NE 571: Project 6

Small Modular Reactors

NuScale and mPower

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# Abstract

***Inset short blurb about results here. Revisit later.***

# Introduction

Diffusion theory is a crucial approximation to simulating reactors. It is an approximation to the neutron transport theory, making several key assumptions and completely breaking down in some circumstances. In most scenarios, it is accurate enough to obtain a reasonable estimation of the neutron flux. While a numerical solution cannot be found for all but the simplest cases, discretizing the equation (shown in Equation 1) to get the equation shown in Equation 2 will allow you to obtain a valid solution, so long as the step sizes are reasonably small.

Current commercial reactors are large-scale baseload type plants, requiring billions of dollars in initial investments, meaning that only large, well-funded utilities can even consider taking the risk of constructing them. Newer, smaller reactors are being developed, with initial investments coming in at several million dollars. This means that even medium-sized towns and utilities could consider purchasing a small-modular reactor (SMR). They have long life-spans, operating cycles, and can even be used for load-following. Some SMRs, such as the B&W mPower and NuScale Power’s Nuscale SMR, even use existing pressurized water reactor fuel rods, just cut to shorter length. While no full-scale plants have been constructed yet, their finalized characteristics have been published, allowing interested parties to simulate the reactors.

Finally, SCALE is an extremely powerful software used for detailed simulations of reactor cores. Using properties described on “input cards,” we can calculate various properties required for other software, such as the absorption coefficient in the simulation used for this project. We used SCALE to determine the properties of our fuel at various points throughout its life, simulating a reactor with fresh, once-burned, and twice-burned fuel rods. We also simulated the fuel with and without its control rods. As such, no individual piece of software can fully simulate nuclear reactors, even small ones, and many independently developed codes must be used in conjunction. Reinforcing this point was the overarching goal of this project.