STUDY ON PERFORMANCE OF VACUUM FRY DRYING SYSTEM

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‘I / we* admit that have read this
work and in opinion of me / we* this work was
adequate from the aspect scope and quality to the significance to awarded\
Bachelor Degree of Mechanical Engineering (Structure & Material)’

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This report is submitted as partial fulfillment of the requirement for the award of
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"I declare that all part of this report are the results of my own work except for a few section which extracted and quoted from other resources that as been mentioned"

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My immense gratitude goes to ALLAH S.W.T, the most merciful and gracious.
Thank you to my parents, friends and supervisor Prof Madya Ir. Mustafa Ab. Kadir
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At last, I also wish to thank both my parent who always encouraging me, giving support to complete my project. All of this had shown me why I should carry out the project. I've realized all of this is only to teach me how to face the future environment, for preparing myself to communicate and show my ability in the future. Once again, I wish to thank all who involved in my project, giving me support and encouragement to complete this project in an organized and professional manner.

ABSTRACT

The main idea of this particular project is to design the fry drying mini plant based on previous studies which will be used to study on performance of vacuum fry drying system. The design should meet the objective of the project which is to develop and design a lab scale vacuum fry drying system and test the performance of frying drying vessel. But for this project, the design of fry drying mini plant can not be done because of some problem which is the vacuum vessel can not be fabricated because of high cost. Because of that the new vacuum vessel was designed. The new design of vacuum vessel created the vacuum vessel that can be evacuated up to 2 mbar. This design process is following the basic design process flow starting from the literature review, conceptual design, detail design and analysis design. In the process of completing this project, the information is gathered through the books, journals and existing products and patents. At the end of the project, the design achieves its target objective of detail theoretical design.

ABSTRAK

Tujuan utama projek ini adalah merekabentuk loji mini bagi penggorengan kering berdasarkan daripada kajian-kajian lepas dimana untuk digunakan bagi mengkaji prestasi sistem vakum penggorengan kering. Rekabentuk seharusnya mencapai objektif projek iaitu untuk membangunkan dan merekabentuk skala makmal sistem vakum menggoreng kering dan menguji prestasi benjana penggorengan kering. Tetapi bagi projek ini, merekabentuk loji mini bagi penggorengan kering tidak dapat dilaksanakan kerana terdapat beberapa masalah iaitu membina vakum menggoreng kering memerlukan kos yang tinggi. Oleh sebab itu, rekabentuk vakum menggoreng kering yang baru dilakukan. Rekabentuk yang baru ini haruslah boleh menahan tekanan 2 mbar. Proses dalam merekabentuk ini mengikut beberapa langkah iaitu mencari maklumat, konsep rekabentuk, rekabentuk khusus dan analisis rekabentuk. Dalam proses menyiapkan projek ini, maklumat-maklumat diperoleh daripada buku-buku, jurnal-jurnal dan dari produk-produk yang sedia ada di pasaran dan juga paten. Di akhir projek ini, rekabentuk yang dihasilkan sepatutnya mencapai objektif bagi teori rekabentuk.

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LIST OF ABBREVIATIONS

Torr	=	torr
k	=	kilo
Pa	=	Pascal
m	=	mili
n	=	nano
kg	=	kilogram
hr	=	hours
mmHg	=	millimeter of mercury
Hp	=	horsepower
M	=	mega
USA	=	United State of America
cm	=	centimeter
^{o}C	=	degree Celsius
mL	=	milliliter
LPG	=	liquid propane gas
Pt	=	platinum

CHAPTER 1

INTRODUCTION

This chapter consists of the background of the project and its problem statement which followed by the objectives, scope and its organization.

1.1 Background

Nowadays, the demand for cooking equipment that can cook a desired food without losing the real taste, smell and color of the food has become the top priority in the food industries. The quality of the food can be maintained by using vacuum fry-drying system or vacuum frying technology. Basically, vacuum frying is a suitable processing method for the production of high quality crispy fruit chips. The vacuum frying technology produces crispy fruit chip with original color and fruit aroma and an ideal crispy texture.

In addition, vacuum is defined as space that is completely empty of all the substances including air or other gases. But in this project, vacuum frying used the principle of low pressure-low boiling point.

1.2 Problem statement

The traditional cooking or specifically frying uses excessive heat which in the end burn the fibres of fruit or vegetables. To control this situation, there is need to utilize vacuum principle to reduce the heat in frying. In addition, to be able to control the situation the reliable design of vessel for vacuum frying must be obtained.

1.3 Objective

The objective of this project is to develop and design a lab scale vacuum fry-drying system and test the performance of frying-drying vessel.

1.4 Scope

These projects cover the literature survey of fry-drying process and design the vacuum vessel and the theoretical performance of the vacuum vessel.

1.5 Organization

The first part of the project is identification of the problem statement and development of the objective and scope of the design. Next step is the review on the existing process of vacuum fry-drying and the research on the existing vacuum application in the industries. Finally, the design a vacuum vessel and the performance of frying-drying vessel will be explained.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Literature review is the most important step to retrieve information's related to the topic chosen. It can be done by searching the information from internet, journals, books and other sources such as attending any seminars or courses offered outside or inside the university. It is important to make a study or research on the system before starting any development. This is to gain knowledge on the system and to ensure this project is within its scope. This chapter will elucidate on the details of the process and technology involved in this vacuum fry-drying system.

2.1 Vacuum

A vacuum is a volume of space that is essentially empty of matter, such that its gaseous pressure is much less than atmospheric pressure. The word comes from the Latin term for "empty," but in reality, no volume of space can ever be perfectly empty. A perfect vacuum with a gaseous pressure of absolute zero is a philosophical concept that is never observed in practice.

