"I hereby declare that I have read this report and in my opinion this report is sufficient in terms of the scope and quality for the award of Bachelor of Mechanical Engineering (Thermal-Fluids)"

Signature : 

Supervisor's Name : EN SUHAIMI BIN MISHA

Date : 8/12/09

# THE SIMULATION AND DEVELOPMENT OF OVEN USING DISSIPATIVE HEAT FROM REFRIGERATOR.

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This report is written as a partial fulfillment of terms in achieving the award for Bachelor of Mechanical Engineering (Thermal-Fluid) With Honours

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## DECLARATION

"I hereby declare that this report is the result of my own work except for quotes as cited in the references."

Signature : 

Author : NURUL HUDA BINTI ZAIFUDDIN

Date : 08 OCTOBER 2009

**To my beloved mom and dad**

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## ABSTRACT

The project research is about the simulation of oven using dissipative heat from refrigerator. The heat transfer from refrigerator condenser to oven compartment will be simulate and analysis. The simulation software that will be used in this project research is CFD which is Fluent Software. It use to investigate the temperature distribution of heat circulation in the oven whether it warm enough to heat the food. There are a lot of thing need to be taken in to consideration in doing this project such as the process applied in this project, the insulator used and many other things. The expected result of this project research is the heat transfer from the refrigerator condenser is high enough to warm the food in the oven compartment. After the experiment and simulation done, the expected result is not achieved. The final result show the heat is capable to warm the oven compartment at 43.64°C. Improvement can be done by putting insulator at the oven wall and coil from compressor to the oven compartment to reduce the heat loss.

# ABSTRAK

Projek ini adalah berkenaan dengan simulasi ketuhar dengan menggunakan haba yang terbebas daripada peti sejuk. Haba yang terbebas daripada pemeluwap akan dikaji dan akan di simulasikan. Haba ini akan di simulasikan dengan menggunakan perisian CFD dimana perisian Fluent di gunakan. Perisian ini digunakan untuk megkaji suhu yg di kitarkan di dalam oven. Terdapat banyak pekara yang harus diambil kira dalam menjalankan projek ini termasuklah bahan penebat yang digunakan, halaju kipas yang di pakai dan sebagainya. Hasil yang dijangkakan ialah haba yang dibebaskan oleh pemeluwap adalah cukup untuk memanaskan makanan di dalam ruangan oven. Namun setelah experiment dan simulasi telah dijalankan, keputusan yang diperolehi tidak mencapai dengan keputusan dijangkakan. Keputusan akhir menunjukkan haba yang keluar bebas di dalam oven itu dapat digunakan sebanyak 43.64°C. Penambahbaikan boleh dilakukan dengan menambah penebat di sekeliling dinding oven dan coil daripada compressor ke oven untuk mengurangkan haba yang terbebas.

# TABLE OF CONTENT

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF APPENDICES

# CHAPTER 1

# INTRODUCTION

## 1.0 The History of the Refrigerator and oven

### Refrigerator

The device found in more homes than any other appliance.

Figure 1: A 1950s fridge

The process to keep food cold by using an evaporative cooling system goes back a long time. The Romans used terracotta pots in water fanned by slaves to cool their food, but it was not until the 19th century that other liquids that would evaporate quicker if under compressions were discovered.

In 1834 an American inventor named Jacob Perkins obtained the first patent for a refrigerating machine, it used ether in a vapor compression cycle. His machine never had much interest as there was already a well established natural ice industry. Perkins later established a factory in England based on an earlier invention he had for printing bank notes.

The natural ice industry was big business in the U.S. and Europe ice was cut from the lakes in winter and stored during the summer, by 1890 the U.S. was exporting 25 million tons of ice, but in Australia it was not cold enough to harvest ice in this way so it was very costly keep food cool.

In 1837 a journalist named James Harrison moved to Geelong Australia from Glasco and set about designing his own machine. His first machine did not work so he took it to England and with the help of a Doctor Seabe he got it working. Harrison returned to Australia in 1856 with the working machine, he was commissioned by a brewery to build a machine to cool beer and this was the first practical use of a refrigeration machine.

The first absorption machine was developed by Edmond Carre in 1850, using water and sulphuric acid. His brother, Ferdinand Carre developed the first ammonia/water refrigeration machine in 1859. Many sources show that this machine of Ferdinand's was the first Refrigerator with no mention of Harrison, Perkins or his brother Edmond Carre.

Within a few years ice factories popped up all over the world to compete with the natural ice industry but the first home unit did not arrive until 1927 when G.E. enclosed the parts in a small cabinet. By the 1950's stylists were designing the refrigerators and in the late 60's the large latching doors were dropped when magnets were placed in the seals, thus reducing costs.

