Analysis of heat transfer through micro channel by different fluids.

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Abstract - *The use of electronics components has been increased, due to that the heat emission is increasing extremely. Due to this synopsis, temperature reduction is an major dissipation in stable operation. So, for cooling down the devices we have used Silicon based microchannel heat sink for simulation. Different working fluids are used which are tested through microchannel. So, to cool down the devices in minimum time this experiment or Investigation is carried out. Mainly the fluids are used. Water, Ammonia, Methanol and Ethanol.*

Key Words: Heat transfer, Micro channel, different coolants, natural convection, heat transfer, heat sink, micro heat sinks.

1.INTRODUCTION

There are three modes of Heat transfer from a system conduction, convection and radiation. Electronic devices show the tendency for smaller and faster devices with high heat transfer rate. And without the efficient way of heat dissipation in the surrounding the temperature of electronic devices or heat sink will go on increasing it will stop working. Due to compactness of this devices there is a huge heat generation in this devices. Hence due to over heating of a device, safety purpose should be taken by removing the excess heat from this device continuously. So the purpose of cooling system is to maintain the temperature in certain limit such as

1) Natural convection

2) Forced convection

All these conventional cooling systems are useful when heat dissipation rate is below 100w/cm^2 but when this rate becomes more than 100w/cm^{2}then these conventional cooling system fails to cool the devices. For cooling purpose of this devices. Micro channel heat sink are used. Microchannel heat sink was first introduced by Tuckerman and Pease in 1981 later on lots of research work has been carried out on micro channel. a specially to increases performance of microchannel heat sink. The main advantage of the microchannel heat sink is it has high heat transfer coefficient and less thermal resistance. Microchannel heat sinks are widely regarded as being among the most effective heat removal techniques for space-constrained electronic devices. **Microchannel** in microtechnology is a channel with a hydraulic diameter below 1 mm. **Microchannels** are used in fluid control (see Microfluidics) and heat transfer (see **Micro** heat exchanger). The concept of the **microchannel** was proposed for the first time by researchers Tuckerman and Pease of Stanford Electronics Laboratories in 1981.

Microchannels are mainly found in many biological systems, such as lungs and kidneys. Microchannels are present where there is extreme heat transfer process. Microchannels are used in a variety of devices incorporating a single phase fluid / liquid flow. The early applications of microchannels are micro pumps, microvalves and microsensors. The development in the microelectron chemical devices naturally require heat removal system that are equally small.

This project work is to cool down the electronic devices in which four different fluids are used to decrease the temperature of device. The four fluids are brine water, Methanol, Ethanol and Ammonia. In this experiment, initially a base plate is arranged for this plate siporex steup was fixed. The rods were attached below it, to give power supply. MCB is used to give the power supply. Supply is given through the rods to the base plate through the rods. The microchannels are made to pass the fluids.

2. LITERATURE REVIEW

A. Aly M.A. Soliman et all the state that In the study, an experimental investigation to the performance of the solar cells coupled with heat sink is presented. Indoor experimental setup was designed and assembled to investigate the impact of using heat sink cooling performance of solar cells. Halogen lamps used to stimulate the solar radiation and the study is carried out at different solar radiation values. Moreover, the study is carried out a natural and forced air to cool the heat sink. The results show that using heat sink cooling system enhances the performance of the solar cell. Temperature of solar cell decreased by about 5.4 % and 11 % by using heat sink cooling system and forced air over the heatsink, respectively. Moreover, the efficiency and power of the solar cell system increase by about 16 % when heat sink cooling system is used. **[1]**

B. Luigi Ventola et al states that Advancement in the electronics industry led to the development of microscale heat transfer devices which offered high heat transfer coefficient in a compact size. Nevertheless, the heat transfer characteristics were limited by the heat transfer fluids that were used. The recent development of nanotechnology led to the concept of using suspended nanoparticles in heat transfer fluids to improve the heat transfer coefficient of the base fluids. The amount of research done in this particular field is fairly new and limited. Most studies done microchannel devices and nanofluids recently have reported enhanced heat transfer capabilities and results that challenge traditional theories and limitations on heat transfer devices and fluids. **[2]**

C. Weerapun Duangthongsuk et al states that Heat transfer and fluid flow in microchannels have been topics of intense research in the past decade. A critical review of the current state of research is presented with a focus on the future research needs. After providing a brief introduction, the paper addresses six topics related to transport phenomena in microchannels: single-phase gas flow, enhancement in single-phase liquid flow and flow boiling, flow boiling instability, condensation, electronics cooling, and microscale heat exchangers. After reviewing the current status, future research directions are suggested.**[3]**

