DESIGN AND DEVELOPMENT OF INCLINED BATCH DRYER (IBD) SYSTEM

Anwar Muhibbuddin bin Noh

BEKC

2009

"I hereby declared that I have read through this report entitled "Design and Development of Inclined Batch Dryer (IBD) System" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation and Automation)"

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A report submitted in partial fulfillment of the requirement for the degree of Bachelor in Electrical Engineering (Control, Instrumentation and Automation)

Faculty of Electrical Engineering
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2009

I declare that this report entitle "*Design and Development of Inclined Batch Dryer (IBD) System*" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature: .....

Name : ANWAR MUHIBBUDDIN BIN NOH

Date : 9 JULY 2009

To

My mother and father and all Muslims

May Allah bless us all here and hereafter

-Al-fatihah-

ACKNOWLEDGEMENT

In the name of Allah, The Most Gracious, The Most Merciful. Peace be upon the Messenger of Allah, Prophet Muhammad s.a.w, his companions (r.a) and followers until the end of day. Thanks to Allah, with His blessing, this final project is successfully delivered.

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Wassalam

ABSTRACT

Programmable logic controller (PLC) is a widely used control system in industry both to control machines and/or processes and to monitor the flow of certain process. Unlike general-purpose computers, the PLC was designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Inclined Batch Dryer (IBD) is a mechanical dryer used to dry paddy. This type of drying method is commonly used in paddy industry in Malaysia. In this project, a prototype of Inclined Batch Dryer (IBD) control system will be developed by using PLC. The system will control the necessary process in paddy drying from wet paddy intake to the sack off process of dried paddy. Also included in the system is hot air temperature monitoring system that is used to maintain hot air temperature in paddy drying process.

ABSTRAK

Pengaturcara kawalan logik (PLC) merupakan satu sistem kawalan dalam industri yang digunakan secara meluas iaitu untuk mengawal mesin atau proses di samping mengawasi perjalanan sesuatu proses. Tidak seperti komputer, PLC direka untuk penyusunan masukkan adan keluaran yang banyak, kepelbagaian julat suhu, bebas dari gangguan elektrikal dan juga tahan pada impak dan gegaran. Pengering Condong Berkelompok (IBD) ialah salah satu dari kaedah pengeringan mekanikal yang digunakan untuk mengering padi. Kaedah pengeringan ini merupakan kaedah yang diguna meluas di Malaysia. Dalam projek ini, sebuah prototaip sistem kawalan Pengering Condong Berkelompok (IBD) akan dibangunkan dengan menggunakan PLC. Sistem ini akan mengawal semua proses yang terlibat dalam pengeringan padi bermula dari masukan padi ke dalam bin sehingga keluaran padi kering dari bin pengeringan. Turut disertakan dalam sistem ini adalah sistem pengawasan suhu udara panas yang akan mengekalkan suhu udara panas untuk proses pengeringan padi

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LIST OF ABBREVIATION

DC	- Direct Current
IBD	- Inclined Batch Dryer
MC	- Moisture Content
PLC	-Programmable Logic Controller
PSM	- Projek Sarjana Muda
UTeM	- Universiti Teknikal Malaysia Melaka

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CHAPTER 1

INTRODUCTION

1.1 Project Overview

Paddy that is harvest from paddy field usually has high water moisture content, which is over 27% of its weight [1]. Before paddy can be mill, paddy must be stored into warehouse or silo before the milling process begin. When paddy need to be stored, water moisture contain in paddy must be between 13% and 14% of its weight so that the paddy quality will not decrease [1]. Paddy drying process are the most crucial process before the milling process which will determine whether the head rice yield after milling are more or less. Head rice is milled rice and has length greater or equal to three quarters of the average length of the whole rice size [3].

The basic of drying is an evaporation process of water moisture in paddy to its surrounding [1]. Water moisture is water that is inside the paddy. This moisture always presented in percentage. The drying process is achieved by drying the paddy with constant temperature for a period until the water moisture in paddy reach the suitable percentage for storage. Delaying in drying process will decrease the quality rice produce after milling process. There are two types of drying process, which are natural drying, and mechanical drying. The natural drying type of dryer use sun as its source of heat and its drying places can be either under sun in paddy field or on drying mats at opened area. The mechanical types of drying consist of components such as fan, air-heater, bin, intake and sake-off machinery. Types of mechanical paddy drying use worldwide are re-circulating batch dryer, fixed bed dryer, continuous flow dryer and fluidized bed dryer [5]. In Malaysia, most of paddy factory use inclined batch dryer (IBD), which is a type in fixed bed dryer.

