Numerical Modeling of Power Reactors' Fuel Bundles

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Abstract

Fuel bundles in pressurized heavy water reactor in CANDU (CANada Deuterium Uranium) reactor are designed for heating the pressurized coolant (heavy water) to generate electricity. Based on the number of heating elements, the designs differ for the fuel bundles [Figure 1][Figure 2]. The flow of heavy water over the elements and inside the shell is highly turbulent. There have been few investigations [2] done on this problem. Due to the complexity of turbulent modeling, there is a lack of fluid flow and heat transfer information for fuel bundles.

In this paper, COMSOL Multiphysics® is used to simulate the heavy water (coolant) flow surrounding a 7 elements bundle. Having the experimental/practical data for the coolant outlet temperature and coolant pressure drop, the results produced by COMSOL will be validated. The next step includes finding the temperature distribution, visualizing the flow field, determining the points with high heat flux, and hydrodynamic as well as geometrical optimization. Modeling the CANDU 7 element fuel bundle is one of the goals of this paper. For this purpose, post processing techniques will be used to make a comparison to the experimental data, thereby validating the model. Once this is complete, different concentrations of nanofluids will be investigated and the heat transfer will be compared with that of base fluid.

Reference

[1] http://www.kincardinenews.com/2012/09/11/let-the-info-on-the-used-fuel-repository-flow
[2] Abbasian, F., Yu, S.D., Cao, J., Experimental and numerical investigations of three dimensional turbulent flow of water surrounding a CANDU simulation fuel bundle structure inside a channel. Nuclear Engineering and Design, 239(11), 2009, pp. 2224-2235.

Figures used in the abstract

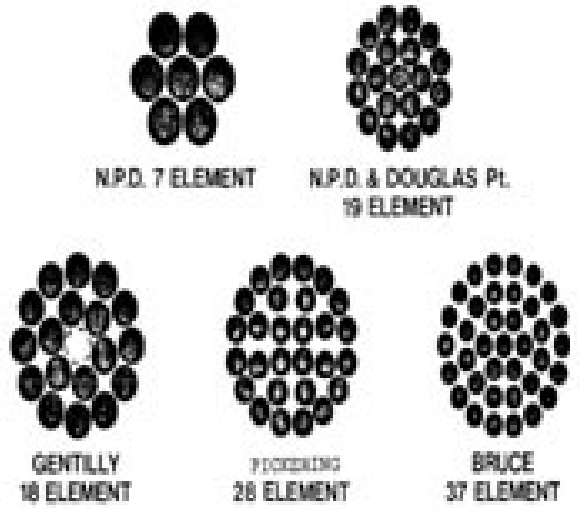

Figure 1: Cross section of different designs of fuel bundles [1].

Figure 2: Fuel bundle with 37 elements [1].