REACTIVITY CONTROL BY THE PUMPING SYSTEM IN THE DUAL FLUID REACTOR

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Abstract

The DFR(m) reactor is a new nuclear reactor concept, and it is therefore necessary at the outset to create simplified models of this design so that appropriate tests and experiments can be carried out under safe, controlled conditions. Such test systems have been named demonstrators, and their purpose will be to conduct heat transfer and flow experiments.

One of the issues described in the thesis is the problem of scalability between demonstrators. The thesis examines whether, having the parameters of one device, it is possible to estimate the parameters of another. By developing such a method, it would be possible to predict the behavior of the DFR using the demonstrators. In the dissertation, it was proven that there is a possibility for demonstrators to be scalable using Nusselt number. The requirements are that the design of the microdemonstrator and the minidemonstrator are matched so that there is the same Nusselt number between the two devices.

The dissertation also focused on the effect of flow velocity on reactivity and heat transfer in demonstrators to prove that in liquid metal-based nuclear reactors, pumping systems also have a regulatory and control function. The Cathare-2 calculations presented here confirm that the flow velocity in the fuel and cooling loop affects heat transfer.

Since the working medium in the minidemonstrator, as well as in the final design of the DFR(m), will be liquid metals reaching high temperatures, it will not be possible to use pumps with internal components, as they may be eroded, corroded or otherwise damaged. Therefore, it was decided to use magnetohydrodynamic pumps, which are based on electromagnetic forcing of the conductive liquid, thus avoiding the aforementioned risks to the pumping system.

However, no one has designed and analyzed these devices for a Dual Fluid reactor with as many as two liquid metal loops. The work in this area is innovative and can be used in the design of other Generation IV reactors based on the use of liquid metals or molten salts. The dissertation presents the Equivalent Circuit Method analytical method and, based on it, optimizes the pump geometry for the DFR to minimize the pump supply current.