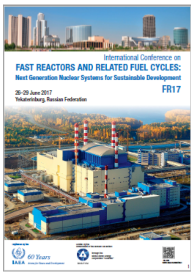

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Possibility studies of a boiling water cooled traveling wave reactor

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This paper investigates the possibility of a boiling water cooled traveling wave reactor, which can improve the natural uranium utilization of a Light Water Reactor (LWR) by umpteen times. The high density variation of boiling water through the core is favourable to fission at the lower part of the core and to the fuel breeding at the upper part of the core. This is the case in a low pressure Boiling Water Reactor (BWR). A serial axial fuel shuffling, which makes fuel moving, is considered. The natural uranium oxide fuel is fed in from the top of the core and discharged from the bottom of the core, as the water at the saturation point is fed in from the bottom of the core as in a boiling water reactor. The asymptotic state of the breeding/burning wave is searched theoretically and numerically, where the power (neutron flux) and the water density are fitted to each other to form a fission-breeding mixed reactor configuration. The major parameters of power, coolant mass flow rate, and the fuel shuffling speed are coupled to each other and determined by numerical solutions. A theoretical model for the water boiling is established based on a slip ratio model of two phase flow. The critical heat flux limit has been taken into account. The neutronics and burn-up calculations are performed with the ERANOS2.2 code, where models of axial fuel shuffling and coolant density change have been implemented. The 1-D preliminary numerical results are encouraging and show that the breeding is sufficient to make the core be critical and the maximum burn-up can reach up to 40%. The more detailed analyses and larger benchmarking efforts should be aimed further as discussed in the paper,. Also safety concerns will be addressed, in particular related to the sign and magnitude of the coolant density coefficient. Moreover a 1-D diffusion model is set up based on numerical neutron fluence and macroscopic neutron cross-sections. The solitary breeding-fission wave is obtained. The wave length of the neutron flux wave length can be understood. This implies that only a sufficient long core is needed for operating such a reactor instead of the fuel shuffling. Further discussions on clad irradiation damage and coolant feedback coefficients will be done.

Country/Int. Organization

Germany, Karlsruhe Institute of Technology

Primary author: Dr CHEN, Xue-Nong (KIT, IKET)

Co-authors: Dr RINEISKI, Andrei (KIT, IKET); Dr GABRIELLI, Fabrizio (KIT,IKET); Prof. SCHULENBERG, Thomas (KIT, IKET)

Presenter: Dr CHEN, Xue-Nong (KIT, IKET)

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