Preliminary Analysis of the Proposed BN-600 Benchmark Core

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1. Introduction

The Indira Gandhi Centre for Atomic Research is actively involved in the design of Fast Power Reactors in India. The core physics calculations are performed by the computer codes that are developed in-house or by the codes obtained from other laboratories and suitably modified to meet the computational requirements. The basic philosophy of the core physics calculations is to use the diffusion theory codes with the 25 group nuclear cross sections. The parameters that are very sensitive is the core leakage, like the power distribution at the core blanket interface etc. are calculated using transport theory codes under the DSN approximations. All these codes use the finite difference approximation as the method to treat the spatial variation of the neutron flux. Criticality problems having geometries that are irregular to be represented by the conventional codes are solved using Monte Carlo methods. These codes and methods (see section 2) have been validated by the analysis of various critical assemblies and calculational benchmarks.

2. Reactor core design procedure at IGCAR

- Two and three dimensional diffusion theory calculations.
  Codes: ALCIALMI and 3DB
- Auxiliary calculations:
  Neutron Balance, Power Distributions, etc. are done by codes that are developed in-house
- Transport theory corrections:
  from two dimensional transport calculations (DOT)
- Irregular geometry:
  Monte Carlo method (KENO)
- Cross Section Set:
  CV2M (25 group)

3. Analysis of the BN-600 benchmark core

The proposed benchmark core of the BN-600 hybrid reactor was analysed by both two dimensional and three dimensional diffusion theory codes. The two dimensional calculations was performed by the code ALCPALMI using the nuclear data from the 25 group cross-section library CV2M. The material reactivity worths were computed by the first order perturbation method using the code NEWPERT, developed in-house. Some of the results of the calculations are presented in Tables 1 and 2.

The three dimensional diffusion theory calculations were performed by the code 3DB with triangular-Z meshes and the 25 group nuclear cross-sections from the DV2Mlibrary. The 3DB k_{eff} for the proposed core is predicted as 1.00504 (10^{-7} converg.).

Table 1. Preliminary 2D analysis of BN-600
k_{eff} of the 2D model given for BN-600 by diffusion theory: 1.00360 (convergence 10^{-6})

Parameter	Zone	
Power (MW_{th})	LEZ MEZ MOX HEZ	616 238 324 261
Fuel Worth	LEZ MEZ MOX HEZ	0.12137 0.05481 0.10809 0.05876
Steel Worth	LEZ MEZ MOX HEZ 1st Shield row	-0.01627 -0.00498 -0.00355 +0.00355 +0.01056
Sodium Worth	LEZ MEZ MOX HEZ 1st Shield row	-0.00311 -0.00092 +0.00013 +0.00044 +0.00156

Table 2. Kinetic parameters of BN-600

group	β	$\lambda(s^{-1})$
1	0.00018	0.127772E-01
2	0.00119	0.316863E-01
3	0.00110	0.122696E+00
4	0.00236	0.324713E+00
5	0.00090	0.139496E+01
6	0.00024	0.388782E+01
Total	**0.00598**	