Buoyancy-assisted mixed convective flow over backward-facing step in a vertical duct using nanofluids

Abstract

Laminar mixed convective buoyancy assisting flow through a two-dimensional vertical duct with a backward-facing step using nanofluids as a medium is numerically simulated using finite volume technique. Different types of nanoparticles such as Au, Ag, Al2O3, Cu, CuO, diamond, SiO2 and TiO2 with 5 % volume fraction are used. The wall downstream of the step was maintained at a uniform wall temperature, while the straight wall that forms the other side of the duct was maintained at constant temperature equivalent to the inlet fluid temperature. The walls upstream of the step and the backward-facing step were considered as adiabatic surfaces. The duct has a step height of 4.9 mm and an expansion ratio of 1.942, while the total length in the downstream of the step is 0.5 m. The downstream wall was fixed at uniform wall temperature 0 = ?T= 30 °C, which was higher than the inlet flow temperature. The Reynolds number in the range of 75 = Re = 225 was considered. It is found that a recirculation region was developed straight behind the backward-facing step which appeared between the edge of the step and few millimeters before the corner which connect the step and the downstream wall. In the few millimeters gap between the recirculation region and the downstream wall, a U-turn flow was developed opposite to the recirculation flow which mixed with the unrecirculated flow and traveled along the channel. Two maximum and one minimum peaks in Nusselt number were developed along the heated downstream wall. It is inferred that Au nanofluid has the highest maximum peaks while diamond nanofluid has the highest minimum peak. Nanofluids with a higher Prandtl number have a higher peak of Nusselt numbers after the separation and the recirculation flow disappeared.