I hereby declare that I have read this report 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)

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CONTROLLING DEVICE FOR AUTOMATION OF HEAT FLOW IN CONFINED SPACE

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This report is submitted in partial fulfillment of the requirements for the award of the degree of Bachelor of Mechanical Engineering (Thermal-Fluids)

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I declare that this report "Controlling Device For Automation of heat Flow in Confined Space" is the result of my own research except as cited in the references.

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ABSTRACT

This thesis discusses a research on heat controlling system using RKC Digital Temperature Controller that was used for measuring and controlling the heat flow of the multipurpose convection oven. The design is based on how to measure, achieved and maintained the desired temperature value for a period of time. All factors which influence the design and performance of the heat controlling system used will be highlighted. Thermocouple principle operation, conduction and convection equation, numerical method of analysis for multiple dimension, normal and force convection equations for heat transfer will be applied in developing the prototype. Comparison will also be made with theoretical values. Previous development on heat controlling system and design patent used as benchmark. The prototype shows a high reliability in heat measuring with satisfactory results.

ABSTRAK

Tesis ini membincangkan tentang kajian keatas alat pengawalan haba menggunakan "RKC Digital Controller Unit" bagi mengukur bacaan dan mengawal pngaliran suhu di dalam oven konduksi pelbagai guna. Rekabentuk sistem alat pengawalan haba yang dibina bertujuan untuk mengukur, mencapai dan mengekalkan suhu haba ke satu paras yang diingini dalam satu jangka masa yang telah ditetapkan. Segala faktor yang mempengaruhi rekabentuk dan prestasi alat sistem pengawalan haba akan diberi perhatian. Prinsip pengoperasian "Thermocouple", rumus perolakan dan konduksi, kaedah penyelesaian angka 2 dimensi, persamaan perolakan secara normal dan paksaan bagi pemindahan haba akan digunapakai di dalam proses pembangunan prototaip bagi sistem alat kawalan haba ini. Perbandingan terhadap nilai teori juga dilakukan. Rujukan terhadap sistem-sistem alat pengawalan haba terdahulu dan telah dipaten dilakukan bagi memastikan sistem kawalan yang dibangunkan dapat memenuhi piawai dan beroperasi sebagaimana yang dikehendaki. Prototaip alat sistem pengawalan haba yang menunjukkan keputusan keberkesanan yang memuaskan bagi pengukuran dan pengawalan suhu .

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NOMENCLATURE

A	amplitude
a	thermal diffusivity
C	radiation constant, electrical capacitance
c	specific heat
D,d	diameter
E	thermal emf
e	thermal emf in a junction
f	frequency, function
$G(s)$, $F(s)$	transfer function
$G(j\omega), F(j\omega)$	frequency response
I	Electric current
K	gain
k	general coefficient
L	time lag also called dead time
l	length
N	time constant
P	power
Q	energy
q	heat flux density
R	resistance
r	radius
s	laplace operator
T	temperature in K
t	time, temperature in ° C

V	voltage, volume
v	velocity
W	thermal resistance, radiant intensity
α	heat transfer coefficient, coefficient of linear thermal expansion, temperature coefficient of resistance, absorbtivity
β	coefficient of cubic thermal coefficient
Δ	error, different, amplitude, sampling time
δ	relative error, penetration depth
ε	emissivity
9	temperature in ° C or F
Θ	excess temperature over a reference temperature such as ambient or original value
λ	wavelength, thermal conductivity
ρ	density, reflectivity, resistivity
ϕ	heat flux or rate of flow
φ	phase angle
ω	angular frequency
τ	transmissivity

CHAPTER I

INTRODUCTION

1.1 Introduction

The study is about on designing controlling device for automation of heat flow in a confined space. Confined space mean here is a cooking space for conceptual oven that will be supplied with the heat flow to study the relation of temperature and pressure rise according to the heat transfer. This project requires a device that can control amount of heat entering the confined spaced by measuring the inside temperature.

