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Topography optimisation for parallel plate heat exchangers

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The presented work focuses on the optimisation of a parallel heat exchanger system. The heat exchanger consists of stacks of parallel plates filled with phase change material in order to use the heat storage capabilities in connection with a building ventilation system [1].

Performing simulation-based design on a full heat exchanger is not feasible, since the system spans a large range of length scales, from millimetre-sized spacings to metre-sized inlet distribution chambers. This requires computational meshes of a very large size to reliably model and optimise. Thus, a lower dimensional model is formulated to simulate the flow through the stacks of the heat exchanger with reduced computational cost. A planar two-dimensional model for the flow between two plates is derived based on assumptions of the flow and temperature profiles in the third dimension. Assuming the profiles allows for analytical integration in the through-thickness direction and the formulation of a lumped model for the stacks of parallel plates.

Using the derived partial differential equations for spatially varying air gap thickness, the surface topography of the plates is optimised for pressure drop and heat exchange [2]. It is shown that the derived topographical model fully covers the span from topography to topology, such that fully solid obstacles between the plates can be introduced as well.

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