

Unsteady heat transfer for a fully developed laminar flow inside a parallel-plate channel and circular duct that are subjected to a periodically varying inlet temperature is studied. The thermal capacitance of the duct wall and the boundary condition that accounts for external convection are considered. An exact solution is presented for this extended Graetz problem as the result of using a new methodology based on a variational method. The quasi-steady approach that employs a heat transfer coefficient at the liquid–solid interface is also investigated, and the results are compared with the variational solution. The damping and phase lag coefficients as functions of the inlet temperature frequency are presented in graphical form