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A Conceptual Fluidised Particle Bed Reactor - Application of Space-dependent Kinetics

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Abstract

In this paper we describe a conceptual helium-cooled fluidised-bed thermal reactor which has been shown in earlier work to have potentially attractive passive safety characteristics. The reactor consists of an axi-symmetric bed surrounded by graphite moderator. 1 mm diameter TRISO-coated fuel particles are fluidised with helium. Improvements in computer performance and in numerical methods now allow numerical simulation of the complex non-linear criticality feedback mechanisms. A coupled neutronics /multiphase fluids dynamics code has been developed, FETCH (finite element transient criticality), which is based on finite element modelling for both fluids and radiation transport. The option of this code for fluidised particles has been used. We present further evidence that this system should be dynamically stable, under normal operating conditions - through modelling extreme transients, where the helium coolant flow is started impulsively at full flow rate with an initially settled bed. We also demonstrate that, although this may be subject to significant short term fluctuations, the temperature distribution inside the reactor remains homogeneous without substantial time variation. In addition, it is shown that, due to the mixing features of a fluidised bed, all particle yields similar fission-heat source over timescales of order 10 seconds. This would result in uniformity in burn up of particles.