Investigation of heat transfer and flow properties in separated flow and reattachment regions for liquid sodium flow at fast reactors

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Abstract

In many engineering applications, such as heating and cooling systems, flow around an automobile or building, separation and reattachment regions are formed. These regions are very important for controlling the amount of heat and mass transfer. Liquid sodium is used as heat transfer fluid in many areas having a high temperature, especially nuclear reactors. In this work, the effects of flow separation and reattachment on the heat transfer and flow properties of step corner structures with different chamfer lengths as h/4, h/2, 3 h/4 and h comparing with and without chamfer (normal) geometry have been numerically investigated in the vertically positioned backward facing step flow geometry for fast reactors that need to be cooled efficiently. One of the walls behind the backward facing step has a constant temperature while the others are adiabatic. The results of the work have been determined by solving steady conservation equations with three dimensional and k-epsilon turbulence model with Boussinesq approach using ANSYS-FLUENT computer program. Water and liquid sodium have been employed as working fluids. The expansion rate of the backward-facing step is 1.5. The study has been carried out at two different Reynolds numbers: 5000 and 10000. The presented work has been compared with the numerical results of the study found in the literature and it has been seen that they are compatible and acceptable with each other. The results have been exhibited as the variations of Nu number, fluid temperature, turbulence kinetic energy and pressure. Besides, temperature, velocity and streamline distributions have been visualized in backward facing step flow geometry. For Re = 10000, it has been determined that average fluid temperature increment value of the backward facing step geometry with h chamfer length in the liquid sodium flow has been 6.54 K higher than in water.

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