Palestine Polytechnic University

College of Engineering

Department of Electrical Engineering

Industrial Automation Engineering

Home Steam-Bath Generator

Project Team

Mohammed Aramin **Bilal Basher**

Mu'ath Al-Skakiyya

Supervisor

A.Nizar Amro

Submitted To College Of Engineering

In Partial Fulfillment Of The Requirements For The

Bachelor Degree In Engineering

Hebron, May 2018

Palestine Polytechnic University

College of Engineering

Electrical Engineering Department

Hebron – Palestine

Home Steam-Bath Generator

Project Team

Mohammed Aramin **Bilal Basher**

Mu'ath Al-Skakiyya

Submitted To College Of Engineering

In Partial Fulfillment Of The Requirements For The

Bachelor Degree In Engineering

Supervisor Signature

……………………….…………….

Testing Committee Signature

…………………………………. **……………………………………**

Chair of the Department Signature

……………….………………….…..

2018

اهداء

الى معلمنا وقائدنا وحبيبا وشفيعنا وقدوتنا سيدنا محمد (صلى الله عليه وسلم)

الى من رسموا بدمائهم خارطة الوطن وطرق المستقبل وهندسوا بأجسادهم معاقل العزة والكرامة والى من هم أكرم منا جميعا شهدا الوطن الحبيب.

الى الذين عشقوا الحرية التي تفوح منها رائحة الياسمين وتواروا خلف القضبان ليفسحوا لنا النور اسرانا البواسل.

الى ابي الذي لم يبخل علي يوم بشيء والى امي التي زودتنا بالحنان والمحبة أقول لهم:

أنتم وهبتونا الحياة والامل والنشأة على شغف الاطلاع والمعرفة.

الى اخوتي وزوجتي واسرتي جميعا.

الى كل من علمني حرفا أصبح سنا برقه يضيء الطريق امامي.

الى من ضاقت السطور بذكرهم فوسعتهم قلوبنا أصدقائنا الاعزاء.

الى كل من اضاء بعلمه عقل غيره، او هدى بالجواب الصحيح حيرة سائليه، فاظهر بسماحته تواضع العلماء وبراحبته سماح العارفين.

الى من رسم معنا خطوات هذا النجاح.

الى من بذل جهده ووقته وكان لنا مرشدا وناصحا واخا مشرفنا الحبيب الأستاذ نزار عمرو.

الملخص

" تصميم مولد بخار منزلي "

الملخص :

يعتبر الحمام البخاري الذي كان واحد من الابتكارات الاناضولية من العصور القديمة وهو أحد العادات التي يمارسها الناس قديما وحديثا، فالناس اعتادوا على الذهاب لتلك الحمامات للحصول على بعض الراحة من الحياة اليومية.

لكن يوجد صعوبة في استخدام الحمام البخاري حيث لا يمكن استخدامه الا في النوادي الرياضية وبذلك انعدام الخصوصية وانتشار الامراض بين المستخدمين وبناء على هذا لقد صممنا غرفة بخار منزلية للتغلب على هذه المشاكل والحصول على حمام بخاري بجودة عالية.

قمنا بتصميم غرفة بخار منزلية حيث استخدمنا تقنية التحكم المنطقي المبرمج (PLC) لرخص ثمنها و حتى نتمكن من التحكم في الغرفة البخارية بضبط درجة الحرارة والضغط والرطوبة بما يتناسب مع المستخدم.

Abstract

" Home Steam-Bath Generator "

It is well known that the steam bath, which has been one of the innovations of the Anatolian countries since ancient times, is one of the customs practiced by ancient and modern people, People used to go to these bathrooms to get some rest from everyday life.

But there is a difficulty in using the steam bath where it can only be used in sports clubs so lack of privacy and spread of diseases is available among users and therefore we made a design of home steam shower to overcome these problems and get a high quality steam bath.

We designed a home steam shower using programming logic control (PLC) for its cheapest price and controlling the steam room by adjusting the temperature, pressure and humidity suitable for people.

List Of Contents

Contents **Page**

Chapter Two: Home Steam-Bath Generator Stages

Chapter Three: Mechanical Components

Chapter Four: Electrical Components

List of Figures

List of Tables

List of Equation

1

Chapter One Introduction

1.1 General Background

1.2 Project Objectives

1.3 Project Description

1.4 Literature Review

1.5 Functional Block Diagram

1.6 Steam Characteristics

1.7 Steam Benefits On Human Body

1.8 Project Cost

1.9 Time structure

1.1 General Background

It is well known that the Turkish bath, which has been one of the innovations of the Anatolian countries since ancient times, is one of the customs practiced by ancient and modern people.

People are going to use a steam shower, it is the best way to get some rest of daily life, and it allows you to isolate yourself in the shower that puts out all the problems, so it is not useful only for the body but also for the soul.

Steam shower helps to get rid of a psychological state or a satisfactory condition or to renew energy, activity and increase heart rate for more than 75%, which expands the blood vessels, arteries and increase accordingly blood flow and thus the complete elimination of toxins body.

From here, it was necessary to design an automatic system that saves time, and effort to use it in house.

Home steam-bath generator it is the best solution to have a steam shower for complete privacy and high quality. We made a questionnaire for 100 people to see how the acceptance of this idea ,the results as shown in figure 1.1.

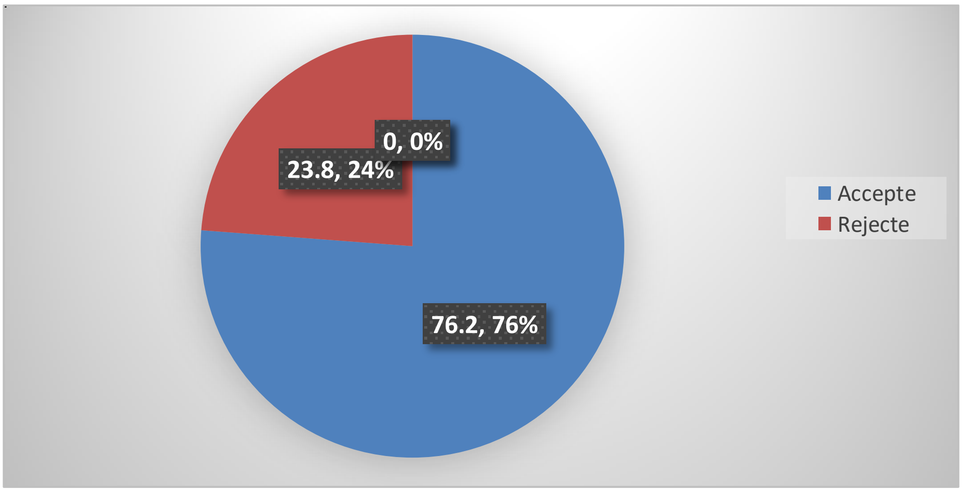

Figure 1.1: Result of a Questionnaire

1.2 Project objectives

The idea of "home steam-bath generator" Comes from the problems facing a lot of community layers, for that the project tries to achieve the following objective:

1- To save a lot of time and human effort in the Gyms.
2- The Quality and high flexibility to control the system variables as desired.
3- To have the full privacy in using the steam shower.
4- To avoid spread diseases and transmission infection between gym participants.
5- To ensure comfort and relaxing ways to old people and patients.
6- To reduce the price of the product to the consumer.

1.3 Project Description

Steam room shower as a solution for the high price in markets, and to avoid spread diseases and transmission infection between gym participants, by using a full automated system saving time, cost, effort, high quality and easy to operate from any non-specialist person.

The system contains a PLC controller, and a group of analog and digital sensors, starting from entering water into the central box, using the appropriate heaters to change water from liquid to steam and injecting steam after regulation it.

1.4 Literature Review

After reviewing the previous studies about Steam Room Shower, we found some of company design for similar Idea, as the following:

1- Mr. Steam Company

   This company design steam room generators like "Mr. Steam MS Super 6E Steam generator" but the cost of this machine is too match it reaches for about $ 7300 .

