DESIGN AND FABRICATION OF IMPROVE PERFORMANCE IN DEEP FREEZER

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ABSTRACT

Techniques of freezing vary for each application. Later it has been discovered that the numbers of viable vegetative microorganisms in food are usually greatly reduced by freezing if quick freezing is employed. The conventional freezers could not cope with this higher rate of freezing. By the development of the deep freezer, the challenge of quick freezing has been met to enhance effective preservation by change the place of compressor, use the door handle and glass lid and use the manually operates flow control valve without using the capillary tube in Deep freezer. In the present work, a Deep freezer consisting of compressor at the bottom which consume more power to push up the refrigerants and when open handle door which wastage the cooled air, So by change the place of compressor reduce the power and using the glass lid which decrease wastage the cooled air and manually operated valve increase the effect of freezing.

Keyword: - *Compressor, Glass lid, Expansion valve, Fabrication, Performance.*

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1. INTRODUCTION

An every product require deferent storage temp for maintaining the quality of eatable or potable material. Keeping that aspect in view a low temp generating refrigeration system has been designed to maintain less than 0°C. It is the process of removing heat from an enclosed space, or from a substance, and rejecting it elsewhere for the primary purpose of lowering the temperature of the enclosed space or substance and then maintaining that lower temperature.

Deep Freezer works on Vapour Compression refrigeration cycle. The vapour-compression uses a circulating liquid refrigerant as the medium which absorbs and removes heat from the space to be cooled and subsequently rejects that heat elsewhere.

1.1 Aim and Objectives

The main objectives of this project helps in providing an alternative solution to the existing problem in deep freezer and improve its COP.

Main Objectives are:

- Design Machine which performers better than existing one.
- System must be compact
- Sliding and shutter double door
- set position for various components
- Use of Expansion valve instead of capillary tube

1.2 Working Principle

Deep freezer is works on Vapour compression cycle. Vapour compression is one type of cyclic refrigeration where the refrigerant will flow through all the components process in a cycle. In the compressor, the refrigerant enters as vapour in its saturated region and will be compressed at high pressure to the condenser pressure.

The high compression will cause the rise of the temperature in the refrigerant and turn into superheated vapour as the refrigerant shift phase into the superheated region. The superheated refrigerant is channelled into the condenser to dispense the heat and lowers its temperature with cooling air or water. The vapour then is cooled and condensed as it flows through the condenser coils. The heat will be released into the surrounding air or circulating water as the superheated vapour is cooled into condensate liquid.

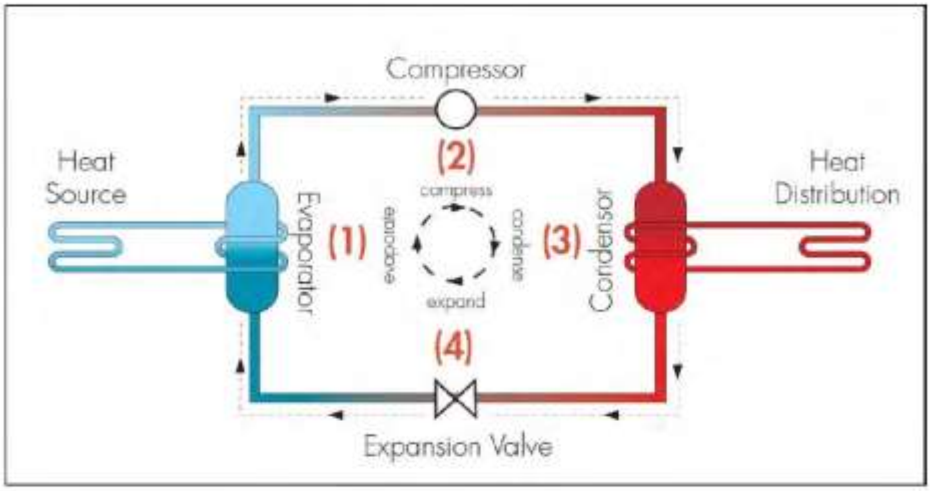

Fig 1: Vapour compression refrigeration cycle

The condensate refrigerant will flow and enters the expansion valve. Both temperature and pressure will drop substantially as the refrigerant undergoes throttling effect. The throttling effect causes the refrigerant to experience adiabatic expansion due to reduction of pressure. The expanded refrigerant then flows into the evaporator where the low-temperature refrigerant will evaporates into vapour and absorb heat during the evaporation process. The saturated vapour then leaves the evaporator and completes the cycle as the refrigerant flows back into the compressor.