**Oven**

An oven is an enclosed compartment for heating, baking or drying. It is most commonly used in cooking and pottery. Ovens used in pottery are also known as kilns. An oven used for heating or for industrial processes is called a furnace or industrial oven. Settlements across the Indus Valley Civilization were the first to have an oven within each mud-brick house by 3200 BC.

Many of the early brick ovens found throughout Europe are quite large in size. These oversized ovens likely belonged to wealthy land owners and were probably used at a price by the entire local community. The brick ovens in ancient Roman civilization, however, were used for both commercial and residential purposes. Many of these early brick ovens were smaller in size, as they may have only been used to feed one or two families at a time. Brick ovens were often used for business in eateries located throughout ancient Italy. These businesses have been unearthed to reveal a surprisingly more modern appearance than one might have expected. These ancient restaurants looked very much like contemporary pizzerias, and were often built with granite service counters. These eateries commonly sported a diverse menu that included rustic versions of modern-day pizza.

Figure 2: Ancient Greek portable oven

## 1.2 Background research

The research of the project are about the heat dissipate from the refrigerator compressor as source of heat for the pre-oven. The existing ovens nowadays stand alone and using electric source to generate the heat but this project, an experiment and analysis will be done to make sure whether the heat transfer from the refrigerator compressor are reliable to warm the oven compartment. The CFD software that use in this analysis is CFD. Fluent is a software computational fluid dynamics where it used numerical methods and algorithms to solve and analyze problems that involve fluid flows. Computers are used to perform the millions of calculations required to simulate the interaction of fluids and gases with the complex surfaces used in engineering. Even with simplified equations and high-speed supercomputers, only approximate solutions can be achieved in many cases. Ongoing research, however, may yield software that improves the accuracy and speed of complex simulation scenarios such as transonic or turbulent flows. After the simulations are done, the analyses for the simulation are done. If the result of the analysis shows the heat transfer from the refrigerator compressor is no high enough to heat the oven compartment, a new design should be done.

## 1.3 PSM flow chart

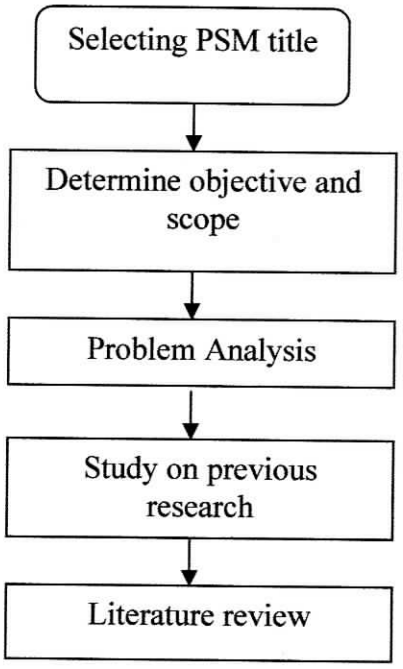


Figure 3: PSM flow chart

## 1.4 Problem Analysis

The heat dissipated by the condenser to the air is carried away by air that enters through the bottom and sides of the refrigerator and leaves through the top.

The heat can be used to develop warm oven at the top of the refrigerator. The oven is not required any external electrical source to generate the heat. Simulation of the heat dissipate from refrigerator can predict the possibility of using the heat from refrigerator compressor to warm the oven compartment.

## 1.5 Scope

**Objective**

- To simulate the oven compartment at the top of the refrigerator.
- To investigate the temperature distribution from the condenser to oven compartment by experiment and simulation

**Scopes**

- Study the refrigerator working principle
- Study the type of suitable oven to be used.
- Analyze and investigate the temperature distribution using data logger.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Theoretical analysis and solution

### Parts of a Refrigerator

Basic idea behind a refrigerator is to use the evaporation of a liquid to absorb heat. As the water evaporates, it absorbs heat, creating that cool feeling. Rubbing alcohol feels even cooler because it evaporates at a lower temperature. The liquid, or refrigerant, used in a refrigerator evaporates at an extremely low temperature, so it can create freezing temperatures inside the refrigerator.

There are five basic parts to any refrigerator:

- Compressor
- Heat-exchanging pipes - serpentine or coiled set of pipes **outside the unit**
- Expansion valve
- Heat-exchanging pipes - serpentine or coiled set of pipes **inside the unit**
- Refrigerant - liquid that evaporates inside the refrigerator to create the cold temperatures.

