ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 5, Issue 3, March 2018

Design of Heat Exchanger and Its Implementation

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Abstract: A cross stream miniaturized scale heat exchanger was intended to augment heat move from a fluid water-glycol to a gas or air for a given frontal territory while holding pressure drop over the warmth exchanger of every liquid to values normal for customary scale heat exchangers. The expected performance of these micro heat exchangers for ceramic, plastic and aluminium is compared with each other and with existing revolutionary car radiators. Forced convection together with increased dissipation radiator form is used to improve heat dissipation from the electronic components. Using the field of integrated micro-sensors and micro-actuators, called MEMS, provides us with a significant link between microelectronics and non-electronics applications and a power method enabling these heat exchanger devices to be implemented. A micro heat exchanger is designed to be made of a non-uniform series of silicon micro pins. Finite Element Modelling (FEW) is used to simulate pin size and shape based on two separate convection models. Three micro-heat exchangers are designed and tested based on the conventional heat transfer enhancement principles for use in a liquid cooling system with a long offset strip, short offset strip, and chevron flow line. The thermal efficiency of the offset strip heat exchangers is higher than the straight channel heat exchanger. The heat exchanger's output with the shorter strip is higher than that of the longer strip heat exchanger.

Keywords: Micro Heat Exchanger, Pin, Chevron, Ports, Channel.

INTRODUCTION

The Ability to efficiently transfer heat between fluids using lightweight, compact heat exchangers is critical for a wide range of applications, such as automotive radiators, air conditioning and aerospace. The flow to the narrow channels, heat transfer is improved as the surface area / volume ration increases and the convective resistance at the solid / fluid interface decreases[1].The well-known heat transfer benefits of small channels must be weighed against the cost of the steep pressure gradient associated with micro channel flow. The micro channels heat exchanger designed and built the advantages of micro-channels while reducing the penalty associated with a large pressure gradient. Although the pressure gradient within the air channels is steep, the multiple short channels allow for a high mass flow rate with a low total pressure drop through the heat exchanger[2].The short length of the channels means a significant rise in air temperature.

A heat exchanger with high ratios of heat transfer/weight and heat transfer/volume is the product of micro channels in a cross flow configuration. The standard theory of heat transfer in micro-heat exchangers tends to be valid. Most of the conventional heat transfer enhancement methods, such as integral fins and tube extensions, are not practical for application to these heat exchangers due to the small channel size in micro-heat exchangers. The standard theory of heat transfer in micro-heat exchangers tends to be valid. One of the most important issues for high-performance micro-heat exchanger design is the heat transfer enhancement methods for flow in micro-channels. A major motivation for the present work is the need to create high-performance micro-heat exchangers that operate for single-phase liquid cooling. The fully developed laminar, turbulent and thermal coefficients of flow heat transfer are very well in line with the theoretical constant heat flux[3].

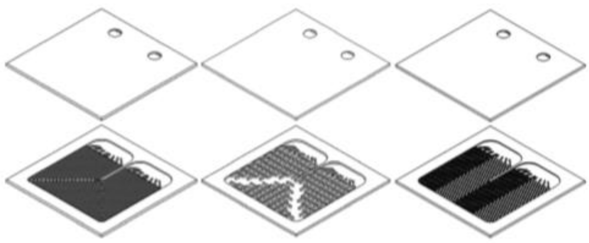

Figure 1: Micro Channel Patterns Designed

HEAT EXCHANGERS DESIGN

Counterbalance strip fins are regularly utilized in cooling heat exchangers to build its airside heat move coefficient by breaking the limit layer. The chevron grooves utilized in plate heat exchangers additionally give a fantastic flow

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blending to lessen flow circulation. Both of these plans are effectively created by the MEMS procedure and chose as the flow way types in the present investigation. Figure shows the flow channel example of the warmth exchangers[4]. A straight U turn directs heat exchanger appeared in Figure is additionally made for correlation. As shown in Figure, each miniaturized scale heat exchanger is made of two 1 mm-thick copper plates with a surface zone of 51 × 51 mm^2. The channels examples of upper plates for balance strip and straight channel heat exchangers are fundamentally equivalent to those of lower plates except that there are two 3 mm-distance across gaps on the upper plates to fill in as the bay and outlet ports. The upper plate chevron grooves are in the reverse direction of those on the lower plate, for the chevron channel heat exchanger. Figure demonstrates the cross section view and detail size of these micro channels. Because these heat exchangers are made using the chemical etching technique, the shapes of the channels are not exactly circular or rectangular[5].