D. Tuckerman D.B. et all state that In recent time due to high performance of electronic component the heat generation is increasing drastically. Due to this scenario heat dissipation becomes a major issue in efficiency promation and stable operation. Silicon based microchannel heat sink fabricated using semiconductor production technique plays important role in cooling devices. The effect of the thermophysical properties of working fluids on the performance of microchannel is tested or we can say investigated. For this purpose the different working fluids are selected. water, ammonia, methanol, and ethanol. **[4]**

E. D.R.S. Raghuraman et al presented average convective heat transfer coefficient, outlet temperature, friction and pressure drop, pumping power and thermal resistance have been plotted against Reynolds number. Micro channel heat sinks play a very important part in the functioning of the microelectronic components. Size reduction is the buzzword in the newly electronic industry. However, with the reduction in small size, different new problems like heat dissipation becomes difficult and sometimes these devices fails and damage due to overheating. **[5] .**

4. PROBLEM DEFINITION

In order to work in convection, heat transfer coefficient for given microchannel is calculated with the help of installation of experimental setup.

5. METHODOLOGY USED

- Defining the problem and literature review.
- Studying Microchannel and basics in detail for calculation purpose.
- Preparing prototype model.
- Carrying out experiment.
- Calculations and finding results by using different fluids.
- Plotting graphs.
- Results and discussion.

6. EXPERIEMNTAL LAYOUT

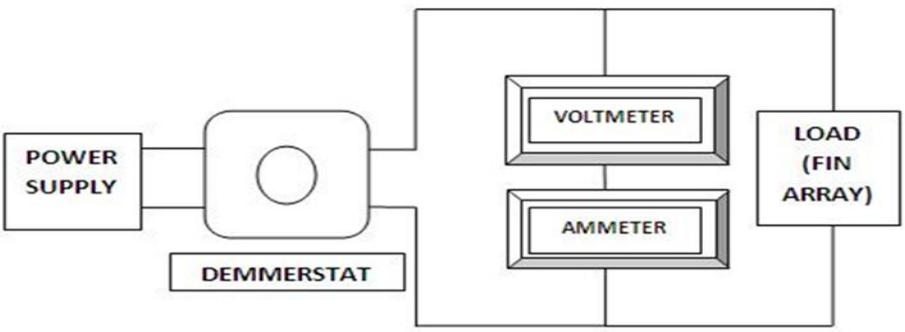


Fig: 5.1: Schematic Experimental Setup

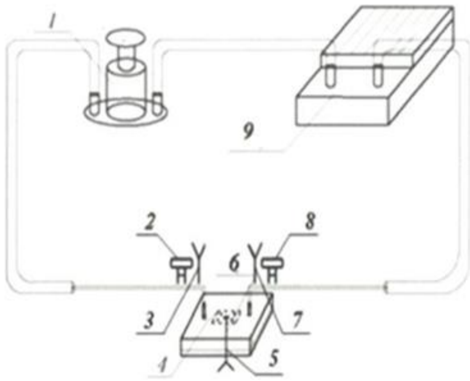


Fig: 5.2: Schematic view of experimental facility

7. Components Used

1. Inline fins with base plate (Microchannel):

Fins are the surface which has extend from an object to increase the rate of heat transfer from environment by increasing the convection. It consist of rectangular base plate having the dimension 180 mm x 140 mm, thickness is 29 mm and it mounted in siporex box the staggered fins and base plate made of the Aluminium material because of the considerations of conductivity, machinability and cost. Spacing between the fins is constant equal to 32 mm. First we using continues array i.e. four plates of 240 mm with thickness 3mm and having height 34mm for 1st reading and 42 mm for 2nd reading. Four sets of fin arrays are of 40 mm height and remaining four are of 48 mm. Then again lengthwise microchannels started first we doing 33.33% microchannels for both heights and taking readings. After that again this procedure repeated for 40% and for 50% lengthwise microchannel. Total fin length is 240 mm.

Uses: Are widely used in heat exchangers, refrigerators and electric conductors.

