BENCHMARK PROBLEM for Pb-Bi Cooled Fast Reactors (ITB, Indonesia)
(Draft 1)

1. Introduction

The benchmark problem was proposed for diffusion and burnup calculation of lead-bismuth cooled fast reactors concept by Bandung Institute of Technology (ITB) in Indonesia. In this reactor concept, 5 years cooled PWR plutonium fuel is used. The life cycle length is 10 effective full power years (EFPY) and reactor power is 200 MW (th).

2. Description of reactor model

The benchmark problem was derived from the 200 MW (th) lead-bismuth cooled fast reactors. 5 years cooled PWR plutonium fuel (PuN) is used, which is composed of ^{238}Pu:1.736%, ^{239}Pu: 56.626%, ^{240}Pu: 22.772%, ^{241}Pu: 10.727%, ^{242}Pu: 3.670%, and the rest is ^{15}N. The core zones are surrounded by axial and radial blankets; which is UN with natural uranium; the structural material is steel (C, Si, Cr, Mn, Fe, Ni, Mo); and the coolant material is lead-bismuth eutectic. Smear density x theoretical density is 90%

The geometry of the reactor is two dimensional R-Z and given in Fig.1. The figure is just ¼ section of the core. In radial direction we have C1 core, C2 core and then blanket region. Dimensions of physical zones and temperature are given in Table.1, and heterogeneous number density is given in Table.2.

Cell geometry is drawn in Fig.2. Main parameters of fuel rod and pin are given in Table.3. Temperature of each zones and homogeneous nuclide number densities are given in Table.4.

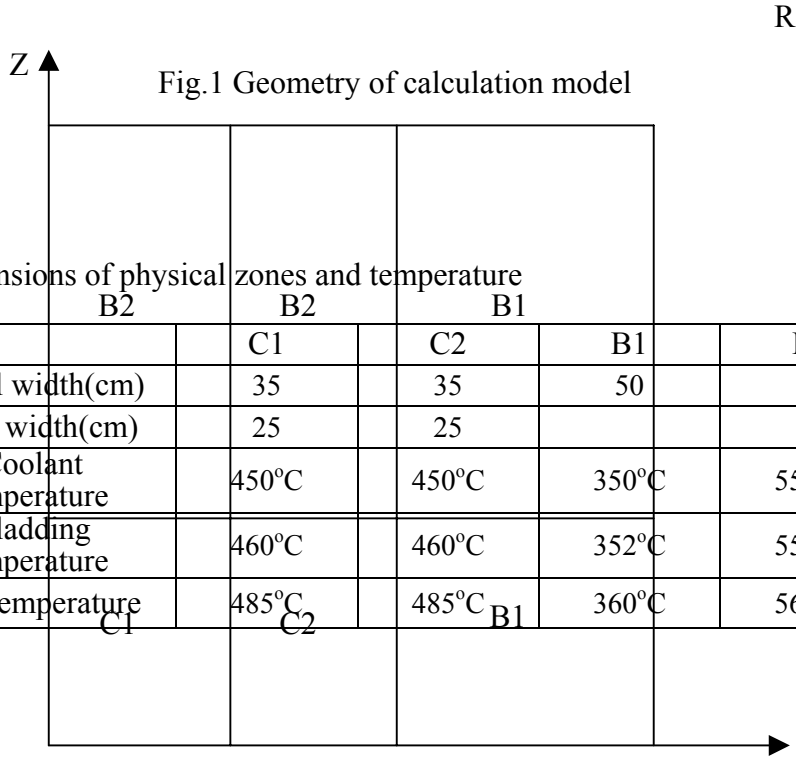

Fig.1 Geometry of calculation model

Table.1 Dimensions of physical zones and temperature

	C1	C2	B1	B2
Radial width(cm)	35	35	50	
Axial width(cm)	25	25		50
Coolant temperature	450°C	450°C	350°C	550°C
Cladding temperature	460°C	460°C	352°C	552°C
Fuel temperature	485°C	485°C	360°C	560°C

