EXPERIMENTAL PROGRAM OF THE IPEN/MB-01 REACTOR

Santos, A.; Fanaro, L.C.C.B.; Diniz, R.; Jerez, R.; Bitelli, U.d'U.; Veneziani, C.L.; Yamaguchi, M.; Silva, G.S.A.

Centro de Engenharia Nuclear - IPEN/CNEN-SP

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The experimental program of the IPEN/MB-01 reactor consists of measuring a lot of quantities to be used as benchmarks for the several methodologies and related nuclear data libraries used in the reactor physics area of IPEN. During the years 2002 and 2004 several experiments have been carried out in the facility. The major ones were the measurements of the effective delayed neutron parameters, the ellaboration of a new experimental approach for the determination of the spectral indices R-28 and D-25 and the experimental characterization of five (5) critical configurations for the International Criticality Safety Benchmark Evaluation Project (ICSBEP). This committee is under management of NEA data bank and INEEL (USA) and IPEN has been recently invited to participate on the project. The measurements of the effective kinetic parameters of the IPEN/MB-01 reactor have been successfully performed by means of two major techniques: Sprigg´s method and the reactor noise method. The Sprigg´s method basically relies on a least-squares-fitting algorithm that simultaneously fits a series of transients produced by small reactivity perturbations of arbitrary size. The function that is least-square fitted is the analytical solution for a step change in reactivity as given by the point reactor model for an arbitary number of delayed neutron groups. The Sprigg´s method is based solely on the measurable quantities of the relative power, time and one root of the inhour equation.

The following experimental implementations have been conceived for the experiment. A very fast removal system. The IPEN/MB-01 sample removal system consists of a high speed electric motor coupled to a beam catcher. The measured removal time is of the order of 6ms which is more than adequate for the experimental purposes of this work. The second aspect is a very fast acquisition system. The data acquisition is composed of a Daq Card 16XE-50 set to 1 kHz which guarantees a very high acquisition rate. At every 1ms one experimental data is collected. The final fitted results are of good quality and can be very helpful to validate theoretical predictions of the delayed constants based on the current knowledge of fission yields and emission probabilities for known precursors. It has been proved, for the first time in a in-pile experiment, that the first decay constant is consitent to that of Br-87. The theory/experiment comparison shows that ENDF/B-VI.8 has the worst performance. Not only its delayed neutron relative abundances show severe discrepancies but also its first decay constant is overpredicted which imposes severe restrictions for the determination of reactivity. The revised version of ENDF/B-VI performed at LANL shows very good progress and also its first decay constant is vey close to the one determined experimentally in this work.

The best performance is obtained by JENDL3.3 which shows excellent agreement in al types of comparison performed in this work. The reactor noise method is performed with two compensated iononization chambers working in the current mode. The signals are transferred to a Dynamic Signal Analyser from which the APSD and CPSD are inferred. The reactor noise method employed in the IPEN/MB-01 reactor is a very novice one since it relies on the measurements of the CPSD and APSD in a very low frequency range (mHz). Assuming a point kinetic model, the theroretical expression for the APSD and CPSD can be least-square fitted and bi and li can be inferrred. The analysis reveal that the reactor noise method can be employed in a very low frequency range and the fitted parameters did not depend on the electronic equipment uncertainties. The theory/experiment comparisons show that there are two libraries with good agreement; JENDL3.3 for the abundances nad ENDF/B-VI(LANL review) for the decay constants. The current version of ENDF/B-VI (release 8) presented the worst performance for all cases.

As a by product, beff; a sum of all partial abundances, was obtained with very high degree of accuracy. Beyond that, this parameter was determined without the need of the Diven Factor and the power normalization. JENDL3.3 presented the best performance for the beff comparison. The new method, based on a scanning technique, for the measurements of the spectral indices R-28 and D-25, has been succesfully implemented in the IPEN/MB-01 reactor. The analyses reveal that the preliminar ENDF/B-VII data overestimates heavily the spectral indices R-28. Finally, five critical configurations have been measured and evaluated for the ICSBEP, the configurations have a small uncertainty and are suitable for a benchmark experiment.