BARS : BWR WITH ADVANCED RECYCLE SYSTEM

Kouji Hiraiwa, Mitsuaki Yamaoka, Yasushi Yamamoto
Toshiba Corporation, Isogo Nuclear Engineering Center, Japan
and
Akira Inoue, Junji Mimatu
Gifu University, Japan

Introduction

An innovative fuel cycle system named BARS (BWR with an Advanced Recycle System) is proposed as a future fuel cycle option aiming at enhanced utilization of uranium resources and reduction of radioactive wastes. In the BARS, the spent fuel from LWRs is recycled as a MOX fuel for a BWR core with fast neutron spectrum through the oxide dry processing and the vibro-packing fuel fabrication.

To achieve a fast neutron spectrum, a tight lattice fuel was adopted. It is well known that the void reactivity coefficient in LWRs has the tendency to be positive as the neutron spectrum harder. Then, a new core concept was introduced to improve the void reactivity coefficient under the restriction of core diameter by adopting a neutron-streaming channel.

Neutronic Characteristics of BARS core

The average void fraction is designed to be about 60%. The operation cycle length is 1year and the number of refueling batch is four. The Pu enrichments of load fuel were determined so that criticality is attained at the end of the equilibrium cycle. The enrichment of outermost assemblies has been set higher than the other fuels aiming at radial power flattening. The enrichment is varied in the axial direction : The enrichment located in the lower region of fuel assemblies near the axial core center is about 20% to 30% lower than those above and below the region. The breeding ratio is 1.04 with average discharge burnup of 44GWd/t.

Benchmark tests on NCA critical assembly

Verification of calculation method is required since the BARS core has unique characteristics:its neutron spectrum is different from conventional BWRs and it utilizes neutron streaming effect that is difficult to evaluate accurately. Therefore, we have a program to benchmark the calculational method. The NCA (Toshiba Nuclear Critical Assembly) is a swimming-pool type critical assembly fuelled with slightly enriched uranium, which has been utilized to verificate both LWR design codes and the specific fuel design. So far, basic characteristics such as conversion ratio and neutron spectrum were measured on the core with tight lattice test zone in the NCA.

Thermal-hydraulic Test on BEST facility

In the BARS core, a tight lattice fuel must be adopted because the conversion ratio needs to be improved to about 1. However, as a fuel rod gap becomes narrower than that of the current BWR fuel, thermal-hydraulic performance, especially critical power, may be reduced. Therefore, the thermal power of the BARS core could be limited by thermal-hydraulic performance of the tight lattice fuel. In the previous section, the fuel is designed as triangular lattice whose rod gap is 1.3 mm. As far as authors know, there are scarce critical power test data and no critical power correlation for triangular lattice with a rod gap of 1.3 mm. Therefore, the purpose of the thermal-hydraulic test is to obtain the critical power database for the tight lattice bundle.