2- Steamers India Company/ India

   This company design F-65G Series Model, for showers up to 500 cubic feet constant steam.

3- Linco Beauty & Cosmetology This Company design steam generators with seating capacity up to 8 persons respectively.

1.5 Functional Block Diagram

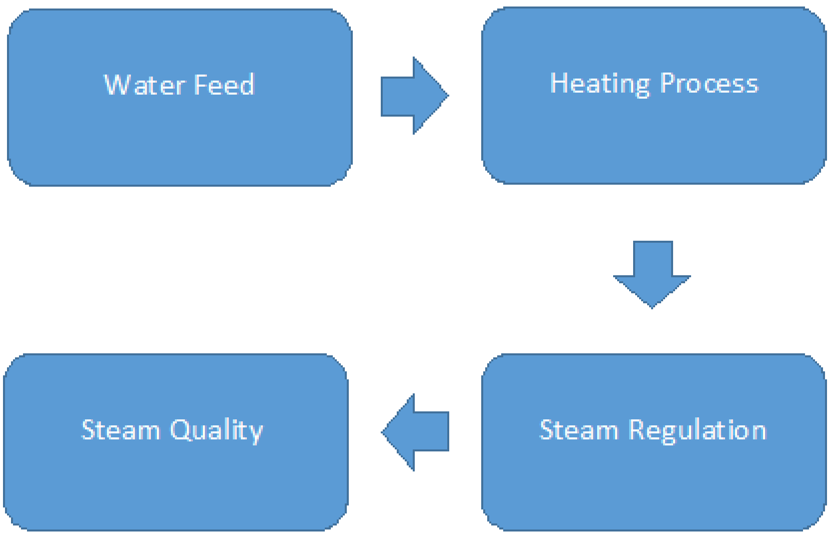

Figure 1.2: Functional Block diagram

1.6 Steam Characteristics

Water vapor has no color and what we see is only the moisture formed during evaporation due to heat exchange in the surrounding atmosphere.
At atmospheric pressure, the boiling point of water is 100 ° C and is approximately 1730 times larger. Steam properties change with pressure and temperature changes.

Saturated Steam:

When water is present in its liquid and gaseous state, its steam is called saturated steam and its temperature is boiling. In this case, the temperature of the water and steam is constant regardless of the amount of heat or heat energy entered under pressure. For example, at sea level, the boiling point of water is 100 ° C and the water temperature remains constant during boiling (although heatedly supplied from the outside) until the entire water turns into steam, then the heat input increases the heat of the steam. During boiling, the water molecules store the heat inside it as latent heat and part of the heat gives it energy to make it escape the liquid and become steamy. Saturated steam has large industrial applications and can be treated as a real gas from thermodynamic direction.

1.7 Steam Benefits on Human Body

There are many benefits of steam on human body and skin as follows:

1. Improve mental abilities, as it helps to expand blood vessels in the brain, thus allowing more blood to flow in them to feed the brain cells.
2. Treatment of some cases of coronary artery disease.
3. Relieve tension and stress and achieve as much relaxation as possible.
4. Exfoliating toxins that cause cancer outside the body.
5. Strengthening the immune system responsible for the most prominent defense of the human body against various diseases.
6. Relieve some respiratory diseases such as bronchitis and respiratory tracts, where the steam baths operate and open up their efficiency.

7. Stimulate blood circulation and strengthen blood throughout the human body, which reflects the vitality and activity on the face.
8. Eliminate the problems of acne pills and pimples and thus enjoy the skin healthy, young and shiny.
9. Relieve muscle and joint pain and thus relieve fatigue.

1.8 Project Cost

Table 1.1: Project Cost

No.	Description	Amount "NIS"
1.	central box	900
2.	PLC delta	1200
3.	Heaters	60
4.	Contactors and circuit breakers	200
5.	Valves	300
4.	Pipes	70
5.	Sensors and switches	400
6.	electrical control panel and wires and cables	400
	Total Price	3530

1.8 Time Structure

Table 1.2: Time Structure

Week / Tasks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Task 1	■	■														
Task 2			■	■	■	■	■	■	■	■	■	■				
Task 3			■	■	■	■	■	■	■	■						
Task 4							■	■	■	■	■	■	■	■	■	
Week / Tasks	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
Task 5	■	■														
Task 6			■	■												
Task 7					■	■	■	■	■	■	■	■	■	■	■	■
Task 8					■	■	■	■	■	■	■	■	■	■	■	■

Task 1- Project title selection.

Task 2- Collection of data and information.

Task 3- Identify function and task.

Task 4- Design and analysis.

Task 5- Determine Mistakes.

Task 6- Generate Solutions.

Task 7- Generate Alternative Designs.

Task 8- Results and Conclusion.

2

Chapter Two Home Steam-Bath Generator Stage

2.1 Introduction

2.2 Water Feed

2.3 Heating Process

2.4 Steam Regulation

2.5 Room Steam Control

2.1 Introduction

This chapter, show the general stages of home steam-bath generator. In our project show a new technology in generating steam in a full automated system programmed with a PLC, which will allow the user to control the operation of the system, the proposed system is shown in figure 2.1.

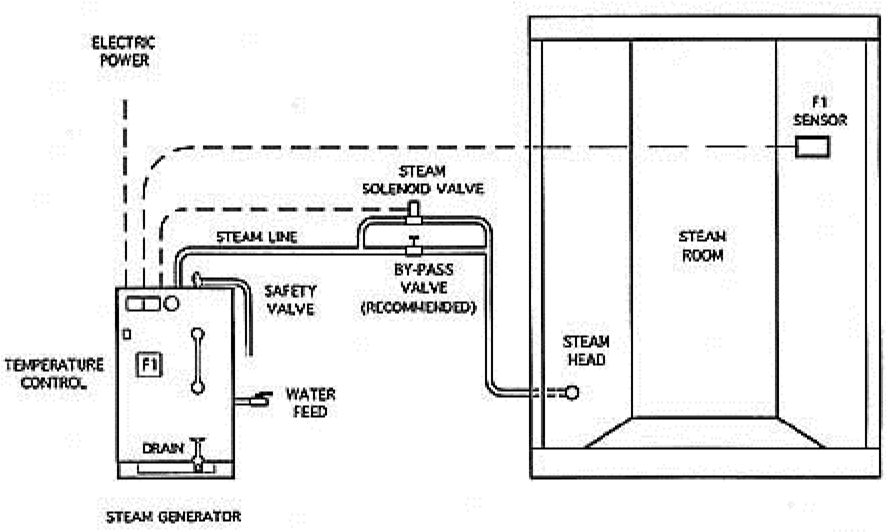

Figure 2.1: The Proposed system

In order to draw an image in our minds about how the system works and how the generated steam stages pass through it to get the final results, divide the stages of the system into four general stages, these stages are:

1) Water Feed
2) Heating Process
3) Steam regulation
4) Room Steam control

2.1 Water Feed

The feed water system is composed of the main pipe lines that supplies water to the steam generator, the system controls the feed water flow by using an electric control valve to maintain the required steam generator level, which is shown in figure 2.2.

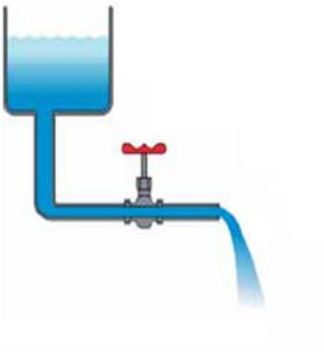

Figure 2.2: The water feed

2.3 Heating process

Heating Process is transfer the energy by use an energy source to heat water that is depends on the electrical heaters, which heats water tell reaching water boiling point (**100 °C**), where in this point the water is changed from liquid to steam, these heaters can be chosen depending on the size of the room that we want to install the steam bath in, the heating Process is shown in figure 2.3.

