Numerical analysis for transients in external source driven 1d reactors

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The main purpose of this paper is to perform a numerical analysis of the neutron spatial kinetic equations, subject to transients of the external neutron source, by applying the Implicit Euler Method as well as the Runge-Kutta Method in order to check which methods are best applicable in transients caused by External Neutron Source.

The 1D spatial kinetic neutron diffusion equations, for two energy groups, six delayed neutron precursor groups and with the presence of an external source are considered. The equations were discretized in space, using the method of finite differences and discretized in time, using the Method Implicit Euler and also by the Rosenbrock Generalized Runge-Kutta with automated time step size control. In the latter, it was implemented with Kaps-Rentrop (KR) and Shampine (S) parameters.

For the first method, the code KDF1D2GIE was developed and for the second the KDF1D2GRK was developed.

The one-dimensional ADS reactor has its geometry and nuclear and kinetic parameters based on the ANL-BSS-6 benchmark reactor, in which case an external source of neutrons located geometrically in the center of the reactor and with a length of 4 cm, with a constant intensity equal to10^{14} neutrons/s, as shown in the Figure 1.

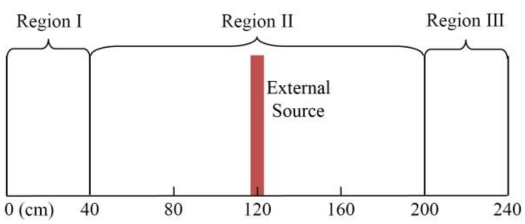

Figure 1. Reactor ADS geometry 1D

Using the KDF1D2GIE and KDF1D2GRK codes, three types of transients associated with an ADS reactor will be simulated. The first transient concerns the activation of the proton accelerator when the ADS reactor is in zero power level condition. The second transient corresponds to the interruption in the proton beam for a short period of time (ABO) and the third transient to be addressed describes the occurrence of a power peak in the proton beam (ABI) [1]. Figures 2, 3 and 4 show the evolution in the time of the power per unit area in the three cases.

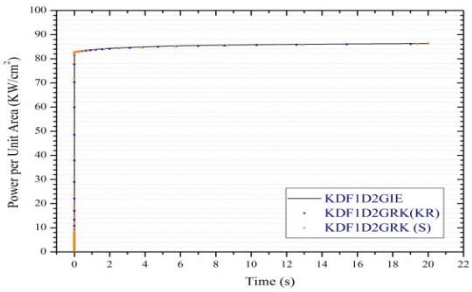

Figure 2. Source of Neutrons Start Case

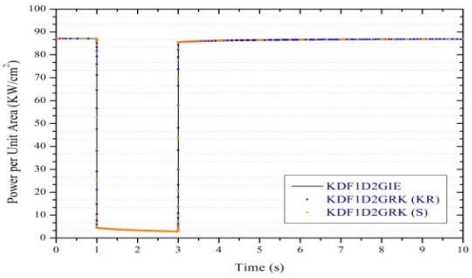

Figure 3. ABO Case

Both codes were satisfactory in the transient simulations for the ADS reactor involving fluctuations in the external neutron source, It is intended to implement the methods in more complex geometries for the ADS reactors.

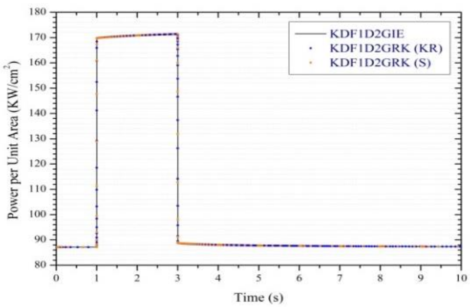

Figure 4. ABI Case

Reference

[1] ABREU, W. V. **Análise numérica de transientes em um reator slab guiado por fonte externa**. 2017, 95 f. Dissertação (Mestrado em Ciência e Tecnologia Nucleares), Instituto de Engenharia Nuclear da Comissão Nacional de Engenharia Nuclear, Rio de Janeiro, 2017.