Study of the migration of power peak as a function of insertion of control rods in a PWR

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This paper aims to present a study on the behavior of the power distribution in a PWR type reactor, considering the intensity and the migration of peak power occurs as the insertion of control rods into the core [1]. To this end, the study of the diffusion of neutrons in the reactor used was performed by computer simulation that employs the Method of Finite Differences to numerically solve the diffusion equation for two neutron energy groups, steady state and symmetry of a room core. Given the positioning of banks control of the reactor employee, there was the rise of intense gradients power, favoring the occurrence of critical situations and logically unconventional for operation of a nuclear reactor. However, these facts led interesting situations to the study of behavior of power distribution in the reactor, showing the migration of the axial power peaks and especially the effect of the geometry of the core on the latter. Thus, the case study in this paper illustrates a hypothetical situation in which banks of control are distributed in the core of a non-uniform, unlike the usual array.
The reactor was adopted EPRI-9R 3D, which is one of the few benchmarks available in the academic literature whose diffusion neutron is treated with three-dimensional homogenization pin-to-pin. It was designed to simulate a PWR type reactor small, with bank presence control, baffle and reflector. However, the above-referenced literature sources, and so little their own references do not provide information necessary to study the heat transfer from the core. Given this situation, we adopted the following strategy: Firstly validate the results obtained with the finite differences code applied to the reactor EPRI-9R 3D, then this last link to the thermal hydraulic parameters of a typical PWR power; Secondly simulate the reactor with new features and verify the consistency of results with respect to data available in the literature, striving for compliance with the relevant theoretical principles; finally, if it is essential, make necessary changes to obtain correct results, and then repeat the previous step.

In the simulation the reactor was partitioned radially into cells of a spatial point for pin ($\Delta y = \Delta x = 1.26$ cm), whereas in axial direction it was sectioned in 100 plans over the height active ($\Delta z = 3.66$ cm). The code was run with bars each positioned 36.6 cm from the top to the lower portion of active core, totaling 11 steps insertion.
In the Figure 1 it is possible to visualize the distribution of power in one of the plans of symmetry of the reactor. There are control rods in the fuel element located at radial position 51-68. In the chart of step 11 of insertion (rods fully inserted), there is the power distribution axially symmetrical and confinement of the peak power at the center of the core.

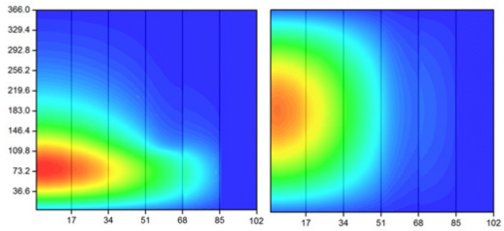

Figure 1. Power distribution in the transverse plane situated on one axis of symmetry of the core.

In the EPRI-9R 3D modified, the atypical positioning of banks led control gradients to intense power, favoring the occurrence of critical situations and logically unconventional for operation of a nuclear reactor. However, these situations of interesting facts guided to the study of behavior of power distribution in the reactor, showing the migration of the axial power peaks.

References

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