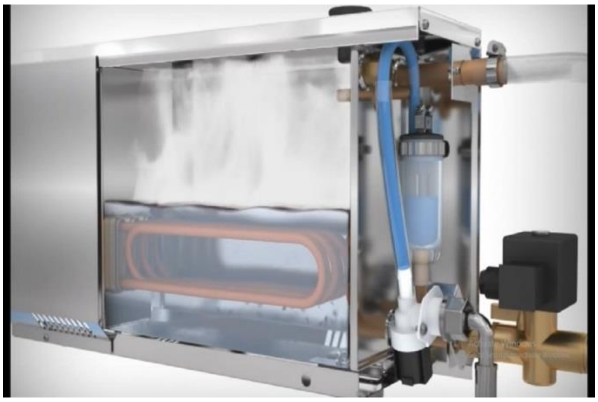

Figure 2.3: The Heating Process [1]

2.3 Steam Regulation

Controlling steam flow, when the steam inside the central box reaches delivered amount a normally closed steam valve opens to let the steam flow throw the steam pipes direct into the steam shower room, in addition to a normally closed safety valve, which is installed to the central box to open automatically when the pressure inside it reaches an unallowable amount [1]. As shown in figures 2.4, 2.5.

Figure 2.4: Steam Flow [1]

2.3 Room Steam Control

Controlling the quality of the steam in the room to keep steam flow in an appropriate way ,by using different components such as humidity sensor, pressure sensors and temperature sensors, as going to be discussed in later chapters .

3

Chapter Three Mechanical Components

3.1 Introduction

As explained before, steam generated pass through several stages, After entering the water in the central box and reach the desired level, the heating process begin, then it will stop when it reaches the desired value of steam after that the steam passes through regulation process and injecting in the room.

Since the system used for facilitating the outputs of the generating process and in order to maintain the steam, the mechanical system parts are made of steel and glass. and in order to obtain a good and simple design a set of parameters must be considered, these parameters are related to the system itself such as: safety, portability, cost, design simplicity, availability, work space, on the other hand, the design must be able to produce efficient suitable for user related into the international standard.

3.2 Mechanical Design

In this section each block will be explained in details, the used material for most parts in this system is aluminum-zinc and stainless steel because it resistant the high pressure and temperature, also thermal glass because bear high temperature and not able to broke.

3.3.1 Central Box

This part explains the process we used for designing central box, begins with calculating dimension, taking in our consideration all the dimensions of electrical parts and the distances of the steam outlet, safety valve, water inlet, drain valve, heaters and power supply cable entrance, The following design as shown in figure 3.1.

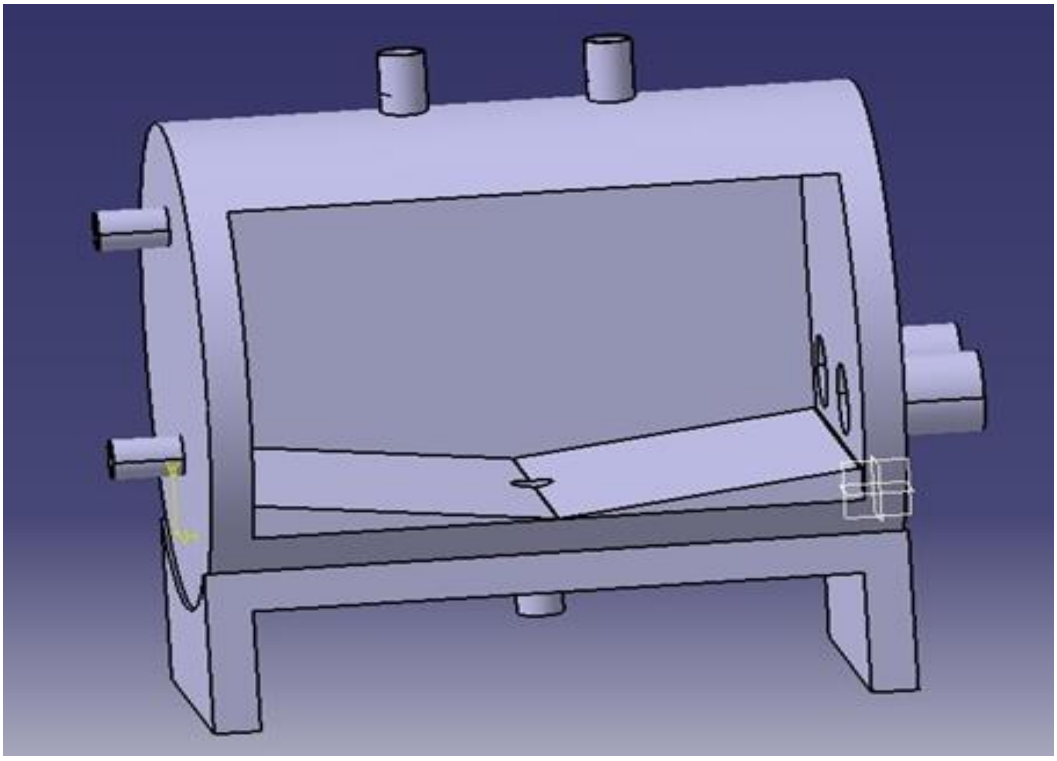

Figure 3.1: The main central box design

The dimension of the Cylinder as shown in Figure 3.2.

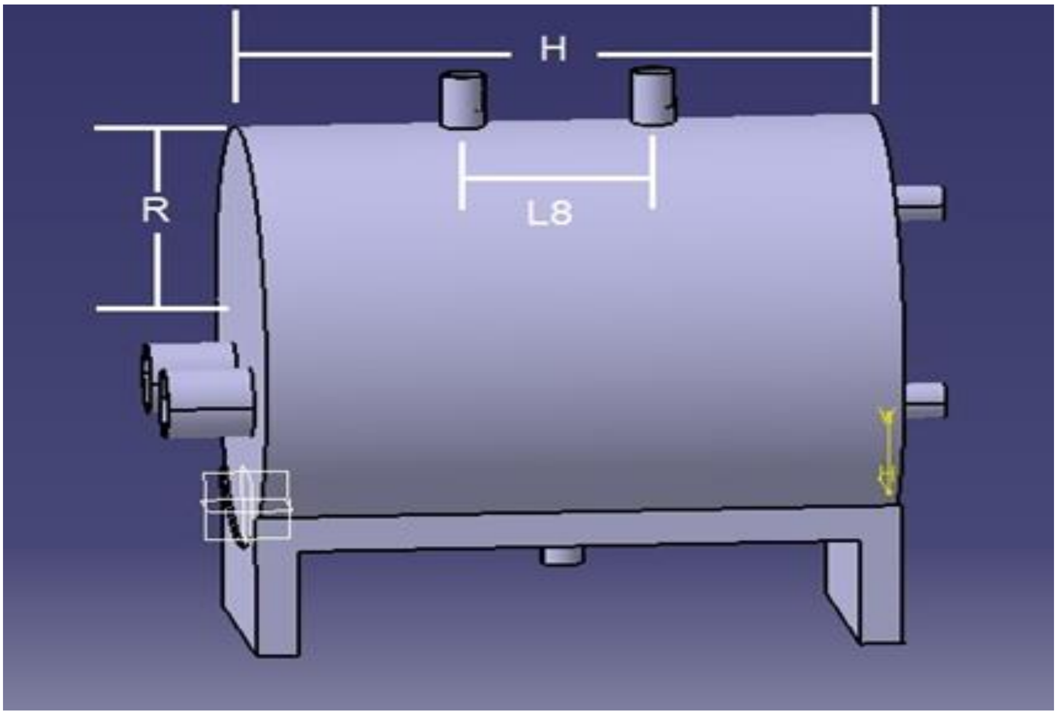

Figure 3.2: The front side of central box design

Where

H = The height in (cm).

R= The radius in (cm) .

L8= the length between safety valve and water level sensor in (cm).

We used H = 42 cm and R = 12.5 cm .

The dimension of the right side of the central box as shown in Figure 3.3.

