Abstract

Though tools developed based on soft computing technique are ideal to handle increased complexity in thermo-fluid engineering problems, their applications to these problems have not received much attention, till date. Soft computing-based methodology is a new paradigm for solving thermal problems. Traditional methods (such as analytical, computational and experimental) alone may fail to provide practical solutions for many of the complex real-life thermo-fluid problems. Incorporation of suitable soft computing-based methodologies can improve the solution or can reduce the cost and effort of obtaining it. Consequently, the emphasis has been given in the present thesis on the synergetic combination of the traditional techniques of investigation with soft computing-based methodologies. Within the limited scope of the present dissertation, four problems have been carefully selected to establish the flexibility and versatility of this approach. In all these problems, either CFD analysis or experimentation has been amalgamated with one or more soft computing tools to arrive at a better solution.

At first, to optimize the shape of 2D systems involving incompressible turbulent fluid flow, a hybrid computing scheme has been developed by combining two commercial CFD softwares, namely Gambit (for shape construction and meshing) and Fluent (for conducting hydrodynamic analysis) with a genetic algorithm (GA) (for optimization). By using some specially designed system commands in C platform, Gambit, Fluent and GA have been integrated seamlessly in a common monolithic platform, where data transfer takes places in a fully-automated manner.

Secondly, an attempt has been made to study the effect of stacking pattern on the performance of Multi-Stream Plate-Fin Heat Exchanger (MSPFHE) and a methodology has been developed to optimize this pattern to get the maximum heat duty, where the numerical analysis of MSPFHE has been done through area splitting and successive partitioning methods.

Next, methodologies have been developed to solve inverse heat conduction problem for estimating boundary conditions in three different ways, such as using regression analysis, multi-layer feed-forward neural network trained by a local optimizer like back-propagation (BP) algorithm, and that trained by the local (BP algorithm) and global (GA) optimizers simultaneously, where the forward problem has been solved using CFD simulations.

Lastly, an extensive and rigorous experimental investigation has been conducted on counter-current air-water two-phase flow. The highly complex nonlinear relationships between the developed flow regimes and input parameters have been captured using soft computing-based methodology. An elaborate scheme of measurements using two conducting probes has been designed. The methodologies have been developed for automatic classification and prediction of flow regimes based on the objective description in terms of conductive probe voltage signals.