Abstract

The Dual Fluid Reactor (DFR) is one of the many new circulating, liquid-fuel nuclear reactor concepts. It is a combination, a hybrid reactor between Molten Salt Reactor and Lead-cooled Fast Reactor. Compared to most Molten Salt Reactor projects, what is unique about the Dual Fluid Reactor is the reactor which also serves as a heat exchanger.

The Dual Fluid Reactor consists of 2 loops: fuel loop and coolant loop. Two options are proposed as fuel: uranium-chromium eutectic or uranium chloride salt - Cl_3. Therefore, two types of the Dual Fluid Reactor can be distinguished: metallic and salt. Type indicates what kind of fuel is used. Much research has been done on the salt version of the Dual Fluid Reactor. On the contrary, the metallic version is not well determined. In this thesis, only the metallic version is considered to fulfil the lack of this data.

However, performing computer simulations without validation or benchmark can be subject to considerable error. Therefore, it has been decided to model the Molten Salt Reactor Experiment (MSRE) first. It was one of the few ever working molten salt reactors. Moreover, it is very well documented.

It has been decided to use Serpent2 and TRACE codes to model the Molten Salt Reactor Experiment and Dual Fluid Reactor. However, the TRACE code is dedicated mainly to light-water reactors. Therefore, the TRACE code's source version has been modified to simulate MSRE fluids. Several transient scenarios for the MSRE have been performed in good agreement with the data from the Oak Ridge National Laboratory - institute, where the MSRE has been built and working for several years.

As for MSRE, the TRACE code has also been modified for DFR.

Then, several different calculations have been performed for the Dual Fluid Reactor: burnup calculations, proposed modified geometry and fuel composition to flatten the k_{eff}, introduction of control rods in the reflector zone, feeding the reactor during operation to avoid a subcritical state for the reactor, temperature reactivity coefficients calculations, coupling Serpent and TRACE to get a temperature and power distribution for steady-state conditions, proposed geometry for coolant and fuel loop, introduced several criteria to choose optimal working conditions and finally calculated several different transient scenarios.