ENHANCING VVER ANNULAR PROLIFERATION RESISTANCE FUEL WITH MINOR ACTINIDES

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ABSTRACT

Key aspects of the Global Nuclear Energy Partnership (GNEP) are to significantly advance the science and technology of nuclear energy systems and the Advanced Fuel Cycle (AFC) program. It consists of both innovative nuclear reactors and innovative research in separation and transmutation. To accomplish these goals, international cooperation is very important and public acceptance is crucial. The merits of nuclear energy are high-density energy, with low environmental impacts (i.e. almost zero greenhouse gas emission). Planned efforts involve near-term and intermediate-term improvements in fuel utilization and recycling in current light water reactors (LWRs) as well as the longer-term development of new nuclear energy systems that offer much improved fuel utilization and proliferation resistance, along with continued advances in operational safety. The challenges are solving the energy needs of the world, protection against nuclear proliferation, the problem of nuclear waste, and the global environmental problem. To reduce spent fuel for storage and enhance the proliferation resistance for the intermediate-term, there are two major approaches (a) increase the discharged spent fuel burnup in the advanced LWR (Gen-III Plus), which not only can reduce the spent fuel for storage, but also increase the 238Pu and 240Pu isotopes ratio to enhance the proliferation resistance, and (b) use of transuranic nuclides (237Np and 241Am) in the high burnup fuel, which can drastically increase the proliferation resistance isotope ratio of 238Pu /Pu. For future advanced nuclear systems, the minor actinides (MA) are viewed more as a resource to be recycled, or transmuted to less hazardous and possibly more useful forms, rather than simply as a waste stream to be disposed of in expensive repository facilities. As a result, MAs play a much larger part in the design of advanced systems and fuel cycles, not only as additional sources of useful energy, but also as direct contributors to the reactivity control of the systems into which they are incorporated. In the study, a typical pressurized water reactor (PWR) VVER-1000 annular fuel unit lattice cell model with UO2 fuel pins will be used to investigate the effectiveness of minor actinide reduction approach (MARA) for enhancing proliferation resistance and improving the fuel cycle performance in the intermediate term goal for future nuclear energy systems.