In order to produces maximum yield of head rice, the process of drying should be monitor by a kind of control system that can monitored the intake and sack-off process and also maintained hot air flow inside paddy bin thus maintaining temperature for drying process. The conventional control system use today just on and off motor for drying process and it cannot monitor temperature directly from control room. This project will create new control system for IBD that monitor the intake and sake-off process in drying process and maintaining temperature by using Programmable Logic Controller (PLC).

1.2 Project Objectives

The main objectives of performing this project are:

- To design a new control system on IBD by using PLC.
- To develop a system that can monitor important aspect in drying paddy such as the maintaining temperature as well as problem tracing when failure occurs.
- To develop a prototype of an automated machine that can work as a learning kit for teaching and learning purpose.
- To develop a system that will reduce the risk that have to be endure by people who work in the paddy drying industry.

1.3 Problem Statements

Maintaining temperature is one of important aspect in paddy drying. In order to maintain temperature of hot air in drying process, workers have to check the temperature of airflow in the paddy every 2 hours and worker need to come to the drying machine to check. When worker went for temperature, the dusty environment when paddy is dry will affect worker health. During maintenance work also, when the motor breakdown, it is difficult to know which motor is involved. In order to overcome all problems stated above, a system that can control and monitored important aspect in paddy drying and also ease the hardship in doing maintenance need to be design and develops. With this system, paddy drying as well as

temperature maintaining process can be done automatically and worker just needs to control and monitor it at the control room.

1.4 Project Scope

Project scope is limitation that being considered in order to perform this project. There are:

- This project will use OMRON CQM1H PLC as the main control system and OMRON CJ1G-H PLC for temperature monitoring system.
- This project will monitor the flow of intake and sake-off process in drying paddy and monitor the temperature needed for drying process which is 45°C.
- The used of thermocouple as temperature sensor for measuring temperature.
- To develop a prototype of an automated machine that can work as a learning kit for teaching and learning purpose.
- The combination of pneumatic actuators and mechanical mechanism in drying paddy from intake to sack-off process.
- This project will not state total cost used in making the prototype.

CHAPTER 2

LITERATURE REVIEW & THEORETICAL BACKGROUND

2.1 The Principles of Drying

Drying process are process for evaporate water moisture from grain by using airflow to evaporate the water moisture to surrounding [4]. Drying process is necessary for all grain to be safely stored because newly harvest grains have high content of water moisture. Grains must dried quickly after harvesting because the sufficient water moisture level in grains can attract to infestation of insect and microorganism and lead to germination process that will decrease the quality of rice after milling.

Moisture present in paddy grains are at two places: at the surface of the grain which is call 'surface moisture' and inside of the grain which, 'internal moisture' [6]. The evaporation process between this to moisture began at different time which is the internal moisture is much slower than external moisture. This different is due to the internal moisture has to move to the outside surface in order to evaporate. The drying rate of moisture from paddy grain are measured it percent per hour (%/hr) and typical drying rates for paddy moisture are from 0.5 %/hr to 1.1 %/hr in range [4].

The most important thing that needs to be monitor in drying grain is temperature. The recommended temperature for drying paddy is between 43˚C to 45˚C and the temperature must be constant all the time until the required moisture achieve. If the temperature that is set for drying paddy exceed the recommended temperature, the time for drying process will be quicker. As a result, the paddy will crack easily and when milling start, head rice yield decrease. If the

temperature for drying is lower than recommended temperature, the process will take longer time to achieve required moisture for drying and will affect the operation cost.

When drying process finished, dried paddy are stored in bulk storage or silos. The period for storing dried paddy may be different according to their final moisture content. The recommended moisture content for safe storage of dried paddy grain and potential problems when the moisture content (MC) exceeds these limits is shown in table 1.

Table 2.1: Different storage periods for Different MC [1]

MC, %	Purpose
<9	Storage for more than one year
9-13	8-12 months storage
14	Optimum milling yields
14-18	2-3 weeks of storage
>18	Rapid deterioration

After storage, paddy will be sent to rice factory for milling and finish product which is rice. In Figure 2.1, it shows about overall rice production.