2. LITERATURE REVIEW

2.1 History

Before the invention of the refrigerator, icehouses were used to provide cool storage for most of the year. Placed near freshwater lakes or packed with snow and ice during the winter, they were once very common. Natural means are still used to cool foods today. On mountainsides, runoff from melting snow is a convenient way to cool drinks, and during the winter one can keep milk fresh much longer just by keeping it outdoors. The word "refrigeratory" was used at least as early as the 17th century.

The history of artificial refrigeration began when Scottish professor William Cullen designed a small refrigerating machine in 1755. Cullen used a pump to create a partial vacuum over a container of diethyl ether, which then boiled, absorbing heat from the surrounding air. The experiment even created a small amount of ice, but had no practical application at that time.

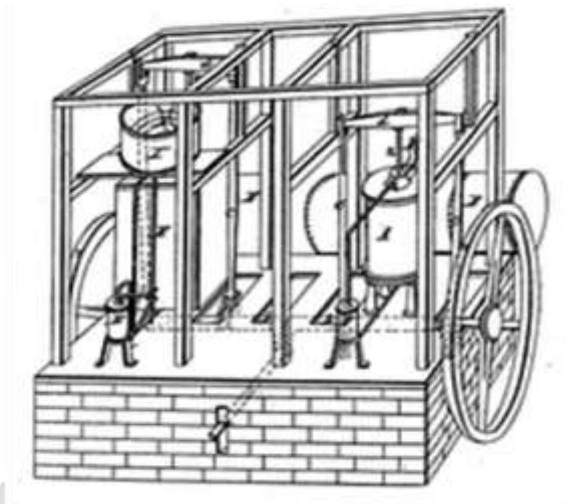

Fig 2 : Small refrigerating machine, 1755

In 1805, American inventor Oliver Evans described a closed vapor-compression refrigeration cycle for the production of ice by ether under vacuum. In 1810, the British scientist Michael Faraday liquefied ammonia and other gases by using high pressures and low temperatures, and in 1834, an American expatriate to Great Britain, Jacob Perkins, built the first working vapor-compression refrigeration system. It was a closed-cycle device that could operate continuously. A similar attempt was made in 1841, by American physician, John Gorrie, who built a working prototype, but it was a commercial failure. American engineer Alexander Twining took out a British patent in 1850 for a vapor compression system that used ether.

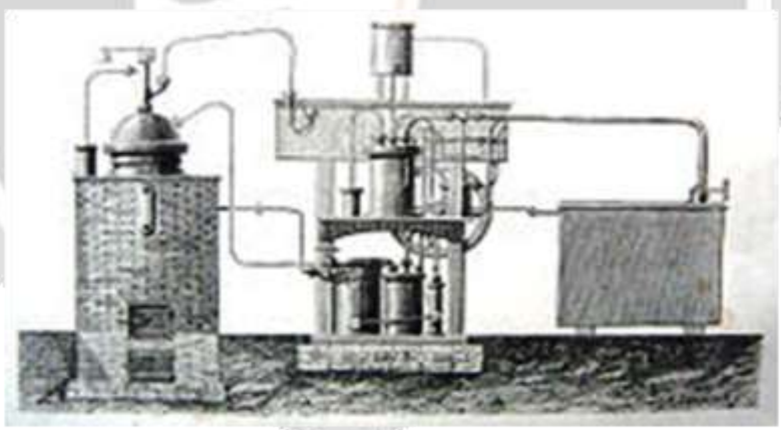

Fig 3: Closed vapor compression cycle, 1805

Harrison also introduced commercial vapor-compression refrigeration to breweries and meat packing houses, and by 1861, a dozen of his systems were in operation.

Fig 4: Commercial vapor compression refrigeration

2.2 Literature Survey

Evaporation in freezers has been a popular topic for about three decades, and there is a very wide literature on the subject. Due to spacing considerations, only the studies with R-134A will be mentioned in this chapter with the exception of the very first study by Lazarek and Black [5] who investigated a circular freezer with a copper pipe diameter of 3.1 mm and length of 113 mm, with R-113 as the refrigerant. This work may be considered as the major milestone of evaporation research in miniature channels.

Yan and Lin [6] presented a study with horizontal, circular channels with copper pipe diameters of 1 mm and lengths of 100 mm. R-134A with different mass fluxes have been used as the working fluid. It has been shown that the boiling heat transfer coefficient is a function of heat flux, vapor fraction and saturation temperature in freezers. Moreover, it is claimed that in low heat dissipation studies, the boiling heat transfer is only a function of the mass flux.

Agostini and Bontemps [7] showed the relationship between the boiling heat transfer and copper pipe diameter for vertical and rectangular channels.

