Experimental investigation of condensation heat transfer in vertical minichannels

Motivation

Two phase flow cooling, especially within mini and microchannels, is employed in different areas like the cooling of power electronics. However, investigation of micro-condensers seems to be far from being mature compared to the macro-scale studies. It is more apparent since focusing on vertical microchannels. Individually, for vertical downward condensation, as it was studied in this project, seems there are no experimental results to evaluate the prediction methods. The local condensation heat transfer behavior of two new refrigerants (R236fa and R1234ze) were investigated and compared with previous results had come out for R134a. The results are desired to be implemented in the power electronics system.

Test facility

- schematic diagram of test facility

Experimental results

- Effect of mass flux at Tsat=40°C
- Effect of saturation temperature at G =200 kgm\(^{-2}\)s\(^{-1}\)
- Effect of heat flux at Tsat=40°C, G =200 kgm\(^{-2}\)s\(^{-1}\)
- Effect of inlet vapor quality at Tsat=40°C, G =200 kgm\(^{-2}\)s\(^{-1}\)
- Effect of inlet vapor quality at Tsat=40°C, G =200 kgm\(^{-2}\)s\(^{-1}\)
- Comparing experimental data with modified Koyama method
- Comparing heat transfer performance of R134a, R236fa and R1234ze

Two-phase heat transfer analysis

- An example of two-phase condensation profiles along the channel with R1234ze (G=156 kgm\(^{-2}\)s\(^{-1}\), Tsat=40°C)

Conclusions

- The validity of new data reduction method was confirmed by showing consistent results for two additional refrigerants.
- Effect of different parameters was investigated for present database.
- Koyama method was modified; predicting 97% of the present data within 20% error band and the MAE resulted in less than 6.2%.
- Comparing refrigerant performance, the higher heat transfer coefficients (about 15-25%) were observed for R134a than two other refrigerants.