1.2 Statement of the problem

1.2.1 Purpose of the study

The purpose of the study is to design a controlling device for automation heat flow in confined space. The study requires the design of a heat controlling device to control amount of heat that entering the confined space and based on heat source used. The heat sources selected are cooking gas and two types of charcoal.

By understanding the characteristic of those three heat sources, the design will be basically influence the management of the heat sources whether using automated or semi-automated system so that the amount of heat transferred into the confined space is supplied consistently.

The main problem in designing the controlling device for the automation purpose is that the variation of the heat source selected to heat the confined space conceptual oven (cooking chamber). Each type of the heat source has its own characteristic that will influence the method that will be applied to control the heat automation to the confined space. The characteristics for each type of heat source are:-

For charcoal:-

a) Smoke
b) Hard to maintain a constant temperature
c) Charcoal burning based on air supply
d) Must completely turned to ember in order to achieve a constant flame

For commercial cooking gas:-

a) burning gas easy to control due to commercial gas stove in market
b) based on gas flow rate supplied
c) fast in increase and decrease the flame size

1.2.2 Objectives Of The Project

This project is to design a controlling device for automation of heat flow in confined space. A multipurpose convection oven will be used as a case study.

1.2.3 This study will focus on

a) Designing a controlling system that consists of pressure and temperature gages for a conceptual oven.
b) Design an automated or semi-automated heating system

1.3 Importance of the study

The study is about controlling heat supply to an enclosure with a constant heat temperature. A heat controlling system for this oven needs to be designed so that the oven will be provided a controlled environment in temperature and pressure measurement.

Table 1. 1 Gantt Chart for complete Thesis

Project Activities	WEEKS											
	JUNE	JULY	AUG	SEPT	OCT	NOV	DIS	JAN	FEB	MAR	APR	MAY
Project Title Selection												
Project Title Discussion												
Chapter I												
Chapter II												
Chapter III												
Chapter IV												
Chapter V												
Workshop												

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter reviews heat controlling systems, types of sensor for measuring pressure and temperature in commercial oven and conventional oven and heat controlling systems patent design. The best method for measuring temperature and pressure inside the multi purpose convection oven will be selected according to the related factors of convection oven parameters and behaviors.

2.2 Heat controlling system

Stanley B. (Stanley B. 1978) has invented temperature sensor for glass ceramic cooktop. A glass ceramic cooktop surface is provided with a temperature sensor integral with the glass ceramic plate of the cooktop. The temperature sensor utilizes the temperature resistance characteristic of the glass ceramic plate as a means of monitoring the temperature of the plate and is formed in the heated areas of the glass ceramic plate. The sensor comprises pairs of metallized conductive strip fired to the underside of the plate and terminated in a cool region of the plate. A continuity resistor is provided at the termination point of each pair of strip to distinguish between cold glass condition and a defective sensor. One strip of each pair is connected to a further metallized strip whichSurrounds the periphery of the glass and forms a common ground for a heating unit control circuit and is also used as a broken glass detector. Each sensor form one leg of an AC voltage divider and Is connected to an associated control circuit. The output voltage divider is applied to two voltage comparators having a common output connected to operate a relay control heater power to the "burner" of the cooktop which may be open coil heaters or film heaters.

This invention is one of the automatic heating systems by using temperature sensor ground to heating unit control circuit. When the temperature of glass ceramic reach the set temperature, electric current will be cut off by the heating unit control circuit and prevent the glass ceramic from generating heat. In order to apply this system in conceptual oven, heating unit control circuit is needed to make this automatic heat generating process is happen.

Horinouchi (Horinouchi 1983) has invented an electric cooking oven having a temperature sensing device with output compensation. An electric cooking oven for use a normal cooking mode and defrost mode is provided which comprises a detector for detecting a temperature of a food body during cooking thereof, the detector comprising a thermistor which detachably attached to the food body to sense the temperature thereof. A circuit is provided for compensating the gradient of the output characteristic of the temperature detector to increase the gradient of the output characteristic curve of the resistance of the thermistor as a function of temperature in when the thermistor is operating in a temperature range in which it has low accuracy of temperature sensing.

