A SMALL SCALE AUTOMATIC WATER SYSTEM FOR BOILER

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A SMALL SCALE AUTOMATIC WATER SYSTEM FOR BOILER

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“In the name of ALLAH the Most Gracious, the Compassionate Merciful”

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ABSTRACT

Currently, for electrical generation purposes, the process of filling water into the boiler tank is done manually. Hence, the operator will manually turn on or off the water pump according to the water level meter. The disadvantage of this operation is that if the operator is not alert to the level of the water the side effect will occur. Thus, the empty boiler tank can cause an explosion of the boiler tank due to high pressured produced by the overheating process. Besides, to change the existing boiler into a new one will result in time consuming as well as the cost. Thus, a small scale boiler with automatic water system is designed in order to increase the efficiency of the existing boiler system and reduce human error. Therefore, an external automatic water level control is developed to control the flowing process of water into the boiler. Review on the theory of boiler and water level control system were done in order to get the theoritical about the control circuit, component in the circuit, sensor, boiler type,operation and design. The development of the project was divided into software and hardware development. Circuit for the water level control were design using porteus software, PIC 16F877A were used as the microcontroller. The microcontroller than been program using Micro C programming software. Mechanical float switch and proximity capacitive sensor are selected as the input of the system. This two sensor will trigger 5V when it detects the low or high level of the water in the boiler tank, from the voltage that been triggered the microcontroller will turn on or off the pup depending on the level of the water. For mechanical software implementation the drawing of the boiler was designed using CATIA software. From the electrical and mechanical design the the hardware being fabricated. The both part than being integrated together. Troubleshoot work is done in order to detect the problem that occur from the integrating process.

ABSTRAK

Pada kebiasaannya, bagi tujuan penjanaan tenaga elektrik, proses mengisi air ke dalam tangki dandang dilakukan secara manual. Oleh itu, petugas akan menghidupkan atau mematikan pam air mengikut paras air yang di paprkan pada meter penentu paras. Kelemahan operasi ini adalah jika petugas yang ditugaskan tidak peka kepada tahap air kesan sampingan akan berlaku. Oleh kerana tangki dandang yang kosong boleh menyebabkan letupan pada tangki dandang disebabkan tekanan tinggi yang dihasilkan oleh proses pemanasan melampau. Selain itu, untuk menukar dandang yang sedia ada kepada yang baru akan memakan masa serta kos. Oleh itu, model dandang dengan sistem air automatik direka untuk meningkatkan kecekapan sistem dandang yang sedia ada dan mengurangkan kesilapan manusia. Oleh itu, kawalan paras air luaran automatik dibangunkan untuk mengawal proses yang mengalir air ke dalam dandang. Kajian mengenai teori dandang dan sistem kawalan paras air telah dilakukan untuk mendapatkan teori mengenai litar kawalan, komponen dalam litar, sensor, jenis dandang, operasi dan reka bentuk dandang. Pembangunan projek ini telah dibahagikan kepada beberapa bahagian iaitu perisian dan pembangunan perkakasan. Litar bagi kawalan paras air direka bentuk dengan menggunakan perisian porteus, PIC 16F877A dipilih sebagai litarkawalan bersepadu. Litarkawalan bersepadu diprogramkan menggunakan perisian pengaturcaraan C. Suis apungan jenis mekanikal dan pengesan kehampiran bermuatan dipilih sebagai input kepada sistem. Kedua-dua sensor ini akan mencetuskan 5V apabila mengesan tahap air yang rendah atau tinggi di dalam tangki dandang. Daripada voltan yang telah dicetuskan litarkawalan bersepadu akan menghidupkan atau mematikan pam air bergantung kepada paras air. Model dandang kecil telah direkabentuk menggunakan perisian CATIA. Model bagi projek di buat bedasarkan rekaan yang telah disiapkan. Bahagian mekanikal dan elektrikal kemudian digabungkan dan kerja-kerja mengesan kerosakkan dilakukan jika masalah berlaku.