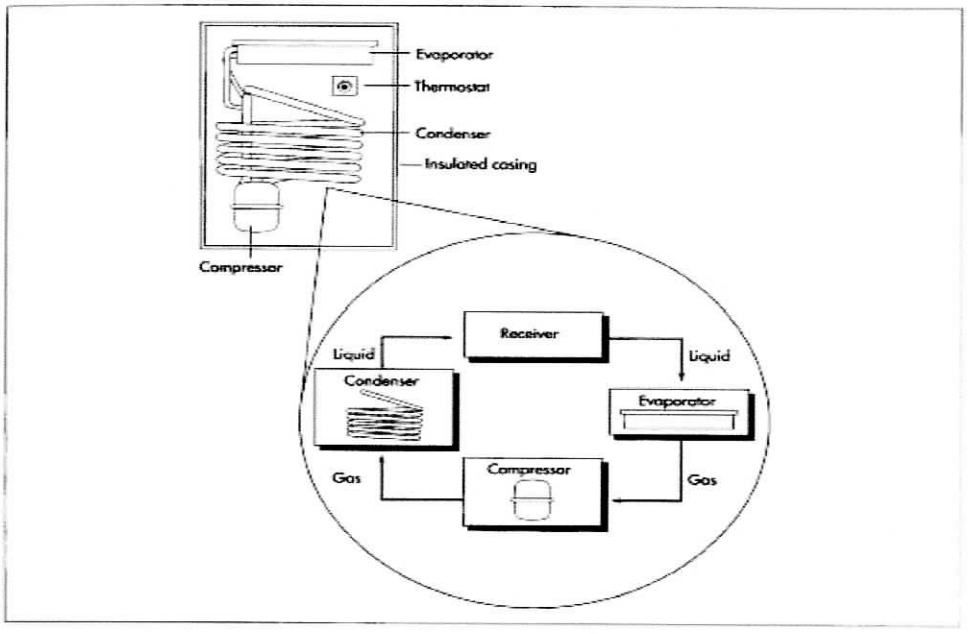


Figure 2.1: Basic parts of refrigerator

**The Complete Refrigeration Cycle**

The transfer of heat from lower temperature regions to higher temperature ones is called *refrigeration.* Devices that produce refrigeration are called *refrigerators*, and the cycles on which they operate are called *refrigeration cycles*. The working fluids used in refrigerators are called *refrigerants*. Refrigerators used for the purpose of heating a space by transferring heat from a cooler medium are called *heat pumps*.

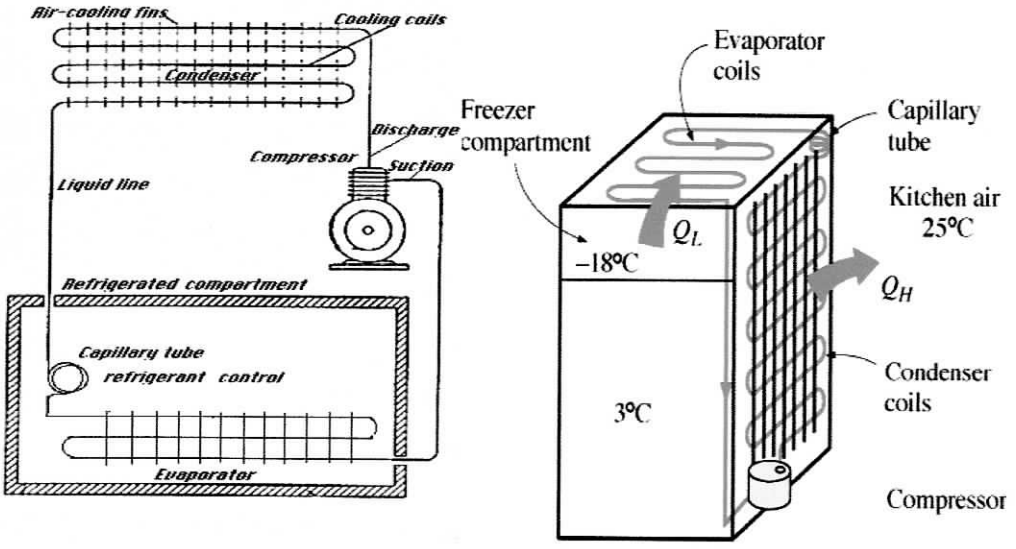


Figure 2.6: Complete Refrigeration Cycle

**The chosen oven**

In the house appliance, there are a lot of type of oven has been sold. There is Dutch oven, microwave oven, reflector oven, solar oven, convection oven and a lot more. Each oven has its own system of work. For the project we choose the convection oven based on how its work and it efficiency.

