 1-2, the effects of increased MA content are recognized in the core design as increased sodium void reactivity and also in the fuel design as extended gas plenum length and as reduced linear heat rate limitation, which are due to increased He gas generation caused by α-decay of MA and due to decreased melting point and thermal conductivity, respectively. However, it has been indicated that MA can be acceptable without serious effects on the core and fuel design specifications for the assumed MA content range of 1 to 3wt%.

It is planned to conduct further investigation of the recycle scenario of LWR spent fuels as well as to promote accumulation of necessary data on MA-containing fuel, which will be reflected in the core and fuel design.

Reference

Naganuma, M. et al., Development of Advanced Loop-Type Fast Reactor in Japan, (6) Minor Actinide Containing Oxide Fuel Core Design Study for the JSFR, Proceedings of 2008 International Congress on Advances in Nuclear Power Plants (ICAPP ’08), Anaheim, CA, USA, 2008, paper 8082, p.526-535, in CD-ROM.