

NE 470 Nuclear Reactor Theory I

Group Project #3

Fall 2016

Consider a one-dimensional cylindrical reactor of radius W of a multiplying medium with a water reflector of thickness δW that can be considered “infinite” (i.e., thick enough).

Using n-group diffusion theory ($n=2$ and $n=4$) write a computer program that solves the numerical finite-difference model to determine the critical core width of this cylindrical reactor with the composition of a typical PWR as described below. Your results should plot the multi-group flux distribution (separate for each group) across the radius of the cylinder and through the reflector. Use a reflective (mirror) boundary condition at $r=0$ ($J=0$) and a zero flux boundary condition at $r=W+\delta W$.

TABLE 7-2 Few-Group Diffusion Theory Constants for a Typical PWR Reactor Core

Group Constant	Two-Group		Four-Group			
	1 of 2	2 of 2	1 of 4	3 of 4	3 of 4	4 of 4
$\nu\Sigma_f$.008476	.18514	.009572	.001193	.01768	.18514
Σ_f	.003320	.07537	.003378	.0004850	.006970	.07527
Σ_a	.01207	.1210	.004946	.002840	.03053	.1210
D	1.2627	.3543	2.1623	1.0867	.6318	.3543
Σ_R	.02619	.1210	.08795	.06124	.09506	.1210

Supplement the above properties with the following water reflector properties:
 $D_1=1.13$ cm, $D_2=0.16$ cm, $\Sigma_{R1}=0.0494$ cm⁻¹ = Σ_{s12} , $\Sigma_{a1}=0.0004$ cm⁻¹, $\Sigma_{a2}=0.0197$ cm⁻¹
 Four group cross-sections for water reflector are in a separate file.

- Illustrate differences between the 2 group and the 4 group implementation.
- Each member of the group will provide a written assessment of his or her contribution to the group project, one page maximum. Include in the report.
- Submit the report via Blackboard.
- Prepare a 10-15 minute presentation of your project. The presentation will be scheduled during the week of your final exam.
- Extra credit opportunities (10% each):
 - Evaluate the impact of changing the thermal macroscopic absorption cross-section by 1, 5, 10, and 25%.
 - Evaluate the impact of changing the diffusion coefficient by 1, 5, 10, and 25%.
 - Evaluate the impact of using or not using the extrapolation distance assumption.