The High-Performance Soluble-Boron-Free Small Modular Reactor ATOM

Xuan Ha Nguyen and Yonghee Kim*

Korea Advanced Institute of Science and Technology (KAIST)
291 Daehak-ro, Yuseong-gu, Daejeon, 34141, Republic of Korea
**Corresponding author: Yongheekim@kaist.ac.kr*

Abstract

PWR-type Small modular reactors (SMRs) have gained significant international attention after the nuclear accident in Fukushima-Daiichi. These reactors, based on most advanced and commonly used technology, are designed to be multi-purpose, compact, simple and less dependence on the active control system. In addition, by integrating steam generators, heat exchangers, and/or adapting the natural circulation inside the Reactor Pressure Vessel (RPV), the inherent and passive safety are enhanced, eliminating the possibility of Loss of Coolant Accident (LOCA). Recently, a high-performance PWR-type SMR, named autonomous transportable on-demand reactor module (ATOM), has been developed at CASMRR (Center for Autonomous Small Modular Reactor Research). The ATOM is designed for autonomous passive frequency and load-follow operations to improve both the reactor safety and power maneuvering capacity. This also reduces significantly human-induced accidents and personnel. Moreover, the ATOM core adapts a newly proposed reactivity control technology, named Centrally-Shielded Burnable Absorber (CSBA). Thank to the high neutronic flexibility of CSBA, burnup reactivity swing can be minimized, and therefore simplify the control rod design and movement. This make the soluble-boron-free operation possible and enhance significantly inherent safety related to negative moderator temperature coefficient (MTC). Furthermore, several heavy reflectors, accident-tolerant-fuel designs, and fuel management schemes are introduced in the ATOM core to increase further the core cycle and accident migration. In this paper, we will analyze and discuss, in details, the ATOM reactor goals, safety, technical designs, and remaining challenges. The core performance is assessed using a well-validated methodology, two-step Monte Carlo-diffusion procedure, which combines Monte Carlo Serpent 2 code, ENDF/B-VII.1 library, and 3D multi-physics nodal code COREDAX.

Keywords: *SMR, ATOM, Soluble Boron Free, CSBA, Heavy Reflector, Accident Tolerant Fuel*