Nuclear Data for Design of Reduced Moderation Light Water Reactor

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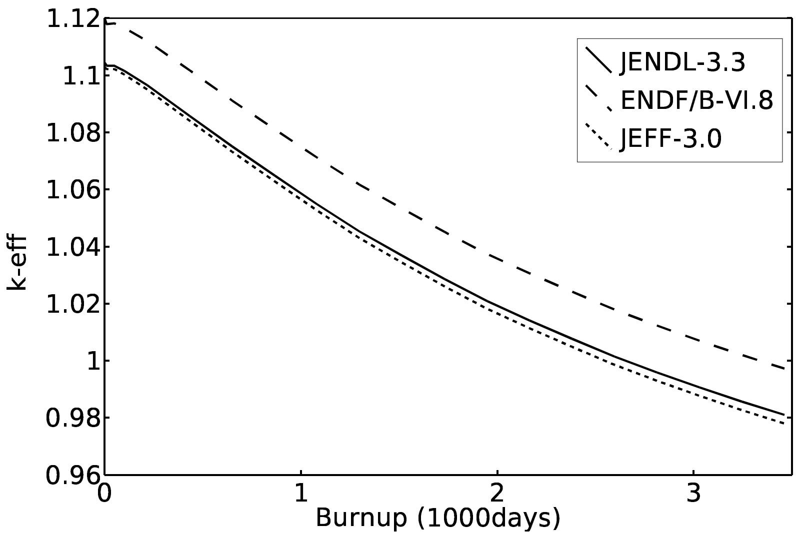
Because of the delay of the fast breeder reactor (FBR) program, the excess plutonium in commercial reactor spent fuels is estimated to already amount more than 1000 ton all over the world. For the efficient utilization of this excess plutonium based on the well experienced light water reactor (LWR) technology, Reduced Moderation Water Reactor (RMWR) concept has been studied in Japan Atomic Energy Agency (JAEA). In RMWR, the conversion ratio of 1.0 is achievable and the plutonium quality (ratio of fissile to total plutonium) can be kept high after burnup. The reactor can therefore sustainably supply energy for a long term through plutonium multiple recycling. The reactor can also act as an active storage of plutonium until the commercial introduction of FBRs.

The current RMWR design is a boiling water reactor (BWR) type, and the very high conversion ratio is realized by reducing the moderator to fuel ratio with the triangular tight pitched fuel lattice and the higher core averaged moderator void fraction than the conventional BWR. Neutronically, the reactor has intermediate neutron spectrum between conventional LWR and FBR. In the reactor core design study, the treatment of the resonance energy region becomes very important. At the lower part of RMWR core, however, the moderator void fraction is not high and the reactions in the thermal energy region is still notable. On the other hand at the upper part of the core, the neutron spectrum becomes very hard due to the high void fraction and the fast energy region is of great importance.

To study the effect of nuclear data uncertainty on the reactor physics characteristics of RMWR, by using a 1-dimensional simplified benchmark calculation model on the axially heterogeneous RMWR core, reactor physics characteristics were estimated with the different nuclear data libraries JENDL-3.3, ENDF/B-VI.8 and JEFF-3.0. As a result, ENDF/B-VI.8 was found to give nearly 1.5% larger effective multiplication factor than JENDL-3.3. This difference corresponds to nearly 500 days or more than 5 GWd/t of burnup period. The difference is caused mainly from the neutron production rate of U-238, Pu-239 and Pu-240 in the fast energy range due to the difference in the fast neutron spectrum calculated with ENDF/B-VI.8 and JENDL-3.3. Other than the multiplication factor, the other important physics characteristics of RMWR, conversion ratio and void reactivity were also compared.



Calculated multiplication factor of 1-d axially heterogeneous RMWR core model of 2 MOX regions with inner, lower and upper blankets