This type of invention was made focused on food temperature. The sensing element used is thermistor attached to the food. The temperature of the food will control the temperature rise for this invention by ignoring temperature rise to another part.

Móczár (Géza Móczár, 2004) Measuring and charging heat consumption are not often worked out in the prevalent warm-water heating systems. The developed modern heat-meter device, which includes microcontroller, is self-calibrating and self-testing, it uses several correctional algorithms in order to increase accuracy after authentication. Consumption data and information about the work-state events are logged and stored by the measuring unit. The discrete devices are connected to a local concentrator via M-bus. The concentrator is connected to the central supervisory system through mobile communication channel (GSM). In this system, the meter devices respond to arising failures. The center collects information about measuring and usage. This solution highly increases the thrift and the trustiness of the system.

This system practically expensive due to high tech technology is used. More funds are needed to make sure this system can be operated and for maintenance work.

Evaluating Sensor Placement In A Thermal System from website (*http ://www .watlow.com/reference/tutorials/0404.cfm*) state that there is four major part in all thermal system they are the work load , the heat Source ,the heat transfer medium and the controlling device .With these four parts in mind, consider placement for each of these with respect to the others. Of the four major parts of a closed loop system, the sensor's location will play a major role, provided the other elements of the system have been properly selected. Placement of the sensor in relationship to the work load and heat source can compensate for various types of energy demands from the work load. Sensor placement can limit the effects of thermal lags in the heat transfer process. The controller can only respond to the temperature changes it "sees" through feedback from the sensor location. Thus, sensor placement will influence the ability of the controller to regulate temperature about a desired set point.

From this excerpt sensor for placement will be according to this basic step of Evaluating Sensor Placement (*http ://www .watlow .com/reference /tutorials /0404. cfm*) In A Thermal System. A critical discussion must be arranged with supervisor in order to make sure the conceptual oven base design does not affected by a sensor placement decision that must be made.

Thomas Seebeck In 1822, an Estonian physician discovered (accidentally) that the junction between two metals generates a voltage which is a function of temperature. Thermocouples rely on this Seebeck effect. Although almost any two types of metal can be used to make a thermocouple, a number of standard types are used because they possess predictable output voltages and large temperature gradients. The figure 2.1 below shows a K type thermocouple, which is the most popular:

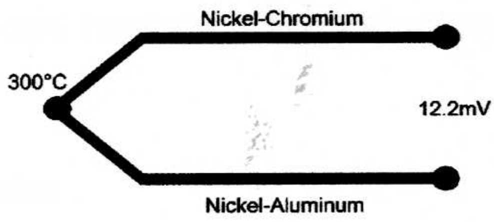

Figure 2. 1 Thermocouple (Junction between two different metals)

There are many, many types of thermocouples but only a small number have been standardized to the point of having distinct calibration tables, color codes and assigned letter-designations that are recognized world wide. The ASTM_Standard E230 provides all the specifications for most of the common industrial grades, including letter designation, color codes (USA only), suggested use limits and the complete voltage versus temperature tables for cold junctions maintained at 32 °F and 0 °C. Needless to say there are other thermocouple standards around the world and the color codes can and do vary in places.

Note that there are about three or four "classes" of thermocouples. Although no one really calls them classes, they really are.

There are:

1. The home body class (called base metal),
2. The upper crust class (called rare metal or precious metal),
3. The rarified class (refractory metals) and,
4. The exotic class (standards and developmental devices).

In most countries all but the most exotic class are codified by a letter designation.

The home bodies, at least in the USA, are the Types E, J, K, N and T. The upper crusts are: types B, S, and R, platinum all to varying percentages. The exotic class includes several tungsten alloy thermocouples usually designated as Type W