OPTIMIZATION OF CONDENSER USING MICROCHANNEL

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Abstract

We conducted an experiment in an attempt to use microchannels to optimize the performance of condenser and make it useable in the common refrigeration and cooling systems. Microchannels can greatly minimize the coil size of condenser without compromising on its effectiveness. Such optimized systems can be used where space constraint exits. We tested the efficiency of the microchannels in a simple vapour compression refrigeration cycle. Copper was used as the material for micro channel and was of circular cross section. The experiment proved to be a successful one with the condenser operating effectively.

Keywords: *Condenser, Heat transfer, Microchannel, Refrigeration system.*

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1. INTRODUCTION

A lot of research is being carried out for the employment of microtechnology in the various fields of science considering the limitations on space availability and the growing demand of energy efficient technology. From the various literatures we have reviewed before the conduction of this experiment we studied that microtechnology is being viewed as an effective alternative to the traditional as well as conventional technology. It has the ability of delivering a light weight, compact and high performance product.

Cooling systems used in microelectronics, biomedical, fuel processing, and aerospace need to be light weight and compact in size. Strive to create something better than the existing cooling systems led us to this experiment. The main aim was to test the effectiveness of micro channels in these cooling systems.

2. MICROCHANNEL HEAT EXCHANGER.

Micro channels have hydraulic diameter below 1 mm.
Hydraulic diameter (D_h) is expressed as,

$$D_h = 4A/P;$$

Where A is the cross sectional area, and P is the perimeter.

The small diameter tremendously enhances the properties of the microchannels. In heat transfer, components are made so that there is maximum possible heat transfer while they consume minimum energy. Considering small diameter of condenser coil, lesser volume of refrigerant charge is required thereby allowing the use of smaller capacity compressor which in turn reduces the energy consumption of the system.

Microchannel heat exchanger provides powerful means for dissipating high heat flux with small allowable temperature difference. The important characteristic of microchannel heat exchanger is smaller hydraulic diameter of channel result in large heat transfer coefficient in microchannel.

2.1 Copper Microchannel

Copper known for its high thermal conductivity is undoubtedly the preferred choice in any heat conduction process. The metal having high ductility enables it to possess very good machinability, which is a vital consideration in the manufacturing of microchannels. Apart from good machinability Copper has high tensile strength, low thermal expansion, corrosion resistance. With these properties of Copper it was easier to use it for making the condenser coil and bend it accordingly.

2.2 Microchannel Condenser

The condenser is required to transfer maximum heat from its surface to the outside atmosphere. In a refrigeration system employing the simple vapour compression cycle, the condenser has to extract the heat from the high pressure refrigerant and transfer it to the outside.

Incorporating the principles of heat exchanger and microchannel a better performing, energy efficient and light weight condenser can be created.

Nusselt number (Nu) provides a relation between thermal conductivity, K, convective heat transfer coefficient, h, and hydraulic diameter.

$$Nu=hD/K$$

In the case of microchannel, the diameter being small ultimately leads to a higher aspect ratio of the condenser coil. The higher aspect ratio increases the heat transfer surface leading to better extraction of heat

3. MECHANISM

Newton's law of cooling dealing with the convective heat transfer shows us the relation between heat transfer rate and coefficient of convective heat transfer.

Mathematical expression for the heat transfer rate,

$$\dot{Q} = h\,A\,(T_s - T_\infty);$$

h is coefficient of convective heat transfer, A is the cross sectional area, Ts is the surface temperature, T∞ is the temperature of the surrounding.

Heat transfer requires greater value of h and a smaller area for the same and vice versa. Since it is desirable to choose a smaller area and size keeping in view the space constraints material with higher convective heat transfer coefficient is beneficial.

4. CONSTRUCTION

Capillary tubes of size 36 gauge, type T (copper-constantan) were used as microchannels.

To create the condenser, we mounted six metal plates vertically parallel as shown in fig.1. The plates had holes over its entire surface as shown in fig 2.The holes functioned as fins for effective air cooling and also allowing the microchannels to pass through them. We used three microchannels to form three coils which where collectively brazed to connect to the compressor's inlet and outlet.

Fig.1 Condenser (top view)

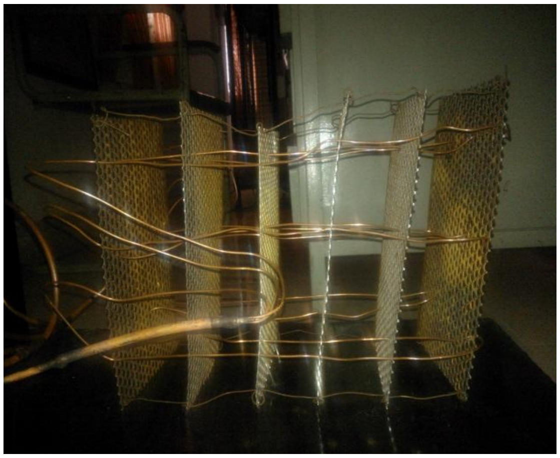

Fig.2 Condenser (side view)

Fig.3 Condenser (front view)

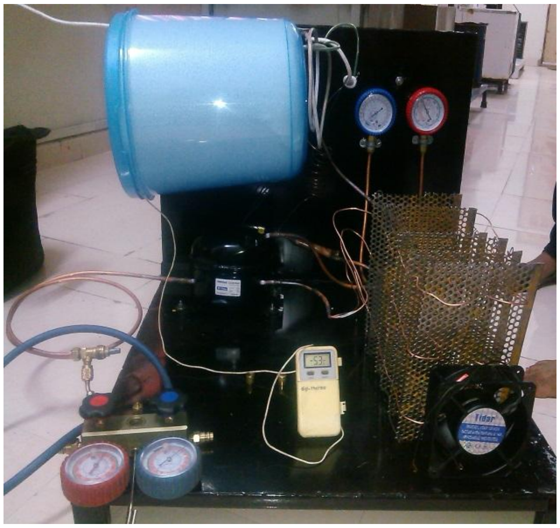

Fig.4 Experimental Setup

5. CONCLUSIONS

As it is rightly said necessity is the mother of invention. By keeping in mind the flaws of existing systems we built energy efficient and a cost effective device.

Such systems can be used commercially in order to overcome. Also by commercializing such systems it would prove to be a boon for the common man.

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