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EFFECT OF INLET TEMPERATURE AND OPERATING LINEAR HEAT RATING (LHR) ON THE MAXIMUM ACHIEVABLE BURNUP OF MK-1 CARBIDE FUEL IN FBTR

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India had constructed and is operating Fast Breeder Test Reactor (FBTR) with Mixed Carbide Fuel, a first of its kind in the world, as driver fuel. Mixed Carbide was chosen as fuel due to its high stability with Pu rich fuel, compatibility with coolant and for its better thermal performance. Being a unique fuel of its kind without any irradiation data, it was decided to use the reactor itself as the test bed for this driver fuel. The fuel has performed extremely well, with the peak burn-up reaching 165 GWd/t. The Linear Heat Rating (LHR) and burnup of the fuel was initially set at 250 W/cm and 25 GWd/t respectively. Based on rigorous theoretical analysis and Post Irradiation Examination (PIE) done at 25 GWd/t, 50 GWd/t and 100 GWd/t burnup intervals, the LHR limit was raised to 400 W/cm and allowable burn-up was raised to 155 GWd/t.
The burnup limit of the fuel SA comes from the following factors: Wrapper dilation; Wrapper residual ductility; Fission gas pressure and Fuel Clad Mechanical Interaction (FCMI) induced stress in pin; Clad strains; Clad residual ductility; Clad Cumulative Damage Fraction (CDF); Subassembly flow reduction, etc. Presently, the operating parameters like inlet temperature and the peak LHR of the FBTR of MK-1 fuel SA are 400℃ and 400 W/cm respectively which may result in different limits on the achievable burnups. In this work, the effect of LHR & inlet temperature have been comprehensively studied on the achievable burnup of the MK- 1 fuel SA. From the analysis, it is observed that the two enveloping parameters that govern the SA life are wrapper dilation and pin CDF. The maximum burnup achievable with an operating LHR of 400 W/cm is 85 GWd/t and 114 GWd/t for inlet temperatures of 400℃ and 380 ° C respectively. The reduction in the inlet temperature by 20 ℃ not only decreases the fuel swelling but also helps in increasing the free swelling phase without FCMI. Thus, this study gives an insight on the behaviour of the MK-1 carbide fuel in FBTR for the present operating conditions of the FBTR and the influence of inlet temperature and operating LHR on the achievable burnup.

Country/Int. Organization

Indira Gandhi Centre for Atomic Research, Kalpakkam, India

Author: Mr DUDALA, NAGASIVAYYA (IGCAR, INDIA)

Co-authors: Mr SOWRINATHAN, CLEMENT RAVI CHANDAR (IGCAR, INDIA); Mr PILLAI, PUTHIYAV-INAYAGAM (IGCAR, INDIA)

Presenter: Mr SOWRINATHAN, CLEMENT RAVI CHANDAR (IGCAR, INDIA)

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