Owhaib and Palm [8] studied heat transfer in vertical and circular channels of 0.8 mm, 1.1 mm and 1.7 mm copper pipe diameter, and 110 mm length. Different mass flux values have been considered in this study for a saturation temperature of 14oC. The dependency of boiling heat transfer on heat flux has been reported. Interestingly, it is stated that the heat transfer coefficient is independent of the mass flux and vapor fraction, which is in contradiction with the study of Yan and Lin [6].

Owhaib et al. [9] claimed the independency of the heat transfer coefficient from the mass flux and the vapor fraction, and highlighted the relationship between copper pipe diameter and the heat transfer coefficient.

The work of Mehendale and Jacobi [10] is another example of the heat transfer studies on freezers where circular channels with 0.8 mm copper pipe diameter and 7.4 mm length have been considered. The claim of their study was that the boiling heat transfer coefficient is independent of the vapor fraction and the mass flux, but strongly dependent on the heat flux. Also, the dominancy of the nucleate pool boiling regime has been indicated.

Huo et al. [11] presented a study with a 1.01 mm diameter and 4.06 mm length circular channel. The heat transfer coefficient has been shown to be a function of the heat flux and the vapor fraction as opposed to the findings of Owhaib et al. [9] and Mehendale and Jacobi [10]. The effect of convective boiling is not neglected in this study. The research by Kandlikar and Steinke [11] and Kandlikar and Balasubramanian [13] may be considered among the most important studies where the correlation of boiling heat transfer coefficient in freezers has been given in terms of the liquid phase Reynolds number. The dominancy of the nucleate boiling or convective boiling regimes has been taken into account in these two studies.

Condensation in freezers has been studied more recently compared to the evaporation studies in literature. Again, only the studies with R-134A will be included here.

One of the first studies on condensation in mini-channels is by Friedel [14]. The study is applicable to channels with a copper pipe diameter greater than 4 mm and it forms a bases of most for the freezer condensation studies even at the present time. About 15000 data have been used in this study, and a pressure drop model for mini-channel condensation flow has been tried to be built up. The separated model has been used based on a two-phase multiplier. The surface tension effects have been included in the pressure drop correlations.

Wilson et al. [15] investigated the effect of channel shape on pressure drop. The smallest channel copper pipe diameter used in this study was 1.84 mm. It has been reported that the pressure drop increases if the profile of the channel is rectangular rather than circular.

Zhang and Webb [16] investigated channels with a copper pipe diameter of 1.13 mm and reported that the work of Friedel [14] becomes inadequate in smaller channels. Still using the separated model, they developed a new two-phase multiplier.

Yang and Webb [17] studied channels with 1.41 mm copper pipe diameter. The surface tension contribution is the major point of their work. The condensation heat transfer coefficient has been given as a function of the surface tension.

Koyama et al. [18] presented a study with horizontal tubes. A saturation temperature of 60oC has been selected in their study. Based on the separated model, a newly defined two-phase multiplier has been built up.

Shin and Kim [19] highlighted that the heat transfer coefficient in square channels is higher than that in circular channels at low mass fluxes, whereas, the opposite is true at high heat fluxes. Square and circular channels with copper pipe diameters ranging between 0.5 mm and 1 mm have been used in this study.

The aim of this study is to design the components of a micro VCRC one by one and to analyze the cycle. The effect of miniaturization on the pressure drop and the heat transfer in condensation and evaporation processes has been investigated. Moreover, an isentropic, reciprocating compressor has been designed for the system. Two alternative evaporator designs with different geometries have been suggested. The effect of polytropic compression process on the cycle COP has also been observed. A second law analysis has been performed at the end of the study. R-134A has been considered as the refrigerant throughout the study.

3. DESCRIPTION

In vapor compression refrigerating system basically there are two heat exchangers. One is to absorb the heat which is done by evaporator and another is to remove heat absorbed by refrigerant in the evaporator and the heat of compression added in the compressor and condenses it back to liquid which is done by condenser.