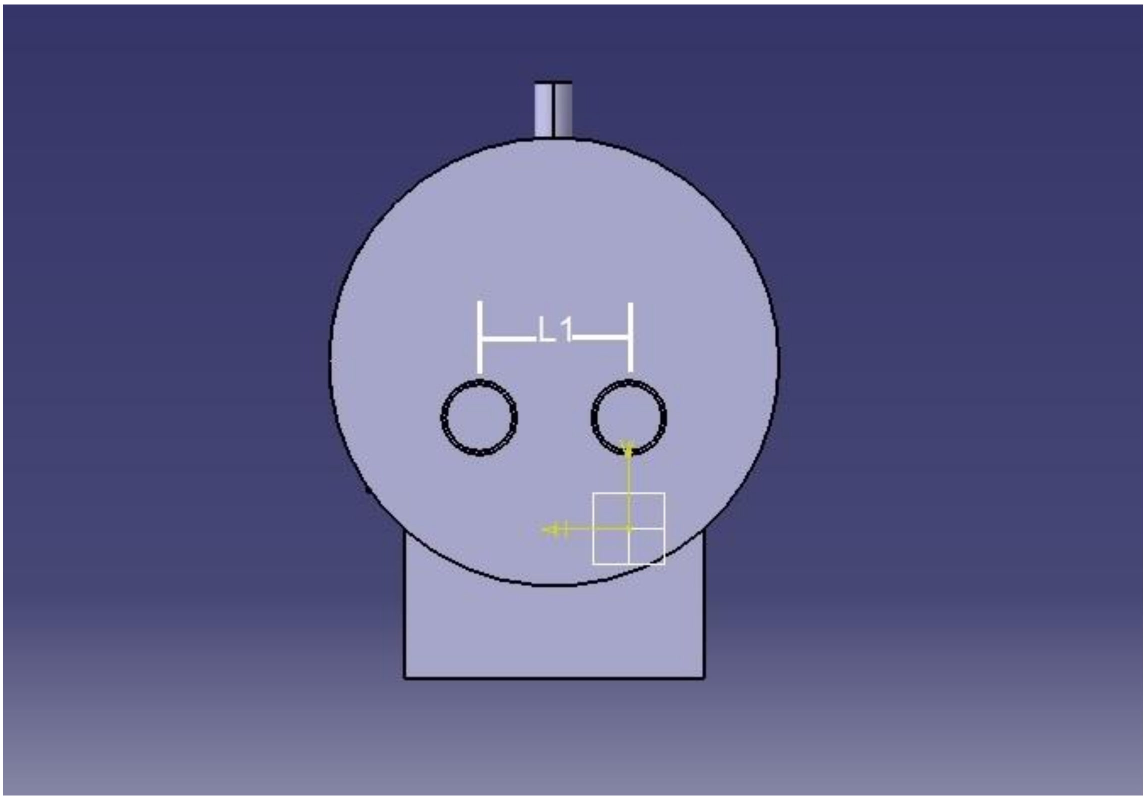

Figure 3.3: The right face of central box design

Where

L1 = the length between the two heaters in (cm).

We used L1 = 22 cm.

The dimension of the left side of the box as shown in Figure 3.4.

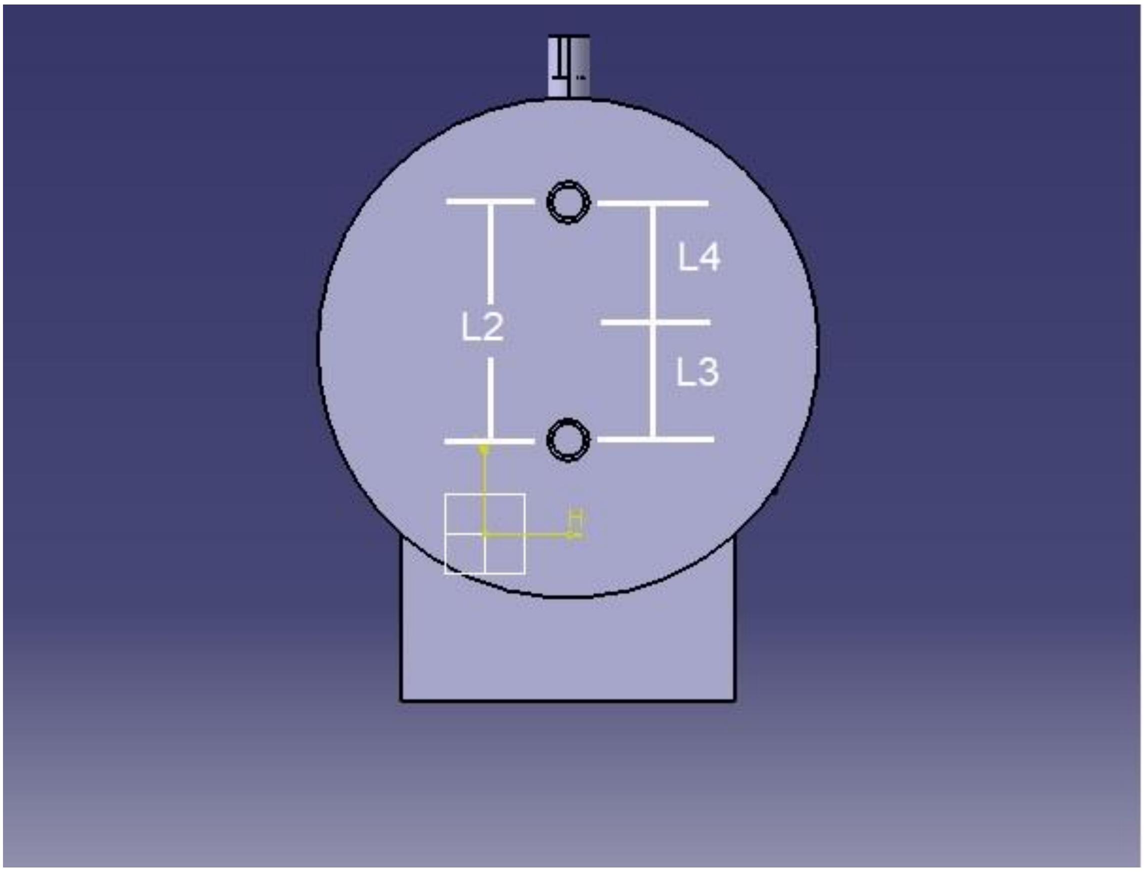

Figure 3.4: The left face of central box design

Where

L2 = the length between steam outlet and water inlet in (cm).

L3 = the length between the center of the central box and water inlet in (cm).

L4 = the length between the center of the central box and steam outlet in (cm).

We used L2 =16 cm, L3 = 8cm, L4 = 8cm.

The dimension of the bottom side of the central box as shown in Figure 3.5.

