A THERMAL HEATED LUNCH BOX

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SUPERVISOR DECLARATION

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

Signature:.....

Supervisor : Dr. Tee Boon Tuan

Date: MAY 2012

DECLARATION

"I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged."

Signature:.....

Author :Tan Kien Guan

Date: MAY 2012

To my beloved parents,

My siblings

And also

To all my trusted friends

Acknowledgement

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ABSTRACT

The purpose of this project is to design a thermal heated lunch box with environmentally-safe feature and economic. It will include fabricating the thermal lunch box which aim to improve the lifestyle of human activity by extending the freshness of the food consumed and to keep warm up the food warm. The prototype will have the capability in maintaining the freshness of the food as consistent heat applies in the lunch box. The two layer cover which is inner and outer help to protect the food. The inner container is made from aluminum which can be remove for cleaning. It is also easy to clean and wash. The thermoplastic material is able to restrain high thermal that make it safe to use compare to other plastic material which will cause health issues when heat applied. This prototype will prevent the user from wasting their food as long the food tastes still remain fresh. The thermal lunch box is simple and user friendly. The prototype is programmed to cut off power when the temperature reached the set limit of 40 ^{0}C. The thermostatic effect makes the lunch box more useful and durable.

ABSTRAK

Tujuan projek ini adalah mereka-bentuk sesuatu kotak makanan untuk memanaskan makanan dengan ciri keselamatan kepada persekitaran dan ekonomi, bekas makanan ini akan digunakan untuk memanjangkan kesegaran makanan dan simpan di suhu tetap supaya makanan tidak mudah rosak. Prototaip ini berupaya untuk memelihara kesegaran makanan dengan pengekalan haba secara konsisten dalam bekas makanan. Bekas makanan ini mempunyai dua lapisan iaitu diluar dan didalam. Bahagian dalam diperbuat daripada aluminium yang mana boleh ditanggakan untuk dicuci, ia juga mudah dibersihkan dan dibasuh. Bahan termoplastik mampu mentahan suhu yang tinggi dan selamat digunakan untuk pengguna berbanding bahan plastik lain yang boleh menyebabkan isu-isu kesihatan. Prototaip ini diharap dapat menyelesaikan masalah pembaziran makanan oleh pengguna. Bekas makanan ini mudah digunakan oleh para pengguna. Prototaip ini telah diprogramkan untuk penghentian kuasa elektrik apabila suhu mencapai 40^0C. kesan termostatik pada bekas makanan adalah lebih berguna dan berkekalan.

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LIST OF ABBREVIATION

ΔT	-	**temperature difference**
q	-	**rate of heat transfer per unit area**
Q	-	**rate of heat transfer**
U	-	**internal energy ; overall heat transfer coefficient**
A	-	**area**
H	-	**specifit enthalpy**

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION TO LUNCH BOX

Lunch box is a tool kit which able to store up food or meal for later consumption. It is capable of protecting the food from dust as well as water and delaying the time of the food becomes spoilt.

The concept of lunch box has been around for very long and less information is know on who did invent it, but it plays significant role in our life especially during work or school. School children use lunch box to pack lunch or snack prepared at home by their family. Common modern form of lunch box appeared in small case with clasp, handle and it is usually printed with colorful image based on children show or film character for example superman, Snoopy, ultra man and etc. For working adult, they mostly prefer using plain aluminum or tin made lunch box with simple graphic only show in Figure 1.

Figure 1.1: Lunch box for children and adult.

There are certain health issues regarding use of vinyl lunch box. Center for Environmental Health discovered that many popular vinyl lunch boxes contained dangerously high levels of lead in 2002. Many manufacturers begin inspecting their product lead lever and labeled lead free. Studies have shown certain plastic made plastic Lunch box Polyethylene, Polypropylene and Polycarbonate from biphenyl will cause certain disease, and one of which is believed to be cancer. All lunch boxes should undergo safety standard rule for food container before commercial use. Right use of lunch box and plastic container will prevent unfortunate incident.

Improper dispose of lunch box will contribute to pollution which will endanger ecology. Some plastic made lunch box will not dispose easily and will bring harm to the animal and aquatic once being consumed. All users should have environment awareness and understand the circumstance. However, lunch box evolves from time to time and even now it still plays an important role in human life having a great bond with human activity. (Debra Ronca)

1.2 OBJECTIVE

1. To design an economical thermal lunch box that can obtain the freshness of meal in longer hours.
2. To develop an environmental friendly thermal lunch box that can be used in everyday life.

1.3 PROJECT SCOPE

1. PIC system is used to control the temperature in the container.
2. Developing CFD simulation to show the heat circulation inside the thermal lunch box.
3. The thermal lunch box will be built from proper material selection such as thermoplastics, aluminium foil, thermoelectric cooler peltier, and PIC controller temperature.

1.4 NEED OF RESEARCH

Due to the advancement in the city, human's lifestyle become hectic each day. Many people cannot even enjoy a proper meal as they need travel to other place to work with people living in hectic working schedule time becomes very important factor in order to success and time not enough for them.

As an alternative, take away or self prepare meal become one of solution. Food storage concept become very essential in life and lunch box or food container become very popular among people in now. But most of the people missed their lunch time and leave their meal, sooner they found their food not fresh. For long term it will affect the health of human. An innovative a thermal heated lunch box to solve this problem.

