On the subcriticality level in operational and start-up transients in an accelerator driven system

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Accelerator Driven Systems (ADS) are sub-critical nuclear reactor cores driven by external spallation neutron sources. These promising devices must be used not only as dedicated burners of transuranic elements and long-lived fission products but also as energy producers. The spallation neutrons are provided by the bombardment of a heavy metal, when impinged by a proton beam, from a high energy proton accelerator [1].

Since a sub-critical core means that $k_{eff} < 1$, and the sub-criticality level implies the power spent to accelerate the proton beam, there is an optimum range of k_{eff} to be used in ADS.

This paper analyses the behavior of the ADS temperatures with the sub-criticality level, represented by the k_{eff} values. Two transients are analyzed: beam interruption and startup transients. These transients are useful to analyze the feedback effect on the power of the Accelerator Driven Systems, since they cover a wide range of temperature variations, from an interruption in power or to a startup, when the ADS are powered up from zero power to power operation. For this purpose, the SIRER-ADS code - a program based on Point Kinetic Model – was used. In the code, the fuel temperature, cladding and channel are solved numerically, after space and time discretization [2].

Beam Interruption Transient

This transient simulates an interruption of the beam in an ADS, for 6 seconds, apart from steady state. Fig. 1 exhibits the normalized power variation. Fig. 2 shows the temperature at channel exit, considering different sub-criticality degrees, expressed by κ_{eff} .

Startup Transient

This transient simulates the power up-rate of an ADS core for 26 seconds. It covers a long range of thermal property variations. The temperatures vary from the hot standby condition to the nominal power. Fig.3 shows the maximum temperature in the center line of the fuel pin.

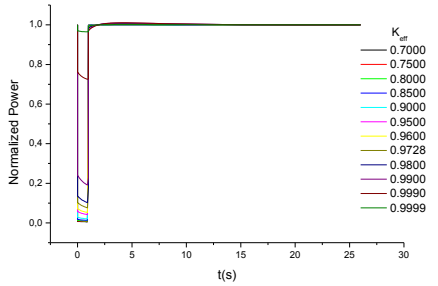

Figure 1. Beam Interruption.

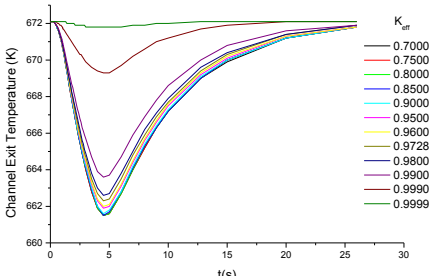

Figure 2. Beam Interruption.

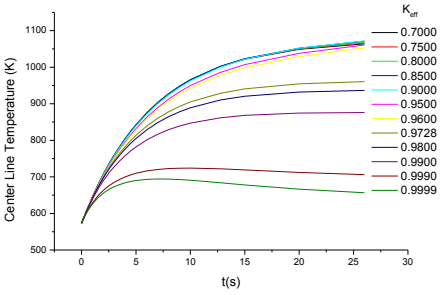

Figure 3. Startup Transient.

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