Physicists often discuss ideal test results that would occur in a perfect vacuum, which they simply call "vacuum" or "free space" in this context, and use the term partial vacuum to refer to real vacuum [1].

The quality of a vacuum refers to how closely it approaches a perfect vacuum. The residual gas pressure is the primary indicator of quality, and is most commonly measured in units called torr, even in metric contexts. Lower pressures indicate higher quality, although other variables must also be taken into account. Quantum theory sets limits for the best possible quality of vacuum, predicting that no volume of space can be perfectly empty. Outer space is natural high quality vacuum, mostly of much higher quality than can be created artificially with current technology. Low quality artificial vacuums have been used for suction for many years [1].

In quantum mechanics, the vacuum is defined as the state with the lowest energy. To first approximation, this is simply a state with no particles, hence the name. However, even an ideal vacuum; thought of as the complete absence of anything, will not in practice remain empty. Consider a vacuum chamber that has been completely evacuated, so that the particle concentration is zero. The walls of the chamber will emit light in the form of black body radiation. This light carries momentum, so the vacuum does have radiation pressure. This limitation applies even to the vacuum of interstellar space [1].

An ideal vacuum cannot exist even inside of a molecule. Each atom in the molecule exists as a probability function of space, which has a certain non-zero value everywhere in a given volume. Thus, even “between” the atoms there is a certain probability of finding a particle, so the space cannot be said to be a vacuum [1].

Atmospheric pressure	760 Torr	101.3 kPa
Low vacuum	760 to 25 Torr	100 to 3 kPa
Medium vacuum	25 to 1×10^{-3} Torr	3 kPa to 100 mPa
High vacuum	1×10^{-3} to 1×10^{-9} Torr	100 mPa to 100 nPa
Ultra high vacuum	1×10^{-9} to 1×10^{-12} Torr	100 nPa to 100 pPa
Extremely high vacuum	$<1\times10^{-12}$ Torr	<100 pPa
Outer Space	1×10^{-6} to $<3\times10^{-17}$ Torr	100 µPa to <3fPa
Perfect vacuum	0 Torr	0 Pa

Table 2.1: The vacuum range

(Source: http://en.wikipedia.org/wiki/Vacuum, (2008))

2.1.1 Vacuum fryer

There are many type of vacuum fryer in the market. The most popular are vacuum fryers which are manufactured in China and Indonesia. These vacuum fryers is adopting steam as heat source, big heating area and high heat efficiency. It is made of stainless material to meet the requirement of food hygienic. These model is intermittent fryer and suitable for the low temperature frying of fruit and vegetable. The food will be processed by vacuum fry and deoiled under the rather low temperature. The vacuum fry can prevent the loss of the nutrient of the foodstuff from high temperature. Besides, it could be efficiently keep the original color and flavor. The oil content rate of the foodstuff is below 15%. The food will be able to be stored a long time, crispy and delicious.

2.1.2 Machine description

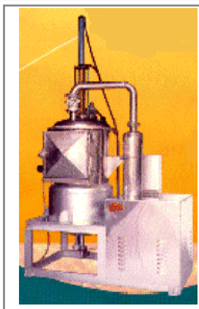
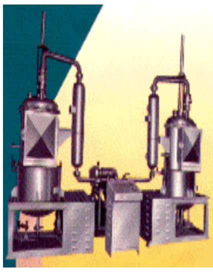
	 PILOT-TYPE	 TWIN-50	 TWIN-100
Capacity (Kg/Hr Chips) **A. Potato, Sweet Potato, Taro, etc.** **B. Apple, Pineapple, Banana, Greenbean, etc.**	25 10	50 20 ~ 25	100 40 ~ 50
Vacuum (mm Hg)	720	750	750
Diameter of retort (mm)	770	770	1216
No. Of retort	1	2	2
Dimension of equipment (mm)	L. 2000 W. 1500 H. 3000	L 4500 W. 1500 H. 3000	L. 5000 W. 3100 H. 3900
Pump power (Hp)	7.5	20	40
Total power (Hp)	11.5	28	48
No. Of steam jacket	1	2	2
Specification of boiler (Kg/Hr)	200	500	1000
Main material of equipment	Stainless SUS-304	Stainless SUS-304	Stainless SUS-304
Main power (person)	1	2	3

Table 2.2: Vacuum fryer type

(Source: http://www.taiwan-agriculture.org/itung/itungpro.html (2008))

➢ ZYZ-16-B (China)

Figure 2.1: ZYZ-16-B Vacuum Fryer
(Source: http://www.alibaba.com/, (2008))

Main technical parameter:
1. Inner diameter of frying pot: DN1000
2. Max. Worked pressure of sandwich structure: 0.27Mpa
3. Max. Worked temperature of sandwich structure: 140
4. Inner bowl vacuum degree: -0.098Mpa
5. Volume: 300L
6. Centrifugal Rotary Speed: 600rpm
7. Weight: 2200 kgs
8.Dimensions:3500×1700x2450
9.Manufacture Standard: GB150

- LTFM-I (China)

Figure 2.2: LTFM-I Vacuum Fryer
(Source: http://www.alibaba.com/, (2008))

Parameter:

1. Model: LTFM-I
2. Tank diameter (mm): DN1000
3. Vacuum degree (MPa): -0.098
4. Steam pressure: 0.25-0.3 MPa
5. Oil Volume (L): 450 L
6. Centrifugal spinning speed (rpm): 300
7. Net weight (kg): 2,500
8. Dimension (mm): 2500 x 1400 x 3850