CHAPTER 1

INTRODUCTION

Heat exchangers are devices that facilitate heat exchange between two fluids that are at different temperatures while keeping them from mixing with each other. Heat exchangers are commonly used in practice in a wide range of applications, from heating and air-conditioning systems in a household, to chemical processing and power production in large plants (Cengel, 2003).

Heat exchangers are typically classified according to flow arrangement and type of construction. A device that classified into heat heat exchangers based on its construction is microchannel. Microchannel is a micro heat exchanger that has tiny geometry, some in millimeter while most of it in micrometer. Microchannels are used in a variety of devices such as microchannel condensers in automobile air-conditioning system, heat removal in tiny electronic devices and many more.

1.1 Background

Microchannels are used in fluid control and to improve heat transfer performance with typical dimension below 1 mm. Wang and Rose (2006) once emphasized that some different treatment methods are needed for larger channels, especially for channels with dimension around 1 mm or less because it would generates surfaces tension effect.

Garimella (2006) once stated that researchers have concentrated primarily on removing of heat using single-phase and boiling processes so that condensation processes received less attention when it compares to boiling processes. Here were some relevant studies about condensation in microchannels :

Goss and Passos (2013) conducted experiment investigation about condensation heat transfer inside eight parallel microchannels (diameter D= 0.77 mm) with R-134a as its working fluid. They evaluated the influence of temperature, heat flux, mass velocity and quality on the heat transfer coefficient, h. The results revealed that mass velocity and vapor quality have an important influence on the heat transfer coefficient.

Goss et al. (2015) investigated experimentally about the pressure losses during the convective condensation inside eight circular with diameter D = 0.77 mm of horizontal and parallel microchanels using R-134a as its working fluid. The experiment conducted with the test conditions include the pressure, vapor quality, heat flux, and mass velocity, which were ranging from 7.3 to 9.7 bar, 0.55 to 1, 17 to 53 kw m^{-2}, and 230 to 445 kg m^{-2} s^{-1}, respectively. The result revealed that the pressure drop increases along with the increase of mass velocity and the heat flux is not much affecting the decrease of saturation temperature.

Lin and Wang (2017) conducted experiment measurement on condensation heat transfer in microchannel heat sink with dielectric fluid as its working fluid. The experiment was observed under some different vapor mass quality. In this experiment the relation between heat transfer, pressure drops and mass flux, vapor mass quality were investigated.

The present study relates to condensation in horizontal microchannels and concentrated in its channel shape. The condensation was observed in square, rectangular, triangular, inverted triangular and circular microchannels. Same topic was investigated by Wang and Rose (2006) using theoretical approach with R134a as refrigerant. They emphasized that the non-circular channels performs better than the circular channel at area near the inlet and the heat transfer coefficient was the highest at square channels followed by rectangular, triangular and circular at near inlet region.

1.2 Problem statement

In microchannels condensation, channel shape would affects flow, and every geometries has different treatment. This theory was proved by some researches about microchannels condensation based on its channel shape. Based on author knowledge, there are still a few research about microchannels condensation based on its channel shape, some of these compared two or three channel shapes and the rest only review microchannels condensation in a single shape. Thus this study would try to compare microchannels condensation in some channel shapes. The present study is aimed to simulate and analyze film condensation in horizontal microchannels with various channel shapes through ANSYS Fluent. The simulation is conducted with the hope that optimal shape is obtained and make easy to understand condensation in microchannels. However, on the other hand, this study is conducted to enrich the understanding of the geometries effect in microchannels condensation.

1.3 Objective

There are some objectives in the present study, they are as follows :

a. To study condensation in microchannels with various channel shape through numerical simulation.
b. To analyze the effect of different channel shape on film condensation in microchannels.

1.4 Scope of study

There are some scopes in the present study, they are as follows :

a. The refrigerant will be used is R-134a.
b. Channels with cross section: square, triangular, inverted triangular, rectangular with longer side vertical, rectangular with longer side horizontal and circular.
c. The software used in the present study is ANSYS Fluent 16.1

d. Most of all equation used in the present study are provided by ANSYS Fluent 16.1.

1.5 Significant of study

Condenser is an important device in the air conditioning system. Since several years ago microchannel condenser has been used successfully in automotive air conditioners. However, there are many shapes developed for microchannel and shape difference would give different performance. Not only that, in the micochannel condensation, liquid film was usually produced around the wall and the liquid film normally would resist heat transfer in the microchannel condenser. The film generated around the wall might affect the microchannel condenser heat transfer performance. So the significant of the present study is to determine the optimal shape in microchannel condenser through numerical methods using ANSYS Fluent with film thickness and heat transfer coefficient as its consideration.