ABSTRACT

The rapid advancement in engineering and technology has prompted the electronic industries to develop small scaled devices and thus Micro Electro Mechanical Systems (MEMS) have become one of the major advances in industrial technologies. Due to its micro sizes, these devises are subjected to high heat generation in them, which endangers its performance. This disastrous situation led to the development of Micro Channel Heat Sinks to eradicate the heat dissipation in MEMS. These heat sinks are efficient devices, designed and developed to upgrade the thermal management in MEMS. At present, the exceptional innovation demands for more efficient heat sinks with high heat transfer rate. Thus the current research focuses on the development of advanced methodologies and techniques to effectively study the characteristics and performance of microchannel heat sinks. Heat sinks are designed such that, fluids are made to flow through micro sized channels, which are placed above the substrate from which heat is generated. Though various kinds of fluids are preferred for achieving higher heat dissipation rate, most of the portable electronic devices adapt heat sinks with gas flows, and hence there arises a necessity to analyse the characteristics of gaseous coolants.

In the last decade, many authors have done a critical study on micro channel heat sinks using conventional theories and they have observed few discrepancies in the numerical results when compared with experimental values. Later it was justified that such dissimilarities existed due to the fact that micro flows do not obey the same physical fundamental laws as in macroflow models. On this account, Durst justified that, flow through microchannels are subjected to high pressure and density gradient and hence

he derived the Extended Navier-Stokes Equations, incorporating the diffusion transport of mass, momentum and energy terms.

Gas flows through micro sized channels comprising higher Knudsen number are classified under slip and transition region. Microflows falling under this region fails continuum and generate velocity slip and temperature break at the walls. Hence to study micro flow models with gaseous coolants, it becomes necessary to model them with Extended Navier-Stokes equations along with velocity slip and temperature jump boundary conditions. Further, determination of accurate values of tangential accommodation coefficient and thermal accommodation coefficient occurring in the slip and temperature jump boundary conditions have become an essential factor as these coefficients characterize the fluid surface interaction.

Thus this thesis tries to calculate accurate values for heat transfer coefficient, wall temperature, pressure drop and accommodation coefficients in micro channel heat sinks with gaseous coolants, which are modelled using Extended Navier-Stokes equations with slip and temperature jump boundary conditions and solved using Integral Transform Technique. These extended equations produced a unique thermal diffusivity term which helped to estimate more appropriate heat transfer rate. An infinite series solution with faster convergence was obtained. First, the Nusselt number and Prandtl number for various aspect ratios for the proposed model were calculated and compared with existing numerical and experimental results. Second, assuming all parameters and variables of the solution from experiments, the accommodation coefficients were calculated and compared with experimental values. Accommodation coefficients were calculated for various Knudsen numbers and Nusselt numbers with different aspect ratios. All the results showed high positive correlation when compared with experimental measurements.

In recent days, in order to satisfy the various designs of electronic gadgets, microchannel heat sinks are developed with different geometries. One such device is the microchannels heat sinks with secondary oblique channels and rectangular ribs, which have been proved to be most efficient one in heat dissipation. In order to improve the performance of these heat sink, its geometrical parameters namely, the relative width of the secondary channel δ, relative rib width ω and relative angle α of the secondary channel were optimized with the objective of maximizing the heat transfer and minimizing pressure drop. Opposition Based Antlion Optimization was proposed and employed to optimize the pressure drop and heat transfer. The results were compared with solutions from Finite Element Method and Antlion Optimization techniques.

In recent times, nano fluids have replaced the conventional fluids in micro flow models, as they provide with higher heat transfer rate. Thus, analysing the effects of different nanofluids on heat dissipation has become very essential. Finally, in this work, Al_2O_3 nanofluid was employed in Microchannel Heat Sink with Secondary Oblique Channels and Rectangular Ribs and its geometric parameters; channel width, relative rib width and relative angle were optimized by employing Modified Dragonfly Optimization (MDFO) algorithm, and further Adaptive Neuro-Fuzzy Inference System (ANFIS) was applied to optimize the heat transfer rate and pressure drop. The results obtained were compared with values from Antlion Optimization. A comparative study on different nanofluid ratio was also executed.