Flow boiling heat transfer allows for the dissipation of large amounts of heat. In this work, the effect of heat flux and pressure on flow boiling of liquid refrigerant R-134a is studied in a vertical thin channel. The experimental setup mimics a refrigeration cycle and specifically looks at the effect of pressure and wall heat flux on the departure size and bubble generation rate.

The experimental setup consists of a closed loop which includes a vertical narrow rectangular channel and two synchronized high speed cameras for optical measurements at either sides of the channel. The setup is built to employ an accurate measurement technique to define wall temperatures of the representative flow boiling process. Instead of using thermocouples on the surface channel, the thermochromic liquid crystallography (TLC) technique is used to determine non-invasively the heater surface temperature at high temporal and spatial resolution. The TLC interval range is 30-50°C. The TLC is attached to a Fecralloy heating section. The high speed Prosilica cameras simultaneously capture, colored TLC images as well as bubble nucleation and departure at very high frame rates. Experiments on subcooled flow boiling heat transfer have been conducted with refrigerant R-134a under a mass flux range of 484.8375 kg/m²s to 1212.1 kg/m²s. With the low mass flux, the wall heat flux ranged from 167.2 to 672.1 kW/m², the inlet subcooling ranged from 0.35°C to 16.55 °C, the system pressure ranged from 621 kPa to 1034 kPa. At high mass flux, the wall heat flux ranged from 329.8 kW/m² to 744 kW/m², the inlet subcooling from 0.16°C to 17.21 °C, and the system pressure from 621 kPa to 1034 kPa. A parametric study was done by maintaining various input parameters constant.

From the high speed images, bubble parameters such as size and frequency are calculated. Temperature contours are utilized to determine the surface wall temperature at specific points. Sequential wall temperatures are traced over a short period of time to understand the cooling effects. The bubble propagation and coalescence are also visualized. Results show that bubble size and frequency increased with heat flux at any particular pressure. At higher pressure, the trend would be for the bubble size to decrease; however, the inlet subcooling and heat flux also affect bubble size. The bubble frequency is also seen to be affected by the inlet subcooling and the heat flux. Even though the inlet subcooling is maintained approximately constant, any slight decrease in subcooling increased bubble growth rate. Another trend that is observed is that at higher the heat flux, the bubble generation frequency is faster; however no specific trend is observed for wall superheat. With an increase in heat flux, the wall superheats are expected to increase; however, the localized nature of the nucleation activity sites is seen to affect the results. The variables are non-dimensionalized to note trends in parameters. In summary, the data analysis demonstrates that both heat flux and pressure significantly influence the bubble generation rate, size, propagation and coalescence.

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The public is welcome to attend.