ABSTRACT

Heat transfer and fluid flow characteristics through porous media were investigated using numerical simulations and experiment in order to determine whether the thermal non-equilibrium model was the more accurate model to use for thermal modeling. For the numerical simulations, two models were created. The first consisted of a two-dimensional numerical model created in MathCAD and was solved using the finite difference approach. The second model consisted of a computational fluid dynamics (CFD) porous media model using Fluent(TM) and was solved using the finite volume approach. The MathCAD model assumed constant fluid properties, constant pore diameter, viscous dissipation, and thermal non-equilibrium (LTNE). The Fluent(TM) model used, along with the same assumptions used in the MathCAD model, the thermal equilibrium or one-equation model (LTE). The experimental investigation consisted of a flow channel with a porous media section that was heated from below by a heat source. The results of the numerical models were compared to the experimental data in order to determine which most accurately predicted the measured heat transfer and fluid flow through porous media.

The numerical model was then modified to better simulate a matrix heat exchanger, since a matrix heat exchanger can be viewed as a porous media heat exchanger due to the perforated plates. This involved redefining the porosity, fluid properties, fluid velocities, as well as the inertia and permeability coefficients. This numerical model then generated temperature profiles that were used to calculate the heat transfer coefficient of the matrix heat exchanger. The data was used to develop a correlation between the Nusselt number and the Reynolds number, which would enable the thermal modeling of a matrix heat exchanger. Finally, the results were compared to previously published data for matrix heat exchangers.