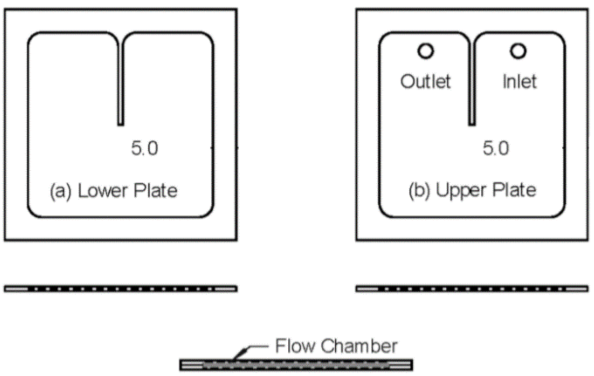

Figure 2: Micro-Heat Exchangers

The plan is made of a variety of silicon pins with the indistinguishable tallness (H). The pin focuses on the structure. The fixation is reduced at the passageway side of the structure and increment gradually toward the opposite end. The pins are secured by a film layer of glass, which is situated on the highest point of the structure. A basic schematic of a variety of pins is represented on figure 3[6].

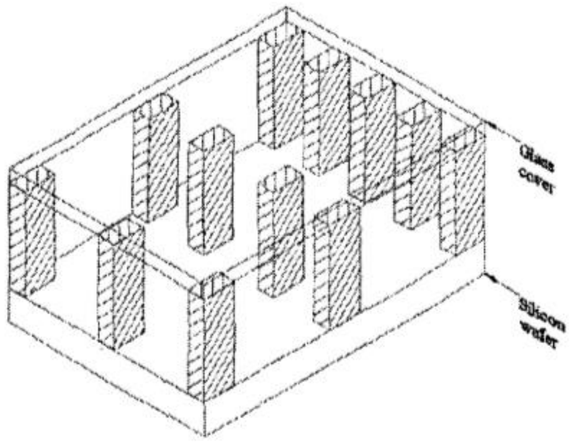

Figure 3: Arrangement of the Pin Arrays

A simple schematic of the micro heat exchanger for cross flow is shown in figure 3. The size of the built heat exchanger is limited by the present fabrication infrastructure. The cross section of each air channel and width of the fins separating adjacent channels is a variable. For manufacturing considerations and strength, the minimum allowed values of both the fin width and channel wide this set accordingly. The thickness of the wall separating the coolant from air is not a variable in design and is given a value of 126 m. This importance is chosen mainly because it is important to ensure the sealing of the coolant channels by aligning and bonding the upper and lower halves of the heat exchanger over length. The minimum permitted value for the width of the refrigerant channel is set at 400 m to ensure a sufficient coolant flow area. The final step of the manufacturing process involves fly cutting and polishing, each half being reduced in thickness. For an integrated heat exchanger the maximum length of the air channels is 1.9 mm[7].

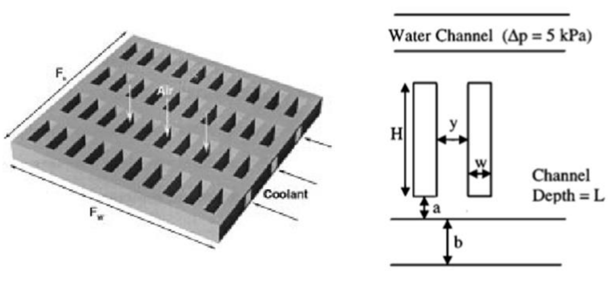

Figure 4: Cross Flow Micro Heat Exchanger

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2-D SIMULATIONS

The quantitative analysis of the results is conducted at two points along each channel's length; the gas passes through the upper part of the plate and passes through the lower part, as shown in figure 5[8].