1.5 BASIC CHARACTERISTIC OF LUNCH BOX

Characteristic of lunch box is important for further research and product development. Therefore, a continuous study is required in order to an understanding to enhance a creative development. There are a few characteristics can be identified in a basic lunch box, which are:

1.5.1 Material

Material in term of manufacturing is refers to part use in fabricating thermal heated lunch box product. Type of material used to manufacture the product is important as determine the cost. Research on characteristic of the material should be done first and ensure it is safe to use and does not affect human health.

1.5.2 Storage space

Storage space refer to the capacity or volume that a lunch box capable to contain. Different people required different volume of food per meal. From the research female adult consume less food than male adult. For children, they only require half of meal of the adult. As for result, different sizes of lunch box appear in the market. (Science daily)

1.5.3 Food protection

Food protection characteristic in the lunch box is another feature should be considered. It refers to the capability to cover the food and protect it from dust or water which will spoil the food. It is essential to separate the food from contacting outside air because the air contains dust or bacterial which will affect the tastiness and freshness of food. The lunch box should also come with an air seal or leak proof feature to ensure it is fully protected from rain or water.

1.5.4 Temperature resistance

Temperature resistance on plastic lunch box is the ability to withstand heat and does not create chemical reaction, the temperature between 35^0C - 45 ^{0}C is good temperature resistance. If the temperature resistance is not high enough it may react and endanger human health when using it. So it is very important to undergo serious inspection and lead lever check before putting out to market.

1.5.5 Thermal insulation

Thermal insulation refers to the material of capable of reduce rate of heat transfer. Thermal insulation is the method of preventing heat from escaping a container or from entering the container. It can be apply to keep the food warm for a

longer period of time. Material selection become important as it will affect the rate of heat transfer.

1.5.6 Mobility

Mobility refers to the object capable of being in motion. In other word, it is the ability to bring along when traveling from a distance. Weight of the product should be as light as possible to allow user carry. The size of the product should also be small. When the size is small it allows is easy to be keep and bring along.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter covers the basic characteristic of plastic in material study, basic electrical and electronic principles, basic PCI controller, CFD simulate of heat. These studies will introduce the basic theory and concept which enable for material selection and heat transfer that is provide a basic of overview on heat and also using ANSYS FLUENT v13 software to simulate of heat. The chapter is also emphasized on conduction theory of the heat transfer study which heavily related to the prototype. It is important that to have the knowledge and understand the concept well before design and construct process take place. A good design depends on the knowledge of one designer have, so it is a necessary that designer understand the concept behind.

2.2 THERMOELECTRIC COOLER PELTIER

Thermoelectric cooler peltier is an electronic component show in Figure 2.1, uses the peltier effect to create a heat flux between the junction of two different type material that is by n-type and p-type semiconductor show in Figure 2.2, which heat transfer is from one side to other side against the temperature from cold to hot. The advantages of thermoelectric cooler peltier are no vibration, low maintenance fee and high reliability. (Huang, Yen and And Wang 2004).

Figure 2.1: Thermoelectric cooler Peltier.

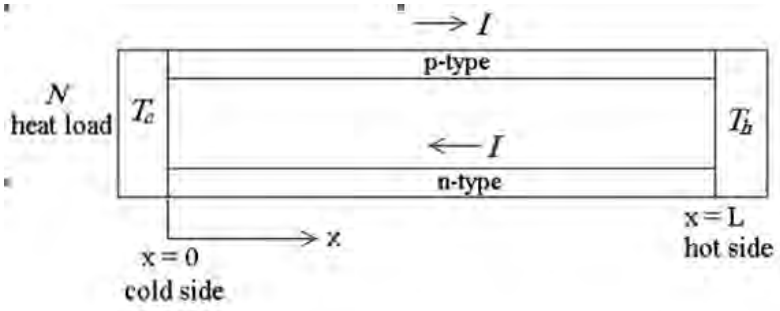

Figure 2.2: Schematic diagram of a thermoelectric cooler.
(Huang, Yen and And Wang 2004).

2.3 THERMODYNAMIC (HEAT TRANSFER)

Heat transfer is where the heat tends to move from a higher temperature region to a lower temperature region. Conduction occurs when there is an exchange of energy by direct interaction between molecules of a substance containing temperature differences in the form of gases, liquids or solid which has a strong basis of molecular kinetic of physic. (Eastop and McConkey, 1993)

2.3.1 Fourier law of heat conduction

When there is a temperature difference appears in the body, the heat will transfer from a hot region to a cooler region. This unique phenomenon is known as conduction heat transfer, and it is also described by Fourier's Law.

$$\mathbf{q} = -k\vec{\nabla}T$$

The vector q in the equation represent the heat flux for a given temperature profile T and k for thermal conductivity. In the equation the negative sign is where heat flows down the temperature gradient. According Fourier Law of cooling, Heat is transfer within a solid material. Derivation of the equation is shown as below,

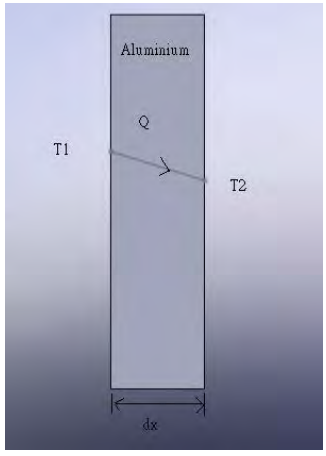

Figure 2.3: Heat transfer through wall.