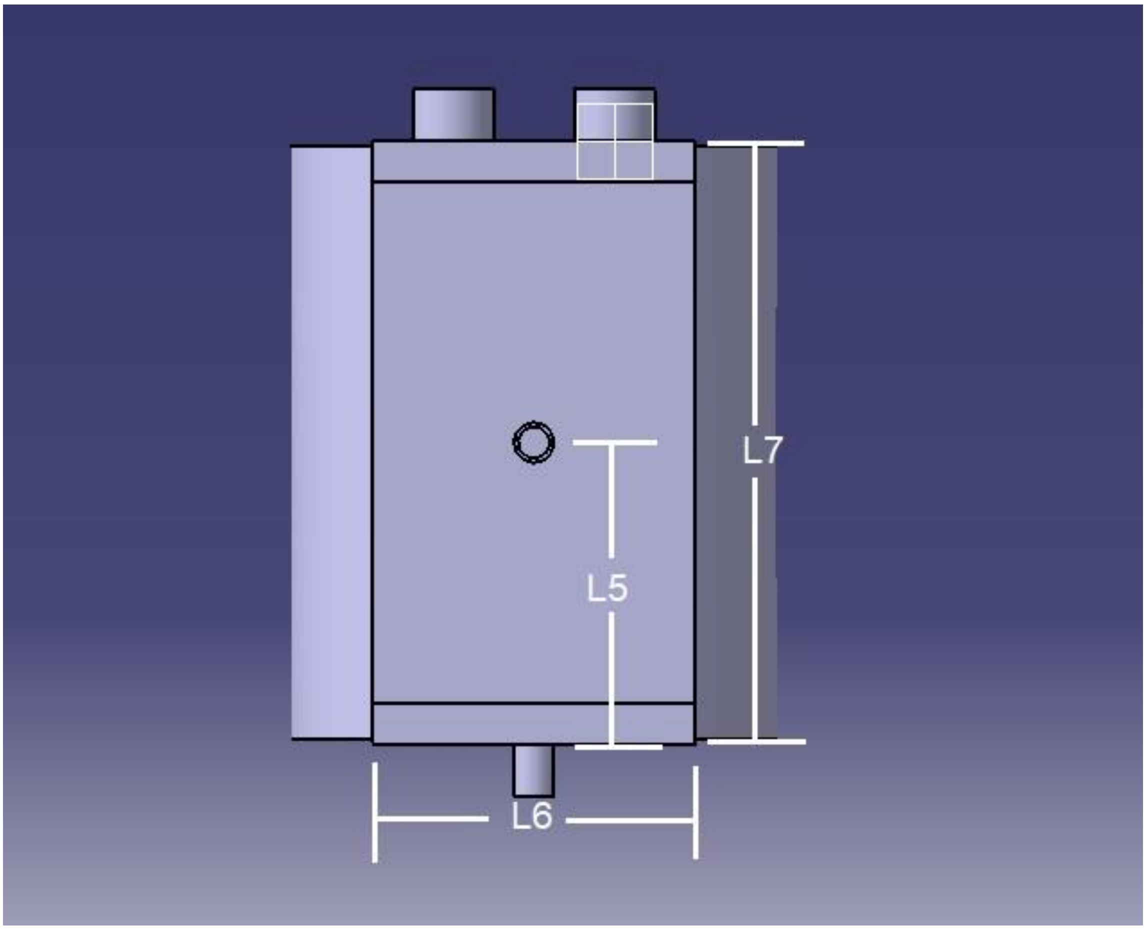

Figure 3.5: The **bottom side of the central box** design

Where

L5 = the length between drain valve and the base of the central box in (cm).

L6 = the length of the base of the central box in (cm).

L7 = the length height of the base of the central box in (cm).

We used L5 = 21 cm, L6 = 25cm, L7 = 42cm.

To calculate the volume of the water inside the box, we have to calculate the size of the cylinder minus The size of the halves of the cones.

Volume of water = Volume Of Cylinder – 2 x (Volume Of Half Cone). (3.1)

The volume of Half Cone can be expressed using the following formula :

Volume of Half Cone = 1/2 x (1/3 x π x R^2 x H) [2] (3.2)

Where

H = the height of the Cone

R = the radius of the Cone

V= 1/2 x(1/3 x 3.14 x 2^2 x 21) = 43.96 Cm3

The volume of Cuboid can be expressed using the following formula :

Volume of The Cylinder = H X R^2 X π (3.3)

Where

H = the height of The cylinder

R = the radius of the cylinder

Volume Of Cylinder =42 x 12.5^2 x 3.14 = 20606.25 Cm3

The total volume of water = 10303.125 – (2 x 43.96) = 10215.205 Cm3

Based on this result each 1cm3 = 0.001 litter .

So we need to fill the central box with about 10 litters controlled using a level sensor as we discussed in (4.5.1).

3.2.1.1 Rock Wool

Rock wool is a mineral inorganic fibrous material with excellent and distinguished properties and the quality is stable and uniform. See figure 3.6.

It is efficiently applied in all fields of thermos-acoustic insulation, furthermore it is used in many industries activities. Rock wool is produced by melting mix of basalt, limestone and coke in a special vertical furnace at very high temperature about 1500 C.

Then the molten rock is made into thin fibers through a high speed centrifugal machine. After adding certain amount of binder, dustproof oil, silicon oil and mechanical operations [4].

So in our project we want to use two layers of Rock wool to maintain heat inside central box.

Figure 3.6:Rock Wool

3.2.1.2 Sintering

In our project we designed the central box from the inside to obliterate the Sintering resulting from the heating process. When the water inside the box is emptied after each steam session, the sloping design facilitates the disposal of the existing lime by about (30-40)% Use materials to get rid of Sintering, such as white vinegar, sodium carbonate, and lemon salt, periodically every week [5] .

3.2.2 Pipes

There are different sizes of pipes we need to use in our project, based on our design to ensure the best quality.

3.2.2.1 Copper Pipes

We used copper pipes with a size of 12mm (1/2") for the steam outlet and the safety valve, because its high quality, rust and corrosion resistance, easy to handle due to flexibility.as shown in figure 3.7.

Figure 3.7: 12mm (1/2") copper pipes

3.2.2.2 Steel Pipes

Made of iron and carbon in varying proportions, depending on the purpose of their use. They are used in water and steam heating systems due to their high temperature tolerance and high pressure. (As we should know, the more carbon in the iron, the more the tube's bearing strength increases to pressure and stress).
In our design we used 18mm (3/4") steel pipes for water inlet and drain water as shown in figure 3.8.

Figure 3.8: 18mm (3/4") steel pipes

3.2.3 Steam Room

We designed a room with dimensions (110*110*210)cm to be installed properly in any home bath-room, to maintain the high efficiency and comfort zone for its users .

3.2.3.1 Thermal Glass

Glass used in double glazing window for thermal insulation is known as Low E, or low-emissivity glass. It has a transparent metallic coating that works in two ways to economies heating energy. The dual action coating reflects heat back into the room. Thermal insulation glass should be used on face 2 or 3 of a double glazing unit.

The most efficient thermal glass use a unique manufacturing process which builds up microscopic layers coating using a technology known as sputtering, under vacuum condition. This advanced process builds up a highly resistant, but it perceptively this coating which gives it a much clearer appearance then other thermal insulation glass. The coating also allows maximum daylight and heat into the room for optimized solar gain. Some products have been shown to reduce heat loss by 24% more than traditional coated thermal insulation glass, and by 40% compared to standard double glazing window. Further energy saving can be made by using warm edge ‘thermal break’ spacer bars. These can reduce heat lost round the edge of the window by to 65% [6].

3.2.3.2 Room Dimensions

In this section we want to describe the dimensions of the room for all sides, we mean the front, top, right sides. As shown in figures (3.8),(3.9),(3.10).

The top side as shown in figure 3.9.

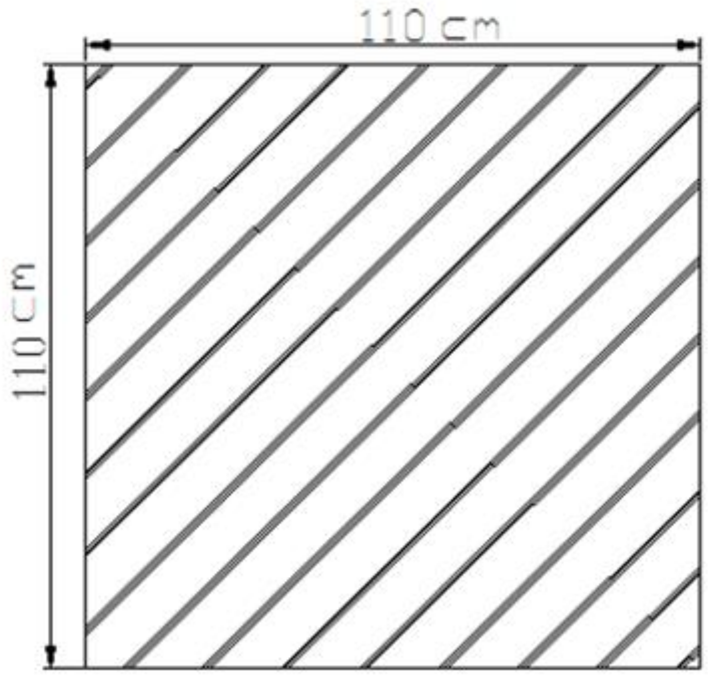

Figure 3.9:Top Side

The front side as shown in figure 3.10.