3.1 Components selected for the project has the following specifications

- Refrigerant used: R-134a
- Capacity of The Refrigerator: 160 liters approx
- Compressor capacity: 150 WATT
- Condenser Sizes Length: 8.5 m
  Diameter: 6 mm
- Evaporator Length: 7.61 m
  Diameter: 6 mm
- Expansion Valve Length: 1.418 m
  Diameter: 0 to 6 mm

3.2 AutoCAD Model

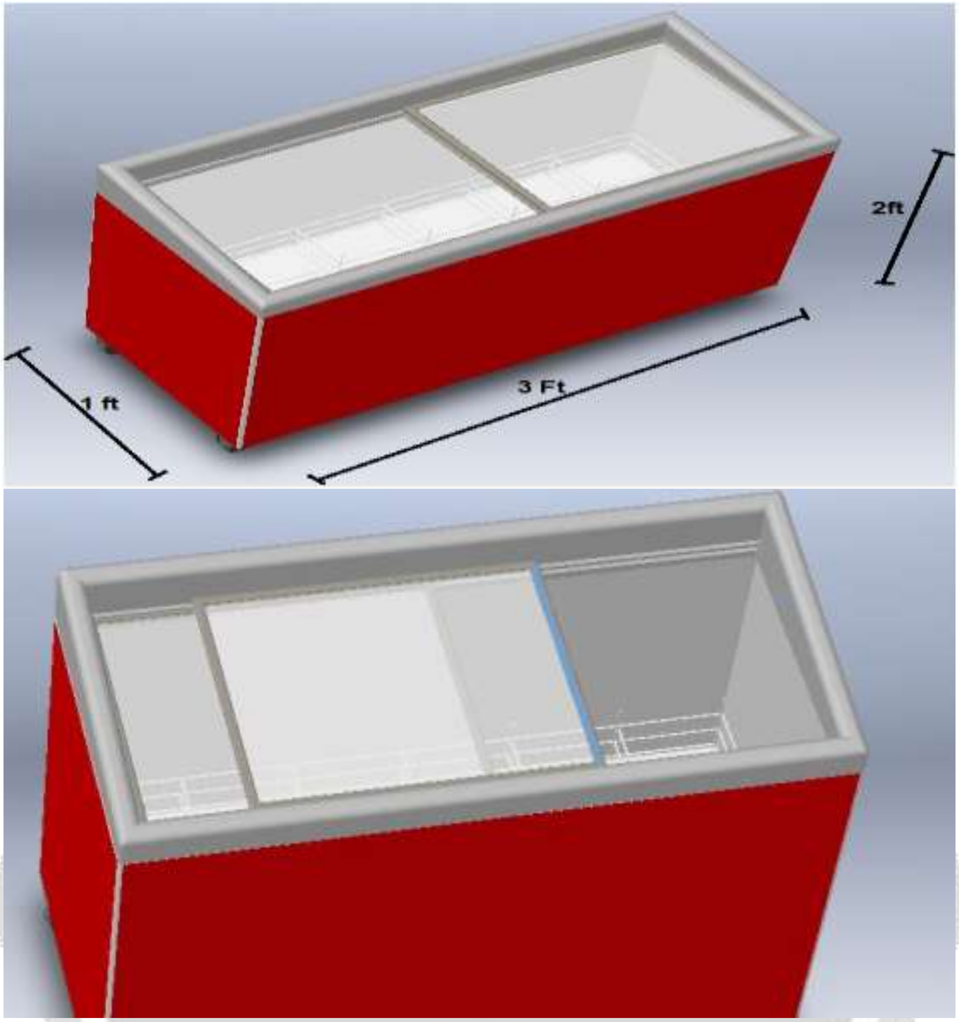

Fig 5: AutoCAD model of Deep Freezer

3.3 Experimental Procedure

The following procedure will be adopted for experimental setup of our project which works on vapor compression refrigeration system

1. The freezer is fabricated and working on vapor compression refrigeration system.
2. Pressure and temperature gauges are installed at each entry and exit of the components.
3. Flushing of the system is done by pressurized nitrogen gas.
4. R 134a refrigerant is charged in to the vapor compression refrigeration system.
5. Leakage tests are done by using soap solution, In order to further test the condenser and evaporator pressure and check purging daily for 11 hours and found that there is no leakages which required the absolutely the present investigation to carry out further experiment.
6. Switch on the freezer and observation is required for 1 hour and take the pressure and temperature readings at each section.
7. The performance of the existing system is investigated, with the help of temperature and pressure gauge readings.
8. The refrigerant is discharged out and condenser is located at the inlet of the capillary tube.
9. Temperature and pressure gauge readings are taken and the performance is investigated.
10. The readings are tabulated.

4. CONCLUSIONS

Change in position in various parts may be result in higher COP and better cooling effect. Deep Freezer works on Vapor Compression refrigeration cycle. The vapor-compression uses a circulating liquid refrigerant as the medium which absorbs and removes heat from the space to be cooled and subsequently rejects that heat elsewhere, depicts a typical, single-stage vapor-compression system. Expansion Valve controlling is very important, because of valve area is changing this result various cooling effect.

5. REFERENCES

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