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LIST OF ABBREVIATIONS / NOTATIONS / GLOSSARY OF TERMS

FPSI	Felda Palm Oil Industries
IEEE	Institute of Electrical and Electronics Engineers
Btu/hr	British thermal unit
Psi	Pound-force per square inch
Gpa	Giga Pascal
PIC	Programmable Logic Controller
°C	Degree of Celsius (temperature unit)
PID	Proportional Integral Deferential
SSR	Solid State Relay
Dc/dc	Direct current
LED	Light Emitting Diode
V	Volt (voltage unit)
Cm	Centimeter
Ω	Ohm (resistor value)
PIC	Programmable Integrated Circuit
ADC	Analog Digital Converter

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CHAPTER 1

INTRODUCTION

1.1 Research Background

This project is about an automatic water system for boiler tank. Many of the factories such as FPSI (Felda Palm Oil Industries) generate their own electrical power using steam turbine. One important part of generating electrical power is a boiler. The boiler will heat up the water in order to produce steam and pressure to be functioning as a prime mover of the turbine engine. During this process, the water in the boiler tank will be decreased and it is dangerous if the water in the tank becomes empty its can became seriously dangerous [1]. For a new boiler system the process of refilling water is being done automatically. This is because some of the new type of boiler has already developed with control system such as using Proportional Integral Derivative (PID) control system for controlling the process of generating heat and pressure for the kind of application such as generating electrical power [2].

However, for certain types of boiler are still using the manual operation for controlling the level of water in the boiler tank. Usually for the manual operation of water control operation, an in charged persons need to be in charge of filling the water into the boiler tank. The level of the water in a boiler tank will be shown on the water level indicator. This in charged persons will on the water pump if the water level is at the minimum conditions according the water level gauge indicator and when the level of water is at maximum level, this in charged persons will stop the water pump manually. This process will be repeated until the operation of the boiler is being stop. To build a new boiler, it will related to the time

consuming and high cost. Therefore, by attaching this external water level system to the water level gauge indicator, the problem can be solved.

1.2 Problem Statement

At FPSI Chalok Barat the process of filling water into the boiler tank is done manually. The operator will manually turn on or off the water pump according to the water level meter. The disadvantage of this operation is that if the operator is not alert to the level of the water the side effect will occur. Hence the empty boiler tank can cause an explosion of the boiler tank due to high pressured produced from the overheating process [3]. In addition to build a new boiler tank, it will take time and high cost.

1.3 Objectives of Project

The main objectives of this project are:

i. To develop an external automatic water level control for boiler tank water level.
ii. To increase the efficiency of the old version boiler system and reduce human error.

1.4 Scope of Project

In order to complete this project, the process is divided into two scopes which is designing small scale boiler and designing automatic water level control for the small scale boiler.

1.5 Layout of the Project

This report will consist of five chapters. Chapter 2 will briefly describe about the literature review which in this part this research about boiler and the water level system will be explained briefly. On the boiler part the literature review will be done part by part its will cover on the definition of the boiler, the type of boiler, the application of the boiler, material of boiler and about its control system. For the control system of the small scale boiler type of control system that's being use also will be explain on this. All of the sources for this chapter are being referred to journal in Institute of Electrical and Electronics Engineers (IEEE) and other website. Reference from book also been taken in order to retain information for this part.

This report will continue with Chapter 3 where in this chapter, the methodology on the research and project development will be discussed on this chapter. For showing the methodology of each part, flow chart was used in order to show how the process of problem solving.

Lastly, Chapter 4 will explain more on the results and discussion, while in Chapter 5 will explained on the conclusion and recommendation.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review about boiler which includes the definition of the boiler, type of the boiler, boiler application and material for boiler is being done in this chapter. For the electrical part a research on the boiler control system and a water level control system also was included in this chapter. In order to gain the information a study on the previous research and other source such as the internet and book are being done.

2.2 Definitions of Boiler

A boiler is defined as a closed vessel in which water or other liquid is heated, steam or vapor is generated, steam is superheated, or any combination thereof, under pressure or vacuum, for use external to itself, by the direct application of energy from the combustion of fuels, from electricity or nuclear energy. Also included are fired units for heating or vaporizing liquids other than water where these units are separate from processing systems and are complete within them. This definition includes water heaters that exceed 200,000 Btu/hr heat inputs, 200 degrees Fahrenheit at the outlet, or 120 gallons nominal water containing capacity [2].

A boiler is an encased vessel that provides a means for combustion heat to be transferred into water until it becomes heated water or a steam. The steam or hot water is then usable for transferring the heat to a process. When water is boiled into steam its volume

increases about 1,600 times, producing a force that is almost as explosive as gun powder. This is very good and efficient means for transferring heat for a process but it can also be extremely dangerous [3].