Fig.6.1.1

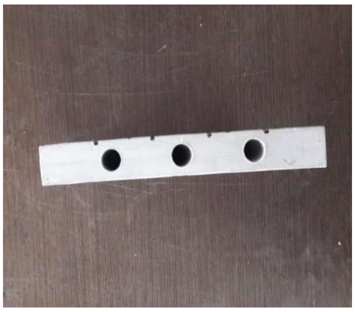


Fig.6.1.2

Fig.6.1.3

Fig 6.1: Inline fins with base plate (Microchannel)

2. Dimmerstat:

It is a controlling device of electrical circuits. Generally they are resistance coil like potentiometer. In resistance type dimmerstat the control of voltage is from 0 onwards to input voltage of dimmerstat. Resistance type dimmerstat are only used in DC circuits.

Specifications: Operating range is [0 to 4 Ampere] and (0 – 220 V) are used for setup.

Use: To adjust the output voltage to an electrical circuit.

Fig 6.2: Dimmerstat

3. Wattmeter:

It is an instrument to measure the electric power.

Specification: Range: 0 – 300 watts and for setup range 0 – 600 watts it is used.

Use: Used to measurement of utilized frequency and audio frequency power.

Fig 6.3: Wattmeter

4. Enclosure:

It is used to resist the extra flow of wind in the atmosphere to the setup. It has 2 wooden plates one from right and one left side of setup and in front and back fibre glass for visualization of flow pattern in Inline fins as shown in figure. The enclosure plays an important and effective role in the process of any experimental investigation in natural convection.

Advantage: We can visualise the pattern of flow from the Inline fins (Microchannel) in natural convection.

Fig 6.4: Enclosure

5. **Siporex box (Wooden insulation):**

Siporex box is used to insulating material for base plate. Base plate is mounted on siporex box. Also two wooden boxes are applied one on right and second on left side siporex box. And other base of siporex box is used for loss of conduction.
Specification: Dimensions of Siporex box: (280 x 240 x 125 mm)

Fig 6.5: Siporex box with wooden blocks

6. **Thermocouple and Temperature Indicator:**

Fig 6.6.1: Temperature Indicator

Fig 6.6.2: Thermocouple

Temperature indicators process the signal from temperature sensors show on the display. We used (K type Cr-Al) type temperature indicator.

A thermocouple is electrical device which consists of two dissimilar electrical conductors to form an electrical junction. The main limitation with thermocouples is precision. We have used 10 thermocouples in the experiment.

Specifications: Temperature Indicator: (0-300 °C.) [K type Cr-Al]. In experiment we used temperature indicator having range 0 – 1000 °C.
Thermocouple: Range (0 – 300 °C). No. of thermocouples used is 10.

7. Heater Unit:

Heater unit are used to increase the temperature of base plate and fins. Electrical heating is a process in which electrical energy is utilized to heat energy. It works on principle of joule heating.
Specifications: 100mm long with 20mm diameter and connected to wattmeter.
Application: Water heating and industrial processes.

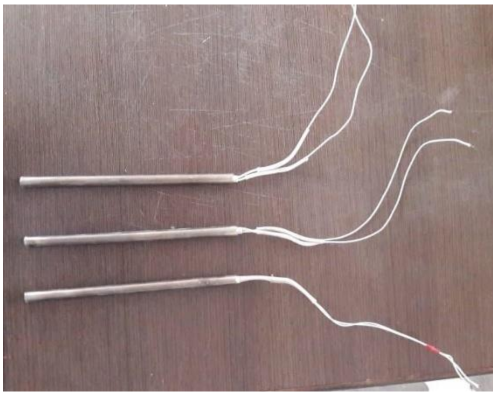


Fig 6.7: Rod type Heater

8. Fluids passing through microchannel:

❖ **Ammonia:**
a) Ammonia is a colorless gas with a characteristically pungent smell.

b) It is lighter than air, its density being 0.589 times that of air.

❖ **Ethanol:**
a) Ethanol is colorless liquid with the pleasant smell.

b) It is completely miscible with water and organic solvents and is very hydroscopic.

❖ **Methanol:**
a) Methanol appears as a colorless fairly volatile liquid with a faintly sweet pungent odour like that of ethyl alcohol

b) Completely mixes with water. The vapours are slightly heavier than air and may travel some distance to a source of ignition and flash back.

❖ **Water:**
a) Warm water vibrates longer than cold water.

b) The thermal conductivity of water is high and rise to maximum at about 130°C.

c) Water has unusual high viscosity.

