DESIGN AND DEVELOPMENT OF THERMAL FOOD CONTAINER

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This report is submitted in fulfillment of requirements for the award Bachelor of Mechanical Engineering (Design and Innovation)

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DECLARATION

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

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ABSTRACT

This project is aim to design and develop a thermal food container with reheat function. Even though the microwave oven can heat the food far quicker, but a simple and more convenient reheating food container is needed. Thermal food container is a box that use to keep the food in a safely place which can bring anywhere with reheat function. The heating element used in the reheat system is nichrome wire and insulated with wine cork. The nichrome wire produces heat by overcoming the resistance of the current flow. PIC16F876A microcontroller was used to manipulate the reheating system by using the temperature sensor and also control the reheating timing by using the timer. The detail design of the product was drawn by using CAD for a better picture of how the thermal food container looks like. Methodology which is referring to the scopes of study and problem statements was identified. The product development process involves planning, concept development, detail design, simulation, testing and refinement, and report writing. Simulation on the thermal food container was performed by utilizing ANSYS and a simple and easy to use thermal food container was developed. The result of this project showed that the temperature that can be achieved inside the food container in 10 minutes was around 90 ℃ for CFD simulation while for prototype testing the temperature shown is 58.5 ℃. Overall, the project was conducted well, since the temperature distribution was obtained from the simulation as well as a prototype of thermal food container was fabricated.

ABSTRAK

Project ini bertujuan untuk mereka bentuk dan membangunkan bekas makanan haba dengan fungsi pemanasan semula. Walaupun ketuhar gelombang mikro boleh memanaskan makanan jauh lebih cepat, namun bekas makanan pemanasan semula yang ringkas dan lebih mudah digunakan diperlukan. Bekas makanan haba adalah satu kotak yang digunakan untuk menyimpan makanan dalam satu tempat yang selamat yang boleh dibawa ke mana-mana dengan fungsi untuk pemanasan. Elemen pemanas yang digunakan dalam sistem pemanasan adalah dawai nikrom dan ditebat dengan gabus wain. Dawai nikrom menghasilkan haba dengan mengatasi rintangan aliran arus. Pengawal mikro PIC16F876A digunakan untuk mengawal sistem pemanasan dengan menggunakan pengesan suhu dan juga mengendali masa pemanasan dengan menggunakan pemasa. Reka bentuk terperinci produk tersebut telah dilukis dengan menggunakan CAD demi memberi gambaran atau imaginasi yang lebih baik bagaimana rupa sebenarnya bekas makanan haba. Metodologi yang menunjukkan kepada skop kajian dan pernyataan masalah telah dikenalpasti. Proses pembangunan produk melibatkan perancangan, pembangunan konsep, reka bentuk terperinci, simulasi, pengujian dan perbaikan, serta penulisan laporan. Simulasi telah dijalankan pada bekas makanan haba dengan menggunakan ANSYS dan satu bekas makanan yang ringkas dan mudah diguna telah diciptakan. Hasil projek ini menunjukkan bahawa suhu yang boleh dicapai di dalam bekas makanan dalam masa 10 minit adalah sekitar 90 ℃ bagi simulasi CFD, manakala bagi ujian prototaip, suhu yang ditunjukkan adalah 58.5 ℃. Secara keseluruhan, projek ini dilaksanakan dengan baik, kerana taburan suhu pada bekas makanan haba telah diperolehi daripada simulasi serta prototaip bekas makanan haba telah dihasilkan.

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LIST OF SYMBOLS

P	=	Power
I	=	Current, A
V	=	Voltage, V
R	=	Resistance, R
Q	=	Total Heat Required
$\overrightarrow{\emptyset_q}$	=	Heat Flux
h	=	Convective Heat Transfer Coefficient

LIST OF ABBREVIATION

TES	=	Thermal Energy Storage
PIC	=	Programmable Interface Controllers
LCDs	=	Liquid Crystal Displays
CSTN	=	Colour Super-Twisted Nematic
DSTN	=	Dual Scan Super-Twisted Nematic
RS	=	Register Select
I/O	=	Input / Output
R/W	=	Read / Write
RAM	=	Random Access Memory
AC	=	Alternating Current
DC	=	Direct Current
NTC	=	Negative Temperature Coefficient
PTC	=	Positive Temperature Coefficient
RTDs	=	Resistance Temperature Detector
ESR	=	Equivalent Series Resistance
Li-ion	=	Lithium-ion
Li-Po	=	Lithium-ion polymer
PDS	=	Product Design Specification
HOQ	=	House of Quality
CAD	=	Computer Aided Design

