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A COMPARISION OF THE THERMODYNAMICS AND FLUID DYNAMICS OF ICE SLURRIES IN CHANNELS WITH CROSS SECTIONS OF DIFFERENT GEOMETRIES

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An overview of existing theoretical treatments of the heat transfer to and from ice slurries - flowing through a cylindrical tube and a rectangular channel - is presented. It takes account of the analytical solutions describing the flow of a Bingham fluid, containing series of Besselt functions, which was derived in 1885 by L. Graetz. But it mainly deals with a new approach for the Bingham fluid ice slurry, which is based on the continuous-properties model for melting and freezing. It is applied to the two basic boundary value problems, the boundary condition with a constant temperature (Neumann boundary condition) and with a constant heat flux density (Dirichlet b.c.). In contradiction with an earlier published perturbation method, now, the solutions are also valid for high heat flux densities. The numerical simulation results are compared with experimental data for horizontal, 45 ° inclined, and vertical tubes and channels.

In this context the concept of hydraulic diameter for pressure drop and heat transfer coefficient determination is experimentally and theoretically studied, and its limitations for the considered complex flow phenomena are outlined.

The main feature of a non-isothermal ice slurry flow is its low thermal conductivity, leading to a thermal boundary layer with a large temperature increase towards the wall. With this in mind, the methods to construct optimal heat exchangers for ice slurries are discussed.