Modeling the discontinuous individual channel injection into fin-and-tube evaporators for residential air-conditioning

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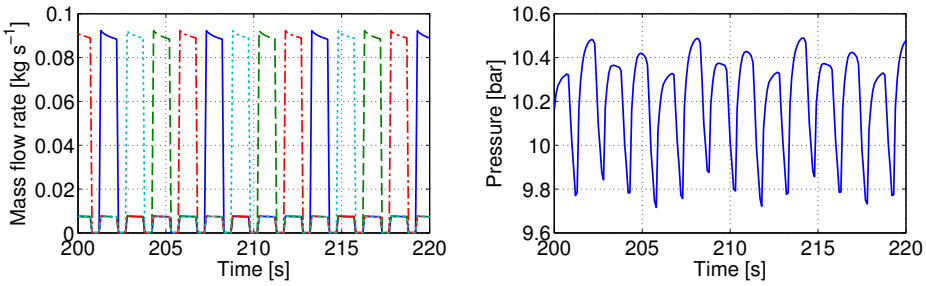
In this paper a working principle based upon the novel expansion and distributor device EcoFlow^{TM} is analyzed. The device enables compensation of flow maldistribution by control of individual channel superheat. The working principle is discontinuous liquid injection (pulsating flow) into each individual channels during a specified cycle time. Moreover, the influence of the injection cycle time is investigated together with an optional secondary flow into the other channels with regards to cooling capacity, overall UA-value and COP.

The results showed spurious fluctuations in pressure when simulating the pulsating flow, thus the dynamic behavior in the mixture two-phase flow model is insufficient to model the discontinuous liquid injection principle. Despite, the fluctuations and imperfections of the model we found that the cycle time should be kept as low as possible and that the optional secondary flow increases performance. Moreover, the paper reports on the applicability of Modelica developed models to analyze and optimize the working principle and design of expansion devices such that Modelica may be used in future development of novel discontinuous expansion devices.



The spurious fluctuations in pressure have not been observed as high in any similar experiments carried out at Danfoss. The current analysis should therefore be seen as a first study of the injection dynamics with the current model approach and limitations. When simulating the injection dynamics, we must keep in mind that the correlations for heat transfer, friction and void may become invalid at large transients in mass flow, since they are developed from steady state experiments. Furthermore, the discontinuous refrigerant injection is essentially pulsating two-phase flow, and the significance of the liquid/vapor interfacial dynamics may become important such as interfacial friction and drag and/or thermodynamic non-equilibrium effects. These phenomenons are not included in the typical mixture two-phase flow model used in many Modelica libraries.