2.3 Type of Boiler

The boiler can be classified into two types either high or low pressure boiler. Commonly for high pressure boiler the operating pressure is between 300 pounds per square inch (psi) and 800 psi. Meanwhile for low pressure boiler the operating pressure is below than 300 psi [4]. Figure 2.1 shows the example of low pressure boiler and Figure 2.2 shows the example of high pressure boiler.

Figure 2.1: Low pressure boiler [5]

Figure 2.2: High pressure boiler [6]

2.4 Configuration of Boiler

There are many types of boiler configuration but the command type of boiler configuration that widely used is fire tube and water tube boiler.

2.4.1 Fire Tube Boiler

In this type of boiler, hot gas will flow through tube and boiler feed water in the shell converted into steam. Commonly for a steam capacity of small and low moderate vapor pressure this type of boiler is used. For this kind of boiler its can produce steam up to 12,000 kg/hr and can produce pressure until 18 kg/cm2. Oil, gas or solid fuel can be used for this boiler type [7]. Hence, Figure 2.3 shows the fire tube boiler.

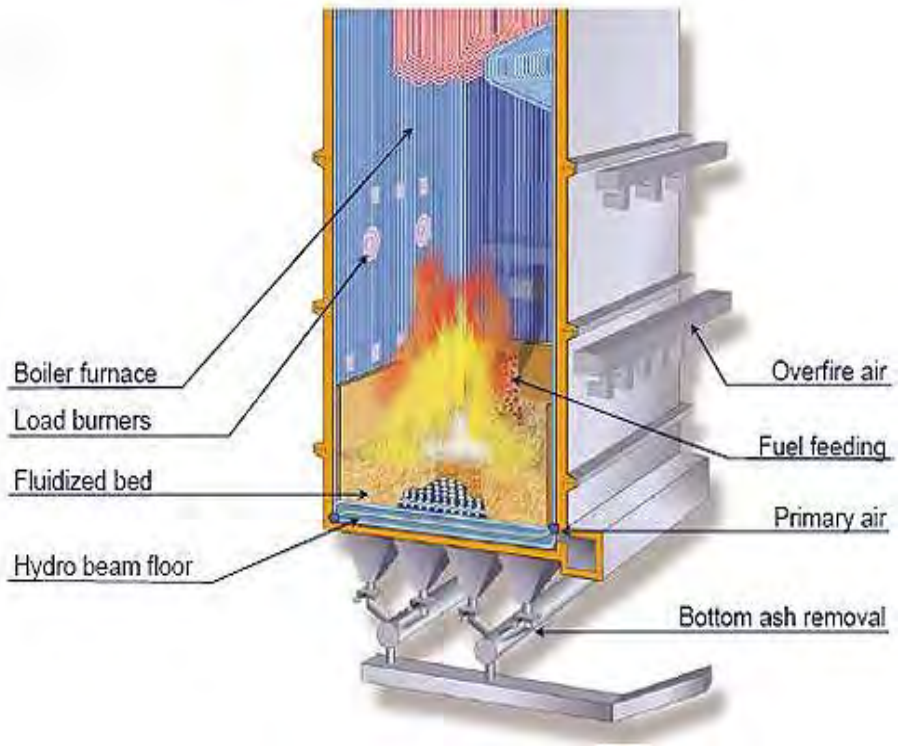

Figure 2.3: Fire tube boiler [7]

2.4.2 Water Tube Boiler

In this type of boiler, the boiler feed water will flows into the boiler drum from the tubes which it flow through the tubes to enter the boiler drum. Using combustion gases the circulated water will be heated and then at the vapor space in the drum the water will be converted into steam. For this type of boiler at high pressure it can produce 4500 until 120000 kg/hour steam [8]. Figure 2.4 shows the example of water tube boiler.

