Point kinetics with temperature feedbacks

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Background

For safety analysis of nuclear reactors one needs to perform coupled neutronics and thermal hydraulics calculations. These models take into account the energy released from the fuel due to the fission events, and the fluid dynamics of the coolant. However, due to temperature feedbacks (eg. due to the resonance broadening of U238 in the fuel) the thermal hydraulics affects the neutron population, and vica versa. In the literature, coupled models of various complexity can be found, however most of these models are overwhelming for a novice nuclear engineer, therefore the application of simple approximations has a clear educational purpose.
In this project a simple model is implemented, where neutronics is handled with the space independent point kinetic approximation of the reactor power with temperature feedbacks. Such model can only qualitatively describe a small sized training reactor, however it can be used as an educational tool for students to develop an intuition about the time dependence of reactivity and temperature during reactor excursion accidents.

Goal

During the project the REMEG model [1] will be implemented. the model consists of a coupled system of differential equations to describe reactor kinetics, fuel temperature and coolant temperature following reactivity insertion. Preferably the model is implemented in Python as a package. Alternatively, the model can be implemented in other languages with a Python API, since the developed code is planned to be used by future students of the Reaktorfysik med Python course. The code should be designed so, that it allows for future extensions (eg. to include more accurate thermal hydraulic models, with little or no change of the API). The developed code is intended to be open sourced (eg. hosted on github), its parts are expected to be tested, and properly documented.

Requirements

It is advantageous if the student(s) has some background in reactor physics, but not mandatory. Knowledge of python and of numerical methods to solve differential equation systems is expected.

References

[1] Khaled Sayed Mahmoud: Numerical modeling of reactivity excursion accidents in small lightwater reactors (PhD dissertation, Budapest University of Technology, 2006)