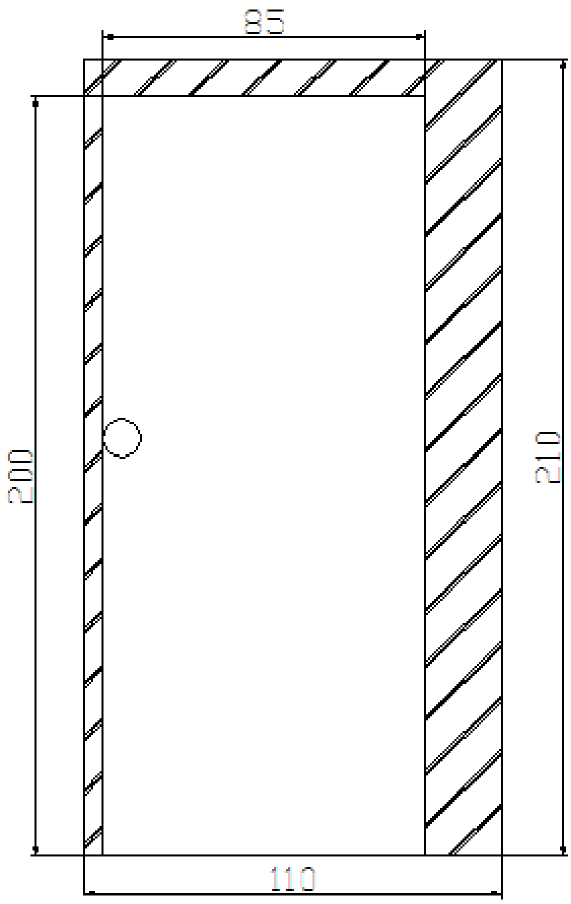

Figure 3.10: Front Side

The right side as shown in figure 3.11.

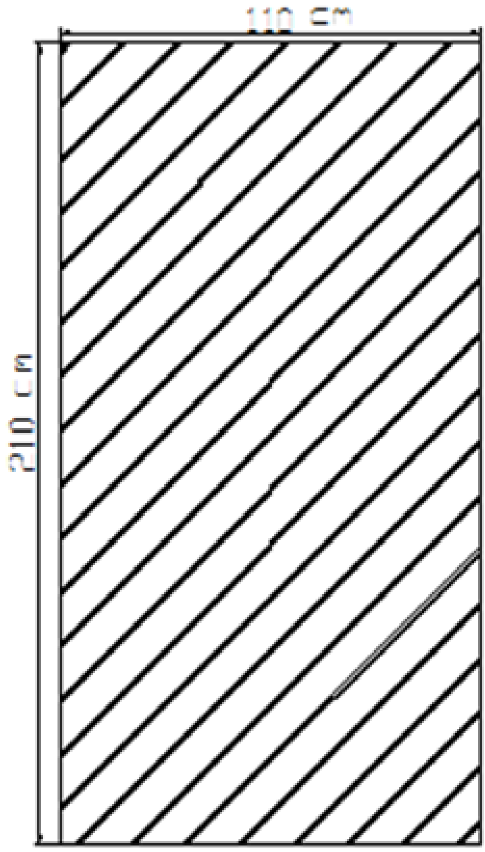

Figure 3.11: Right Side

3.3 Valves

We used a group of different types of valves to control the flow of steam , water and safety of central box .

3.3.1 Water Solenoid Valve

solenoid valves control critical flow of air, gas, water, oil, and steam in applications spanning numerous industries**.**

These valves are incorporated into the equipment so that the equipment can be used safely and efficiently. In our project we want to use the solenoid valve to control the input water into the central box so that we can control the level of water inside the box. The water solenoid valve as shown in figure 3.12.

Figure 3.12: The water solenoid valve

3.3.2 Steam Solenoid valve

Solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid In our project we want to use the steam solenoid valve to control the input steam into the rom so that we can control the amount of steam inside the box The steam solenoid valve as shown in figure 3.13 [7].

Figure 3.13: The steam solenoid valve

3.3.3 Drain ball valve

This valve used to dispose of sediment and rust manually as a result of heating from inside the central box, this process happen when the system turned off at the end of day, this valve as shown as in the figure 3.14.

Figure 3.14: The drain ball valve

3.3.4 Regulation valve

A pressure regulator is a control valve that reduces the input pressure of a fluid to a desired value at its output. Regulators are used for gases and liquids,we use it to control the pressur of steam, when the pressur reasched (0.5bar) this valve will open or increased over (0.5bar) also open, the valve as shown in figure 3.15.

Figure 3.15: The regulation valve

3.3.5 Safety valve

The function of the safety valve is to prevent the increase of steam pressure in

The central box a above its design pressure. When the pressure increases above design pressure, the valve opens and discharges the steam to the atmosphere. When this pressure falls just below design pressure, the valve closes automatically. Usually the valve is spring controlled. The safety valve as shown in figure 3.16 [7].

Figure 3.16: The safety valve

4

Chapter Four Electrical Component

4.1 Introduction

This chapter contains the electrical component specifications (heaters, sensors, contactors, etc.), power and control circuit and PLC program, which used in our project.

4.2 Flow chart

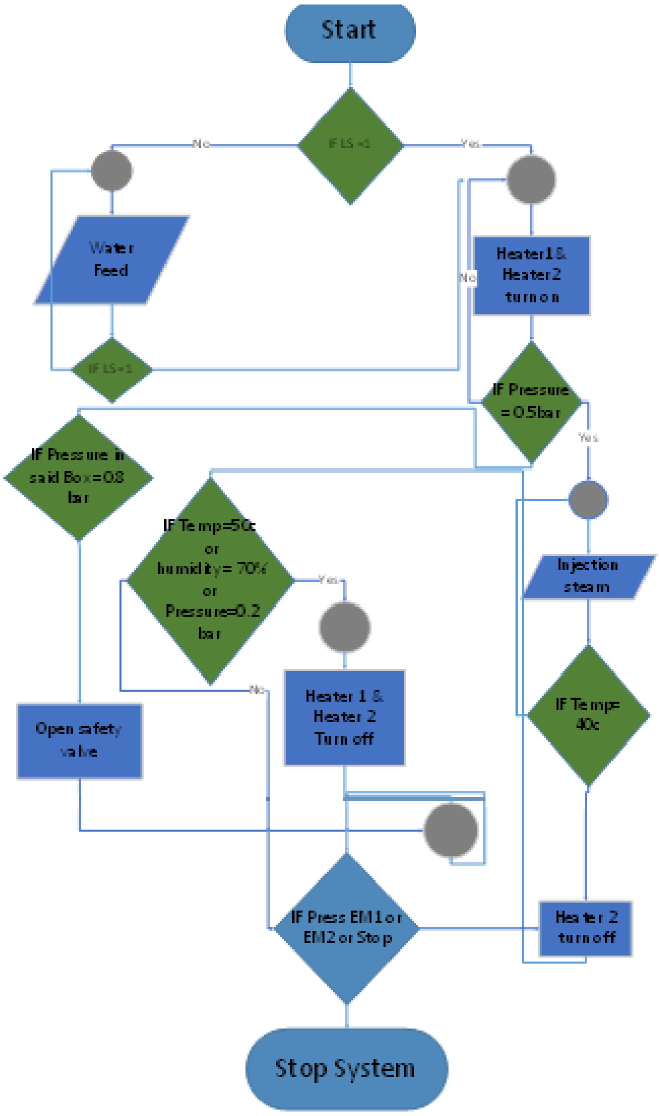

Figure 4.1: Flow Chart

4.3 Control Module

We use the programmable logic controller (PLC) in our project to control the system because the PLC is having several advantages for example the Flexibility: the program can be easily modified without resorting to changing connections, whether in input or output, the exact location of the errors can be determined and therefore an adjustment can be made to the program so that the performance of the machine continues to normal until the fault is repaired and The best advantage is the ability to control temperature at high accuracy and not affected by humidity and high temperature.