CATIA = Computer Aided Three-dimensional Interactive Application

ANSYS = Analysis System

CFD = Computational Fluid Dynamics

3D = Three Dimensional

IGS = Initial Graphics Specification

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

Food container is a box used to store food or leftover and is easy to carry anywhere. The quality of food is safely preserved and can make it last longer by keeping it inside a food container. It can use to store wet and raw provision such as meat, fish, and poultry so that they are separate and do not contaminate the other foods. It also can store dry foods such as biscuit, oat, flour, and so on and so forth so that it will not pour out and keep safely in a closed container. Besides, most of the people may throw out the food due to spoilage, this phenomena can be reduce by storing the leftover such as vegetable, cake and so on into the container so as to maintain the freshness and the quality of the food for a longer period of time. (Pinola, 2011)

In term of protect the green environment, by using a food container, it can cut off the quantity of disposable plastic container. Nowadays, people like to pack foods

due to rushing of time and for convenience. But this act may lead to significantly increased of landfill. Thus, it has an advantage to use reusable food container instead of disposable plastic container to take away the consume foods form the restaurant or cafe for the purpose of cuts down the total number of trashes to clean up the planet and also saves energy on plastic manufacturing and recycling process. (Thompson, 2009)

The functions of food containers include that it can withstand high temperature and can directly reheat the foods inside the container without transport it out to another reheat able receptacle or cooking pan to reheat the foods. This is much more convenient other than keep the foods fresh and clean. In addition, it can stand for low temperature that will be able to place inside the fridge for those wet foods which require to store in fridge temporary before want to cook or consume. (Thompson, 2009)

1.1 OBJECTIVES

1. To design and develop a thermal food container with reheat function.
2. To enhance the insulation of the thermal food container.
3. To create a thermal food container that is simple and easy to use.

1.2 SCOPES OF STUDY

1. Conducting relevant analysis to be used in the design.
2. Applying PIC16F876A microcontroller for the reheat function.
3. Developing the innovative model of the food container.

1.3 PROBLEM STATEMENT

Even though the microwave oven can heat the food far quicker, yet a simple and more convenient reheating container is needed. (Littlejohn, 2012) One of these advances has been the microwave oven which greatly shortens the time it takes to initially heat or reheat the food. However, the microwave would adequately heat the food which is placed therein, the typical platter or food receptacle which is placed under the food while it is being heated in the microwave oven does not become warm or retain any heat. (Sepahpur, 2012) This situation also is true when food is prepared at a central kitchen to be dispensed to individuals not in proximity with the central kitchen. Besides, it is inconvenient and necessitates transferring the food to another, oven compatible container before the food can be reheated. (Hillebrand, 2010) Thus, developing a heat-retaining food container is needed which would ensure that food placed therein would retain its heat for a relatively long period of time.

CHAPTER 2

LITERATURE REVIEW

2.0 OVERVIEW

Food container for this market should be attractive, low in cost, easy to seal, easy to open, easy to reseal, stackable, and storage in the lowest possible volume. Most importantly, they must be low in cost and easy for user to use. In addition, container should offering foods on a carry-out basis which is substantially ready for consumption but are meant to be taken home and, possibly, reheated the foods before consume. (Littlejohn, 2012)

Food container for food materials, particularly solids or semisolids, to be kept in a sanitary condition and also when the cover therefore is removed and the food is ready to be eaten by the consumer. It also contemplates a container having a single compartment, as well as two compartments. It includes housing in a cover for the container for a utensil with which food is eaten, such as spoon, fork, or the like. (Biggins, 2012)

Food packaging has evolved from simply a container to hold food to something today that can play an active role in food quality. Many packages are still simply containers, but they have properties that have been developed to protect the food. These include barriers to oxygen, moisture, and flavors. (Risch, 2009) Food container, or that which plays an active role in food quality, includes reheat the foods and retain the heat inside a food container.

Beside reheat function, thermal food container is particularly effective in keeping prepared foods hot while in transit to the consumer. The container must effectively retain the heat of prepared foods. However, some steam should escape from the closed container so that excess condensation will not accumulate within the container. Moreover, since such container is frequently used as lunch box, the container should in general be easy to handle so that to avoid foods pour out or get messy inside the container. (Cyr, 2012)

The designed thermal food container is rapidly reheated the foods preserve in the container and can keep foods warm for extended periods of time. The heater is selectively positioned relative to a small area of the food container for the purpose of rapidly heating the food within the container by taking advantages of convection action by the food within the container. Such a feat is accomplished by the use of a nichrome wire as the heating element. (Hager, 2006)

A power supply receptacle is provided to produce low volt current to operate the heater. The food container heater is preferable upon the bottom of the container so that the heat will travel upward and heat the air. This air is then circulated to warm a space and passing warmth to the foods above as it rises, and heat will be evenly distributed. The high output heater provides a high concentration of heat at the bottom of the food container just as with the normal cooking pot on an electric range. (WiseGeek, 2012)

The thermal insulating material of the kind consisting of a pair of reflecting surfaces, usually composed of metal foil and parallel with each other. It is used for the heat insulation of refrigerators and refrigerated chambers as well as for the insulation of heated bodies and other purposes. This is aim to provide thermal insulating material having a separator for keeping the reflecting surfaces at a desired separation and deliver low heat conductivity between the surfaces. (Still, 2006)