Multi-objective numerical optimum design of natural convection in different configurations of concentric horizontal annular pipes using different nanofluids

Natural convection heat transfer within concentric annular pipes has many engineering applications such as in heat exchangers, electronic devices, the nuclear energy sector, aerospace and pipeline systems. Therefore, this investigative research includes three parts, with the first containing numerical simulation to study the natural convection heat transfer in a concentric annular horizontal pipe for six different geometries (Circular, Square, Diamond, Triangular, Rectangular, and Elliptic) using pure water. The results showed that the heat transfer rate of concentric elliptic and circular pipes is nearly 40% and 37% respectively greater than that of the other geometries. Once the optimum geometry had been adopted, two types of nanofluids (Al2O3-H2O and H2OSiO3) were examined to investigate whether nanofluid has positive effects compared to pure water. For the Al2O3-H2O nanofluid with 0.5% volume fraction, the heat transfer coefficient was found to increase by as much as 6% compared to pure water, with a low pressure drop. Finally, in order to find a novel multi-objective optimisation process, the effect of inclination angle (θ) and aspect ratio (AR) was also examined to find the optimum design for the concentric annular pipe for maximum heat transfer rate and minimum pressure through the annular gap. The multi-objective optimum design detected the scope of enhancement in heat transfer with acceptable pressure inside the annular gap at AR = 8 and θ = 90o . Therefore, some useful guidelines on the influence of both geometrical and working fluid parameters on concentric annular pipe design can be derived from this research.