4.3.1 Programmable Logic Controller

The way many industrial processes look today, is the result of many year of research and hard work of people committed to improve their functionality, management and organization. One could recall the phrase "necessity is the mother" and certainly, this would fit the everyday work of control engineers and technicians working in industrial processes during the 50's and 60's. This necessity was the origin of devises such as the programmable logic controller (PLC).

A programmable logic controller (PLC) is an industrially hardened computer based unit performs discrete or continuous control functions in a variety of processing plant and factory environments. It was originally intended as relay replacement equipment for the automotive industry. Nowadays the PLC is used in virtually every industry imaginable. Though they were commonly referred to as PCs before 1980, PLC become the accepted abbreviation for Programmable Logic Controllers, as term "PC" become synonymous with personal computers in recent decades.

Figure 4.2: Programmable Logic Controllers-Delta Group

4.3.2 Working principle

When pressed on the normally open push button (**Sstart**), the solenoid water valve (**Y**1) opens starting to fill the central box of water, When the water level inside the central box reached a desired amount depending on the water level sensor (**LS**) the valve (**Y1**) will be closed immediately , in the same time heaters (**H1** and **H2**) turned on by(**K1=1** and **K2=1**) to start heating the water and the steam solenoid valve **(Y2**) opens to allow injection the steam in the room. , while the water is boiling ,and when the water level decreased inside the central box than the allowed amount , water solenoid valve **(Y1**) opens again to refill the reduced water.

When the one of temperature sensors **(TS1)** or **(TS2)** indicates that the temperature inside the room reached **(40 °C)** the heater **(H2)** turned off, while the temperature rising at **(50),** or the value of the pressure sensor (**PS**) increased to (**3 psi**) ,or the humidity inside the room increased to (70**%**) the two heaters (**H1,H2**) turned off immediately.

When pressed on the normally closed push button (**Sstop**), or when something wrong happened in the system by pressing one of the normally closed emergency switches internally (**EM1**) or externally **(EM2)** the system turns off.

Sstart, Sstop, EM1, EM2, LS, TS, SP, HS, from Table (4.1).

K1, K2 Y1, and Y2 from Table (4.2).

Table 4.1: Input parameter

Input	Symbol	Logic allocation
Start (NO)	Sstart	Sstart=1, Operation is run
Stop (NC)	Sstop	Sstop=0.Operation stops
Internally Emergency(NC)	EM1	EM1=0. Operation stops immediately
Externally Emergency(NC)	EM2	EM2=0. Operation stops immediately
Water level sensor	LS	LS reading the value of the level of water
Temperature sensor 1	TS1	TS reading the temperature inside the room
Temperature sensor 2	TS2	TS reading the temperature inside the room
Pressure sensor	PS	PS reading the pressure value inside the room
Humidity Sensor	HS	HS reading the humidity value inside the room

Table 4.2: Output parameter

Output	Symbol	Logic allocation
Contactor 1	K1	K1=1, Heater 1 is on
Contactor 2	K2	K2=1, Heater 2 is on
Water solenoid valve	Y1	Y1=1 , water valve open
Steam solenoid valve	Y2	Y2=1,Steam valve open