Table.2 Heterogeneous number density, $1/cm^3$

	C1	C2	B1	B2
Fuel				
U235	8.7326E+19	8.4913E+19	9.6961E+19	9.6961E+19
U238	1.2241E+22	1.1902E+22	1.3591E+22	1.3591E+22
Pu238	2.4664E+19	3.0835E+19		
Pu239	8.0102E+20	1.0014E+21		
Pu240	3.2885E+20	4.1112E+20		
Pu241	1.5426E+20	1.9286E+20		
Pu242	5.2564E+19	6.5714E+19		
Coolant				
Pb	5.3818E+21	5.3818E+21	5.3818E+21	5.3818E+21
Bi	6.6546E+21	6.6546E+21	6.6546E+21	6.6546E+21
N15	1.3689E+22	1.3689E+22	1.3688E+22	1.3688E+22
Structural material				
C	1.1689E+18	1.1689E+18	1.1689E+18	1.1689E+18
Si	2.4988E+20	2.4988E+20	2.4988E+20	2.4988E+20
Cr	2.2943E+21	2.2943E+21	2.2943E+21	2.2943E+21
Mn	2.5552E+20	2.5552E+20	2.5552E+20	2.5552E+20
Fe	8.1792E+21	8.1792E+21	8.1792E+21	8.1792E+21
Ni	1.4347E+21	1.4347E+21	1.4347E+21	1.4347E+21
Mo	1.8289E+20	1.8289E+20	1.8289E+20	1.8289E+20

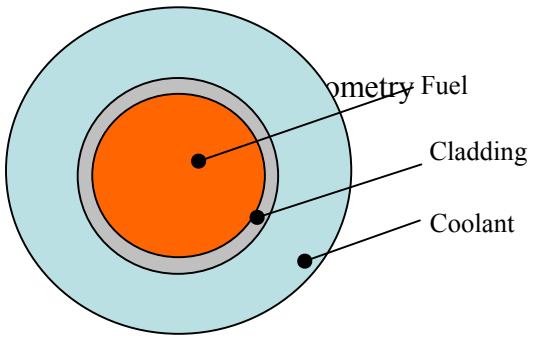

Table.3 Main parameters

	C1,B2(upper of C1)	C2,B2(upper of C2)	B1
Fuel rod pitch, mm	10.8		15.3
Fuel rod pitch to diameter ratio	1.50	1.42	1.43
Fuel pellet outer diameter, mm	6.2	6.6	9.7
Fuel rod cladding thickness, mm	0.5		

Table.4 Temperature of zones and homogeneous number densities, $1/cm^3$

	C1	C2	B1	B2(upper of C1)	B2(upper of C2)
Coolant Temp, K	723	723	623	823	
Cladding Temp, K	733	733	625	825	
Fuel Temp, K	758	758	633	833	
Fuel					
U235	2.8779E+19	3.1711E+19	3.8972E+19	3.1955E+19	3.6211E+19
U238	4.0342E+21	4.4449E+21	5.4628E+21	4.4791E+21	5.0757E+21
Pu238	8.1283E+18	1.1516E+19			
Pu239	2.6398E+20	3.7398E+20			
Pu240	1.0838E+20	1.5354E+20			
Pu241	5.0838E+19	7.2025E+19			
Pu242	1.7323E+19	2.4541E+19			
Coolant					
Pb	2.9899E+21	2.7167E+21	4.6900E+20	2.9899E+21	2.7167E+21
Bi	3.6970E+21	3.3592E+21	5.7992E+20	3.6970E+21	3.3592E+21
N15	4.5114E+21	5.1122E+21	5.5017E+21	4.5110E+21	5.1119E+21
Structural material					
C	1.0422E+17	1.4230E+17	5.9721E+17	1.0422E+17	1.4230E+17
Si	2.2280E+19	3.0421E+19	1.2767E+20	2.2280E+19	3.0421E+19
Cr	2.0456E+20	2.7931E+20	1.1722E+21	2.0456E+20	2.7931E+20
Mn	2.2783E+19	3.1108E+19	1.3055E+20	2.2783E+19	3.1108E+19
Fe	7.2927E+20	9.9575E+20	4.1789E+21	7.2927E+20	9.9575E+20
Ni	1.2959E+20	1.7466E+20	7.3301E+20	1.2792E+20	1.7466E+20
Mo	1.6307E+19	2.2265E+19	9.3441E+19	1.6307E+19	2.2265E+19

2.1. Functionals to be calculated

In two reference points: beginning-of-life and end-of-life

- k_{eff},
- Axial and radial power profiles in the core,
- Power peaking factors in the core zones,
- Volume averaged neutron spectra in the core zones,
- k_{inf} in the core central zone.