

# Jordan University of Science and Technology

## Assessment of the local thermal non-equilibrium condition in developing forced convection flows through fluid-saturated porous tubes

**Authors:** S. A. Khashan, A.M. Al-Amiri and M.A. Al-Nimr

**Abstract:** The present investigation is concerned with the numerical simulation of forced convection heat transfer flows in a tube filled with a fluid-saturated porous medium. Steady state incompressible flows with isothermal tube walls are considered along with a uniform inlet approach velocity and temperature conditions. In addition, the generalized form of the momentum equation is considered by accounting for the solid boundary and the Forchheimer quadratic inertial effects without invoking the boundary layer approximations. Moreover, the energy transport is simulated using the two-equation model, which accounts separately for the local fluid and solid temperatures. The numerical solution is obtained through the application of the finite volume method. The validity of the local thermal equilibrium (LTE) was tested over a wide domain of the employed dimensionless parameters, namely; the Peclet number, Biot-like number, effective fluid-to-solid thermal conductivity ratio, Reynolds number, Forchheimer dimensionless coefficient and Darcy number. The validity of the LTE condition was examined for the full tube length and upon excluding the first tube diameter length.