Numerical Investigation of Heat Transfer to Supercritical Pressure Water in Vertical Tube With Non-Uniform Heating Form

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Abstract: Deeply analysis and prediction of turbulent convection heat transfer of supercritical pressure fluid in one-side non-uniform heating vertical tube plays a major role in system design and security. The Over-prediction of convection heat transfer of supercritical pressure fluid in vertical tube is attributed, at least partly, to the invalid of turbulent model on simulating the buoyancy effect. The present paper adopt an improved turbulent model, which is validated suitable to three dimensional model, to simulate flow and heat transfer of supercritical pressure water in vertical non-uniform heating tube. Heat transfer deterioration phenomenon occurs in non-uniform heating condition, while the degree of deterioration is weaken due to the influence of variable physical properties and buoyancy effect. The velocity profile is distorted into "M-shape" in the heating side and present parabolic distribution in the adiabatic side, which lead to different deterioration mechanisms in non-uniform heating condition. The larger density difference between the heating side and the adiabatic side increase the shear stress production of turbulent kinetic energy, turbulent development is much faster recovery than the phenomenon in uniform heating condition. The results show that non-uniform heating condition can effectively alleviate the degree of heat transfer deterioration in vertical tube.

Keywords: Supercritical pressure water; numerical simulation; buoyance effect; non-uniform heating

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