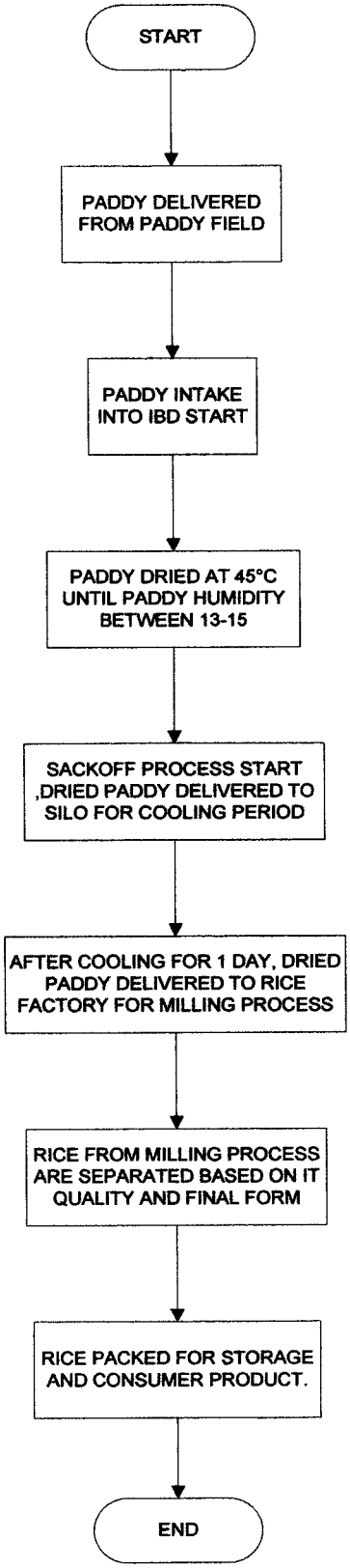

Figure 2.1: Rice production

2.2 Drying Method

Drying method can be separate into two groups that are natural and mechanical. There is no ideal dryer for drying paddy since each drying method has its own inherent advantages and disadvantages. In natural method, the source of heat came from sun and this process run at daytime only. This type of drying does not need much cost and effort. For the mechanical drying type, it consists of fan, heater, bin, and intake and sack-off machinery [1]. In this method, the heat is generate can either be fuel or electricity or from cyclonic husk furnace (CHF). Table 2: show the advantage and disadvantages between natural and mechanical dryer.

Table 2.2: Advantages and Disadvantages of Natural and Mechanical Dryer [1]

Natural Dryer		**Mechanical Dryer**	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
Cheap operating Cost	Heat cannot be controlled	Heat source can be controlled	High operating cost
	No sun during rainy day	Unlimited drying process	Need more worker
	Limited drying process	Large quantity of grain can be dried	

2.3 Mechanical Dryers

There are three types of mechanical dryer commonly use today. The types are batch-in/flat bed dryer, re-circulating batch dryer and continuous flow dryer [4] [5]. All of this mechanical have same basic instrument, which is fan, heater, bin, and intake and sack-off machinery. The different between these three types is their operation method and their design.

2.3.1 Batch-in/Flat bed Dryer

This type of dryer is the basic design and usually built in rectangular bins with plenum chamber underneath. There are three types of dryer in this design, which are flat bed dryer, inclined bed dryer and circular-bin dryer [6][3][4]. Large capacity batch-in-bin dryers can be use in cooler dryer areas. The advantage of this technique is that the bin is use for both drying and storage with savings in both capital and operating costs. When heated air is at temperature of 40-45 °C, bed depths of 2-3 m allow air velocities through the bed not exceeding 0.08 m/s [5]. Inclined bed dryer are commonly use in paddy factory in Malaysia since the yield of head rice obtained in this method are higher than other type of dryer. The different between these designs are show in Figure 2.2.

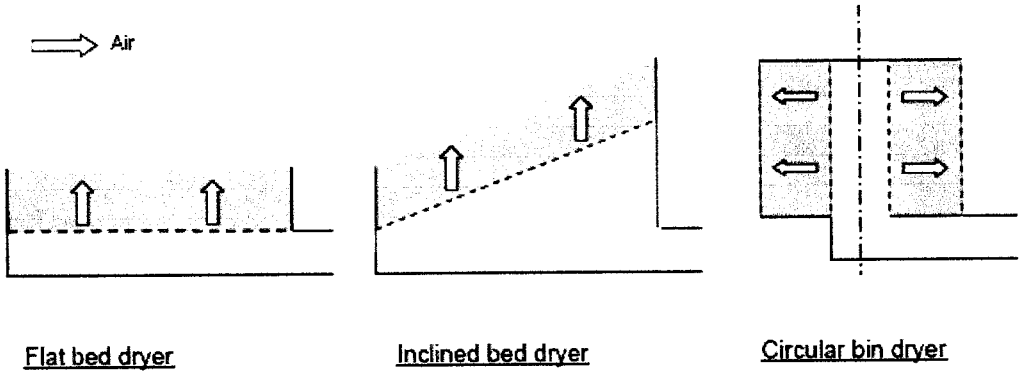

Figure 2.2: Batch in Dryer

In flat bed dryer, the air flow vertically from below in order to dry paddy while for inclined bed dryer, the air also flow vertically but because of the inclined shape of the dryer, the area for paddy drying is more wider than the flat bed dryer. As for the circular bin dryer, the air flow from bottom to upper but when it enter the bin, the air will flow horizontally toward paddy that surround it.