Modelling refrigerant distribution in minichannel evaporators

This thesis is concerned with numerical modelling of flow distribution in a minichannel evaporator for air-conditioning. The study investigates the impact of non-uniform airflow and non-uniform distribution of the liquid and vapour phases in the inlet manifold on the refrigerant mass flow distribution and on the cooling capacity of the evaporator. A one dimensional, steady state model of a minichannel evaporator is used for the study. An evaporator consisting of two multiport minichannels in parallel is used as a test case and two different refrigerants, R134a and R744 (CO$_2$), are applied in the numerical experiments using the test case evaporator. The results show that the reduction in cooling capacity due to non-uniform airflow and non-uniform liquid and vapour distribution is generally larger when using R134a than when using CO$_2$ as refrigerant. Comparing the capacity reductions with reductions of the area covered by refrigerant in a two-phase condition shows that the capacity decreases significantly more than the two-phase area when imposing a non-uniform airflow. On the other hand the reductions in capacity and in two-phase area are almost equal when imposing a non-uniform distribution of the liquid and vapour in the inlet manifold. Combining non-uniform airflow and non-uniform liquid and vapour distribution shows that a non-uniform airflow distribution to some degree can be compensated by a suitable liquid and vapour distribution. Controlling the superheat out of the individual channels to be equal, results in a cooling capacity very close to the optimum. A sensitivity study considering parameter changes shows that the course of the pressure gradient in the channel is significant, considering the magnitude of the capacity reductions due to non-uniform liquid and vapour distribution and non-uniform airflow. It is found that a large pressure gradient in the first part of the channel is beneficial.