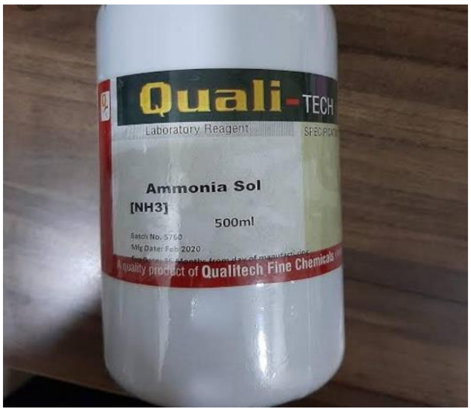


Fig 6.8.1: Ammonia

Fig 6.8.2: Ethanol

Fig 6.8.3: Methanol

Fig 6.8.4: Water

Fig 6.8: Fluids passed through microchannels

8. PROCEDURE FOLLOWED

This chapter includes steps involved while carrying out the experiment, observations of the experimentation and the methodology to determine heat transfer coefficient.

The experimentation is carried out for finding average heat transfer coefficients for microchannel through 4 fluids.

The step by step procedure adopted is as follows:

1. Place the arrangement under study in the test section.
2. Adjusting wattmeter power supplied to microchannel.
3. Achieving the stable temperature, we will pass fluids from microchannel.
4. After steady state, calculate the reading of temperature of test section with temperature indicator by thermocouple.
5. Heat transfer coefficient of conduction and convection is calculated.

Observations

Following are the common observations for each set.

Distance between holes in siporex box (xb) = 0.025 m

Thickness of wooden insulation (tw) = 0.018 m

Area of base (Ab) = l × b = (0.2 × 0.18) = 0.036 m^2

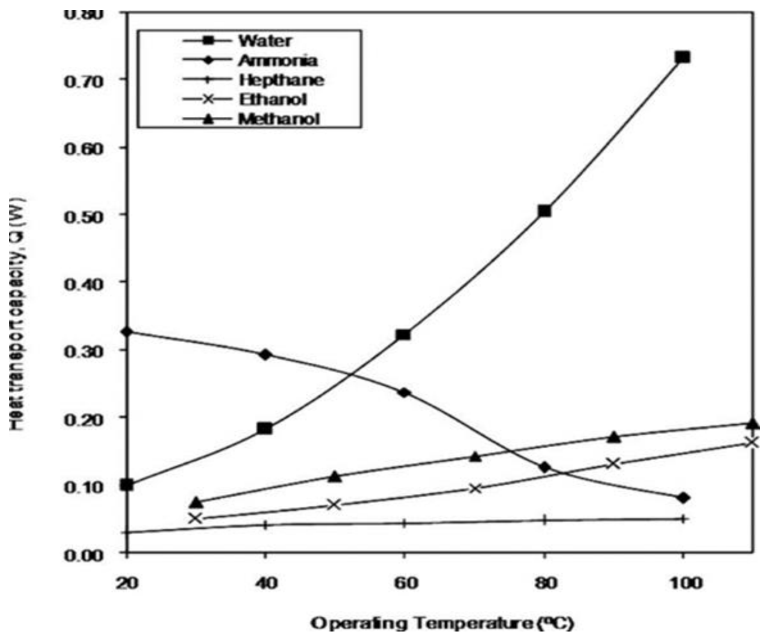
Average area of fin (Aa) = Ab + 5(l × h) × 2 =0.036 + 5 × (0.040 × 0.2) × 2 [For 40 mm height Arrays]

Average area of fin (Aa) = Ab + 5(l × h) × 2 =0.036 + 5 × (0.048 × 0.2) × 2 [For 48 mm height Arrays] Fin Material = Aluminum.

9. RESULTS

The heat transfer capacity as the function of the operating temperature and the test module is filled with the different working fluids.

And they observed the heat transfer capacity of these different working fluids. We also observed that except the water other four working fluids shows that, when the operating temperature increases in the heat transfer capacity also increased. And in case of water as the operating temperature increases the heat transfer capacity is rapidly increases. So we can say that the water can gives the best result than the other working fluids. The following graph can shows the operating temperature varies with the heat transfer capacity.



10. CONCLUSION

- Microchannels are capable of removing heat up to 1000 w/cm^2 due to their high thermal conductivity.
- It is clearly seen that for operating temperatures below 50°C, it is more advantageous to use ammonia as the working fluid to maximize the heat transport capacity.
- When we used water as fluid we can conclude that, as the temperature increased the heat transfer capacity of water is increased.
- Water is preferable if the operating temperature is higher than 50°C. According to that we can say water can gives good or better result than any other working fluids.

9. FUTURE SCOPE

The work provided in this thesis provides an effective comparison of staggered fin and continuous fin arrays. The proposing problems for the future study are given below,

- Theoretical Analysis of Microchannel. .
- The Ansys analysis to observe actual flow pattern.

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