UPPSALA UNIVERSITET

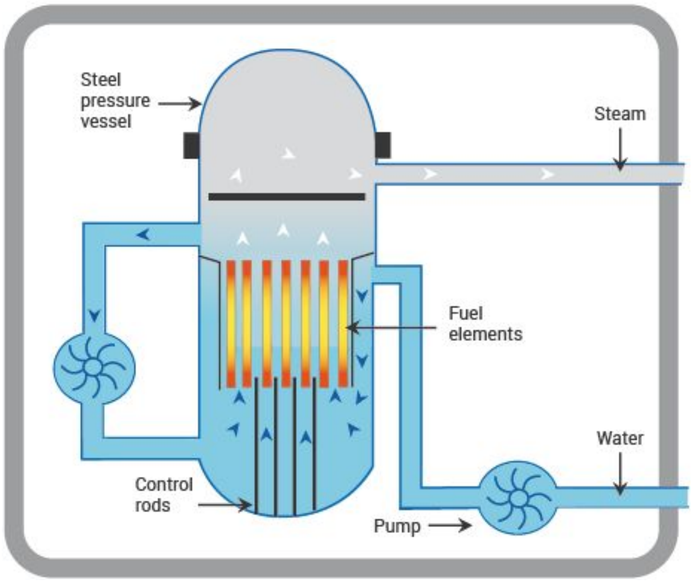
Point Kinetics with Temperature Feedback

Goal

To make a simulator of the behavior of a nuclear reactor using a point kinetics ODE model.

Nuclear Reactor

- Fuel: Rods of unstable atoms.
- Moderator: A liquid that absorbs and transports the heat.
- Cladding: A material that separates the moderator from the fuel.
- Control-rods: Rods that regulates the quantity of neutrons.



https://world-nuclear.org

Criticality and Reactivity

Criticality depends on factor k:
- k < 1: subcritical, less neutrons
- k = 1: critical, neutrons stable.
- k >1: supercritical, more neutrons

Reactivity describes how far the reactor is from being critical.

Simulations

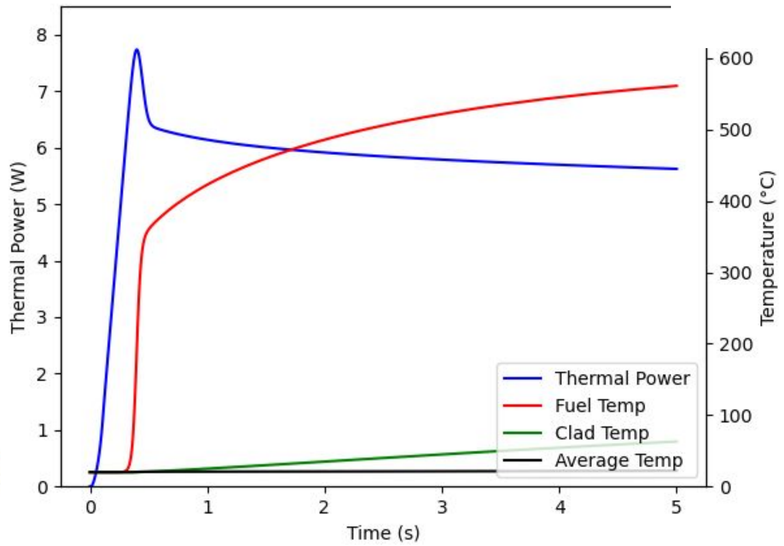


Fig 1: A large reactivity is inserted which pushes the power to several megawatts. At this stage the fuel temperature rapidly increases. This results in the feedback forcing down the reactivity and leaving the power in an equilibrium.

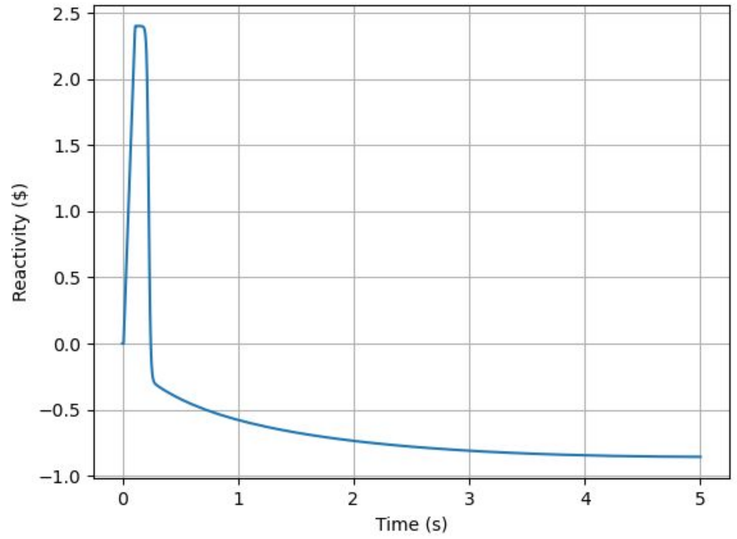


Fig 2: An example of what a large reactivity insertion looks like.

Conclusion

The simulator behaves accordingly to the reactor's basic functioning in practice.

The simulator is easy to use and understand, and is suitable for teaching purposes.

Further Reading

Simulation with:
- Shutdown-rods
- Other reactivity incursions
- Other materials
- Only prompt neutrons

Project in computational science 2021

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