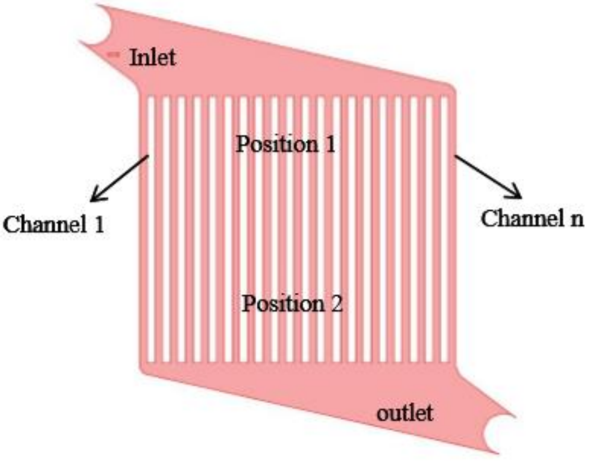

Figure 5: Analysis of the Simulations

A-type geometry, the average speed standard deviation is 0.11 and the maximum speed is 0.17.B-type geometry shows higher average and maximum velocity deviations, respectively. Geometry of the C-type is accomplished with relatively small standard deviations; the average velocity deviation is 0.10 and the highest velocity was 0.13.D-type geometry, standard deviations are even lower, average speed is 0.007, maximum speed is 0.008. Distribution of flow in this geometry may be considered the most homogeneous among the four geometries studied for a speed of 10m/s[9].

PERFORMANCEPARAMETERS

Performance requirements have been developed to design the cross flow micro heat exchanger. A car radiator is chosen as the specification because of the similarity of the design. For other uses, such as air conditioning and aerospace, the success requirements may be slightly different, but the majority of concepts that will be addressed can be applied to others. A car radiator's purpose is to dissipate heat to the air to avoid overheating of the engine. A well-designed cross-flow radiator provides a high rate of radiator heat transfer / frontal area for a given set of design constraints (i.e., pressure drop of each fluid and difference in inlet temperature between the two fluids .Certain construction performance measures include the criteria for weight, height, noise and filtration. The purpose mentioned in this paper is to design, within defined design constraints, a micro channel cross-flow heat exchanger that maximizes heat transfer/frontal area. The heat transfer / frontal region of the micro-cross-flow heat exchanger is estimated to be 2-4 times lower than revolutionary car radiators, but it is interesting to note that the heat transfer / unit volume and unit weight are two to eight times that of current radiators. Noise and filtering criteria are not only heat transfer / frontal field but also possible performance parameters. Noise measurements are not conducted and the noise should be comparable since the velocities and flow rates are similar to existing designs. The cross flow micro heat exchanger's filtering requirements are expected to be larger than a car radiator that requires virtually no filtering. The purpose of this paper is to compare the micro heat exchanger's performance with a conventional heat exchanger of a size, irrespective of the filtering problem. However, in cases where the micro heat exchanger offers a possible advantage, the filtering issue will eventually need to be addressed[10].

CONCLUSION

The use of micro-channels in a cross-flow micro-heat exchanger reduces the lengths of the thermal diffusion, allowing for more heat transfer / volume. To provide a function similar to a car radiator, a cross flow micro heat exchanger was developed. The design goal is to optimize heat transfer/frontal area for provided air and coolant pressure drops. The micro heat exchanger heat transfer/frontal area efficiency did not match creative radiators with the current set of dimensional design constraints. The rectangular pins will transfer more heat from the hot surface to the liquid coolant than the square pins and circular pins and this heat absorption can increase by increasing the circumferential area in contact with the liquid coolant. Three micro-heat exchangers based on the conventional heat transfer enhancement principles are developed, produced, and tested with a long offset strip, short offset strip, and chevron flow path. For comparison also a straight channel heat exchanger is made. The test results show that for each heat exchanger there is no significant difference in thermal resistance at different heating power levels. The lowest thermal resistance is given by the chevron channel heat exchanger.

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