Convection ovens or fan ovens or turbo ovens augment a traditional oven by circulating heated air using a fan. The fan motor is in a separate enclosure, to protect it from overheating. Food warms faster in a convection oven, because the moving air strips away the thin layer of air which otherwise would surround and insulate the food. Technically, all ovens have natural convection currents, which vary with food placement and the position of the heating elements. For this reason, a more accurate term for convection ovens would be "forced-convection ovens". The popular term, "convection oven", could therefore be construed as a shortened version of this more precise name.

By moving fast hot air past the food, convection ovens can operate at a lower temperature than a standard conventional oven and yet cook food more quickly. The air circulation, or convection, tends to eliminate "hot spots" and thus food may bake more evenly.

A convection oven will have about a 50 degree Fahrenheit (30 degree Celsius) reduction in cooking temperature, compared to a conventional oven. This comparison will vary, depending on factors including, for example, how much food is being cooked at once or if airflow is being restricted by using an over sized baking tray.

Many convection ovens also include a proofing capability using the same fan but at a much lower temperature. A residential double oven will often include the fan capability in only one of the two ovens. Convection ovens provide more uniform heat than regular ovens by moving the oven air away from both the heat source and the top of the oven cavity. Circulating hot air seals in natural juices from the start of cooking. With a convection oven, food cooks faster or at a lower temperature than it does in a regular oven.

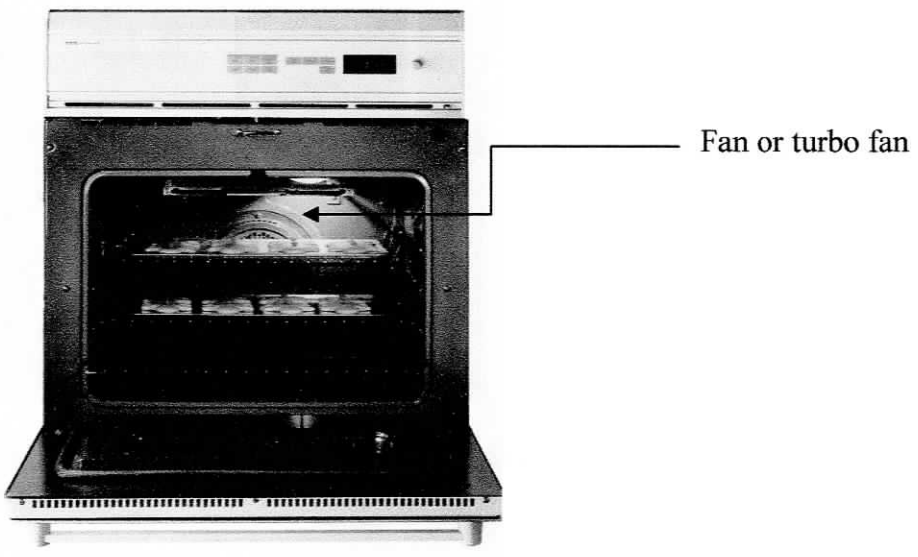


Figure 4: Image of convection oven

**The circulation of convection oven**

In a regular oven, air is warmest close to the heat source. Placement of food is critical for best results since food cools the air immediately around it and the area near the elements may be too hot. When the air is still, heat rises from the source at the bottom and collects at the top of the oven. In the regular electric oven, food must be place in the centre of the oven for even baking and roasting results. The convection oven moves cool air away from the food. As hot air flows around the food, the cool air is recirculated past the source of heat. To use a convection oven most efficiently, the oven door must be kept closed as much as possible. Airflow must be maintained.

The air in the oven must circulate freely. Shape of food affects convection cooking. A long thin meat cooks faster than a bulky one of the same weight because more surface is exposed to moving hot air. Size of pan also must be considered. The same quantity of food cooks faster in two small pans than it does in one large pan since air can circulate more freely.

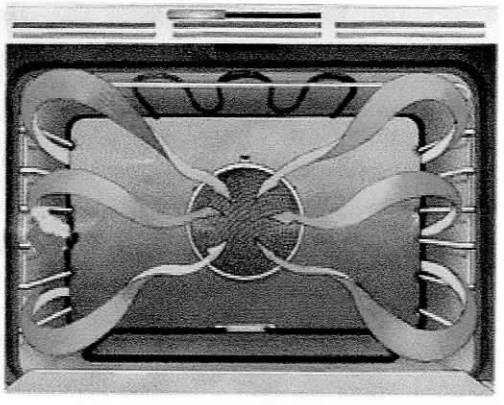

Figure 5: Air circulation in a convection oven