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THREE-DIMENSIONAL FLUID-STRUCTURE INTERACTION NUMERICAL SIMULATION OF NEW TYPE VORTEX GENERATORS IN SMOOTH WAVY FIN-AND-ELLIPTICAL TUBE HEAT EXCHANGER

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ABSTRACT A three-dimensional numerical fluid-structure interaction (FSI) framework is successfully carried out on mechanical behaviour of new vortex generators (VGs) – rectangular trapezoidal winglet (RTW), angle rectangular winglet (ARW), curved angle rectangular winglet (CARW) – in smooth wavy fin-and-elliptical tube (SWFET) heat exchanger using the ANSYS MFX Multi-field® solver. The purpose of the present study is to provide better understanding of the performance of the vortex generator structures in SWFET heat exchangers associated with the alloy material properties and geometric factors, because change in the flow geometry due to deformation of components affects the flow field and the pressure drop or pumping power in finned tube heat exchangers. The Reynolds-averaged Navier-Stokes (RANS) equations with *Shear Stress Transport* (*SST*) $k-\omega$ turbulence model are applied for modelling of the turbulent flow in SWFET heat exchanger and the linear elastic Cauchy-Navier model is solved for the structural von Mises stress and elastic strain analysis in the vortex generators region. An arbitrary Lagrangian–Eulerian (ALE) formulation is employed for this FSI application. Three-dimensional FSI numerical results illustrate that the maximum magnitude of von Mises stress and elastic strain occurs at the root of the vortex generators and depends on geometrical parameters – geometric shape of VGs, angles of attack ($\alpha_{VG} = 15^\circ - 75^\circ$) – and material types. These results reveal that the titanium alloy VGs shows a slightly higher strength and lower elastic strain compared to the aluminium alloy VGs. The lowest values of von Mises stress and elastic strain are obtained for CARW vortex generators and higher values of the von Mises stress and elastic strain occurred for RTW vortex generators, particularly at large attack angles.