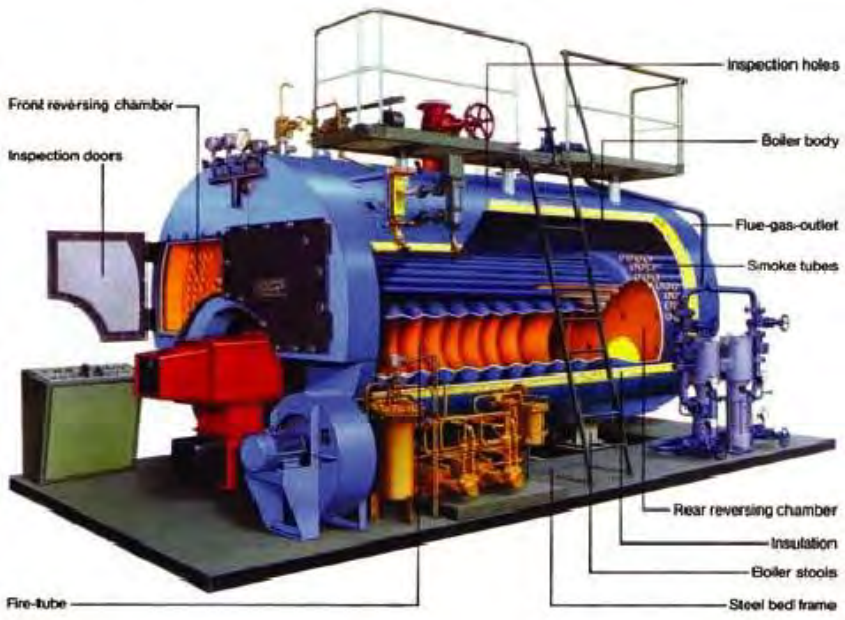

Figure 2.4: Water tube boiler [8]

2.5 Boiler Tank Material

To build a boiler, suitable material for boiler need to be chosen correctly. For selecting material there are several factor needs to be selected properly. Usually for building a boiler, type of material that's been used is Plain carbon steel (stainless steel) is being used because its cafeteria such as this type of material can withstand temperature until 1000°c. For the strength, this material also can hold until 170 Giga Pascal (Gpa) for the pressure. For the other criteria is this type of boiler is do not oxide and had high duality [9]. Figure 2.5 shows the example of plain carbon steel.

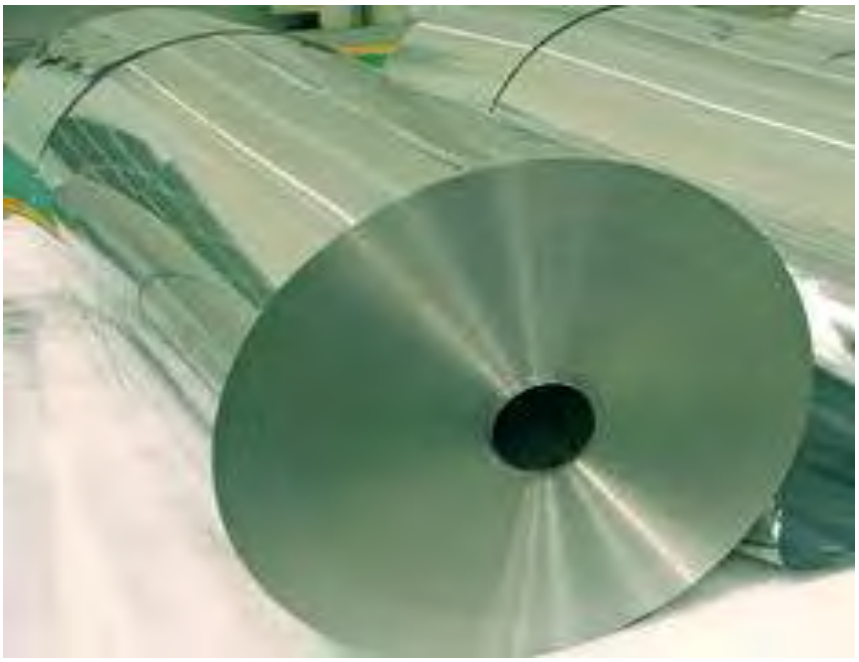

Figure 2.5: Plain carbon steel (stainless steel) [10]

2.6 Boiler Concept Application

Commonly people just knew that boiler just use for industrial application. The concept of boiler is to boil water and produce steam that will produce pressure [3]. These mean that water heater also use the concept of boiler. One of another boiler concept application is in Small-scale mushroom cultivation [8]. In an article about small-scale mushroom cultivation, it states that a single grain kernel may contain thousands of bacteria, fungi and actinomycetes. A heat treatment of 15 minutes at 121 °C is usually sufficient to kill all organisms [8]. Furthermore to solve this problem the best solution is by using Pressure cookers [8].The concept of producing pressure is the same concept of boiler which, pressure cookers use to boil water to produce steam. Pressure cooker usually produces pressure around 10-15 psi which same concept of low pressure boiler [4]. Figure 2.6 shows the example of pressure cookers.