4.3.3 Power circuit

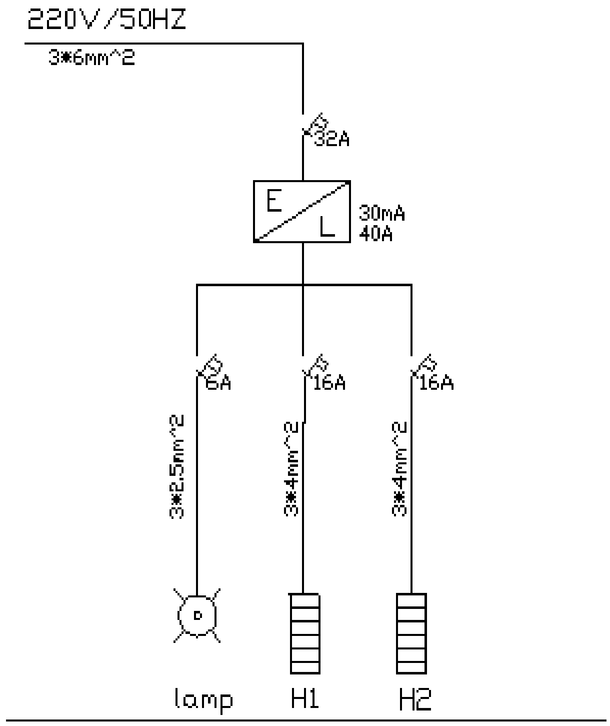

Figure 4.3: Power Circuit

4.3.4 Control circuit

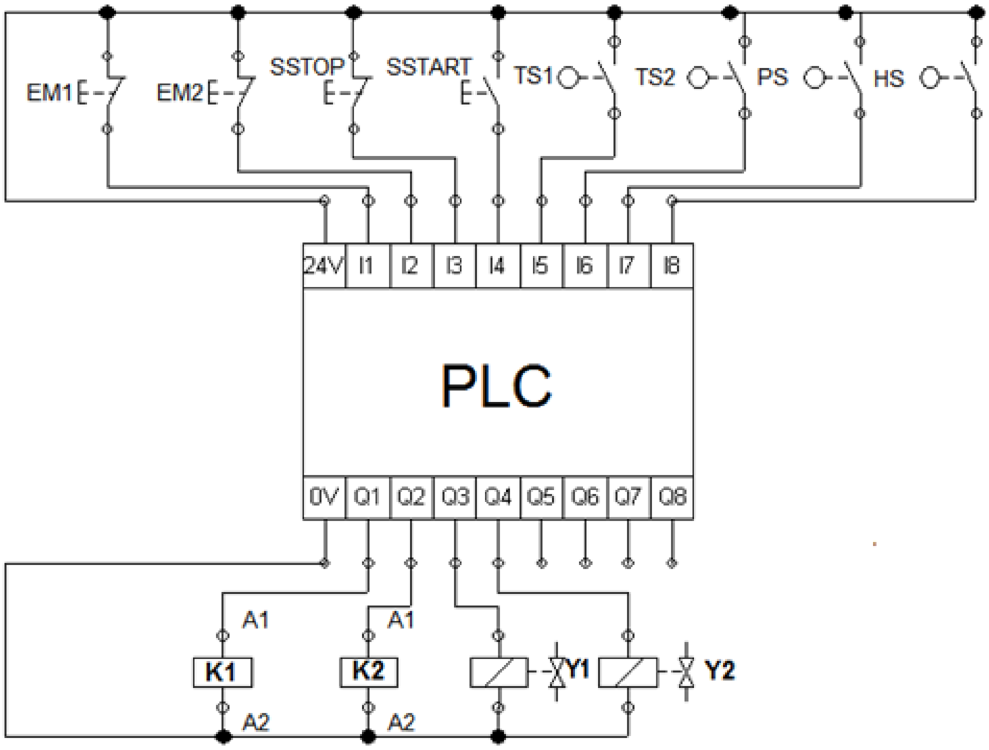

Figure 4.4: Control Circuit

4.3.5 State graph

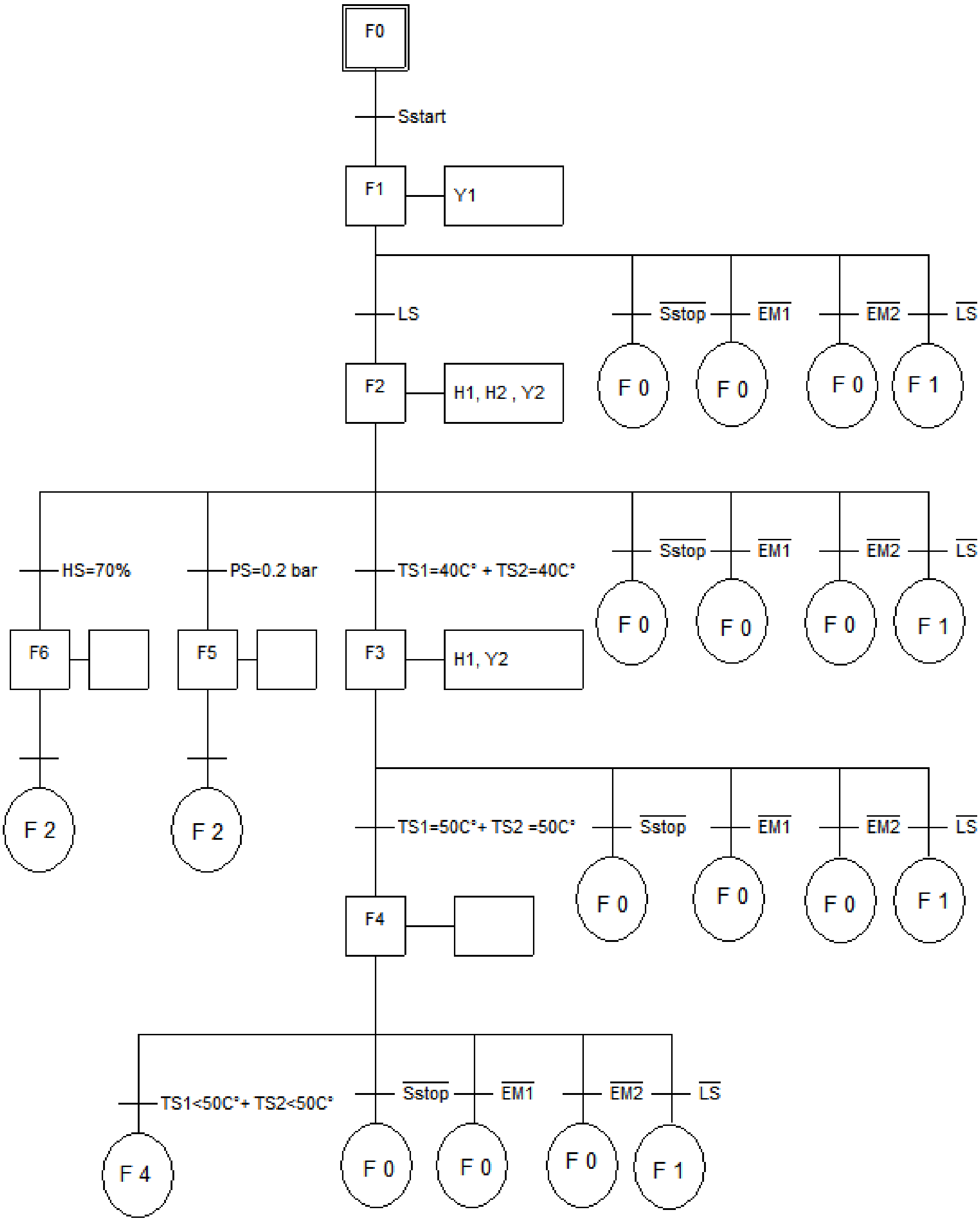

Figure 4.5: State Graph

4.3.6 Ladder Program

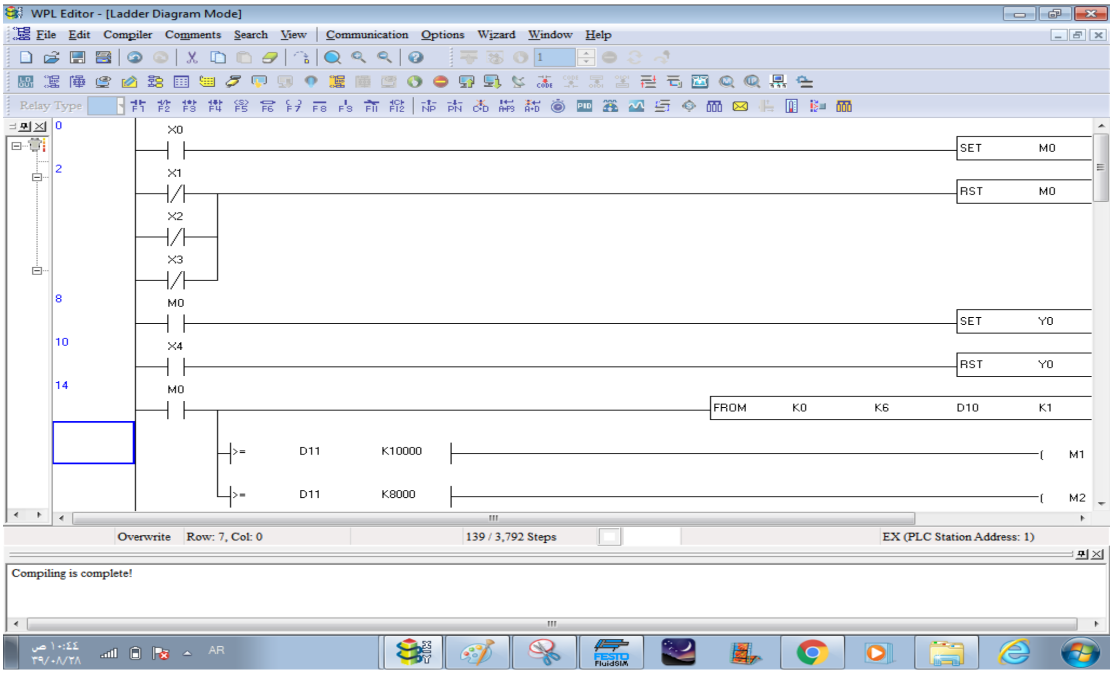

Figure 4.6.a: Ladder Program

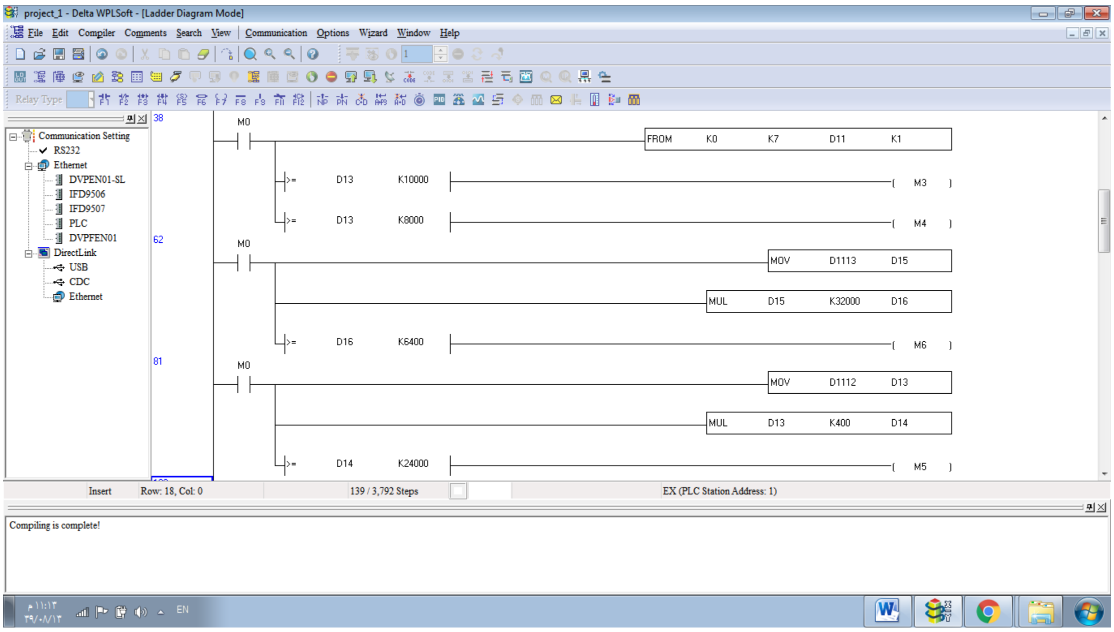

Figure 4.6.b: Ladder Program

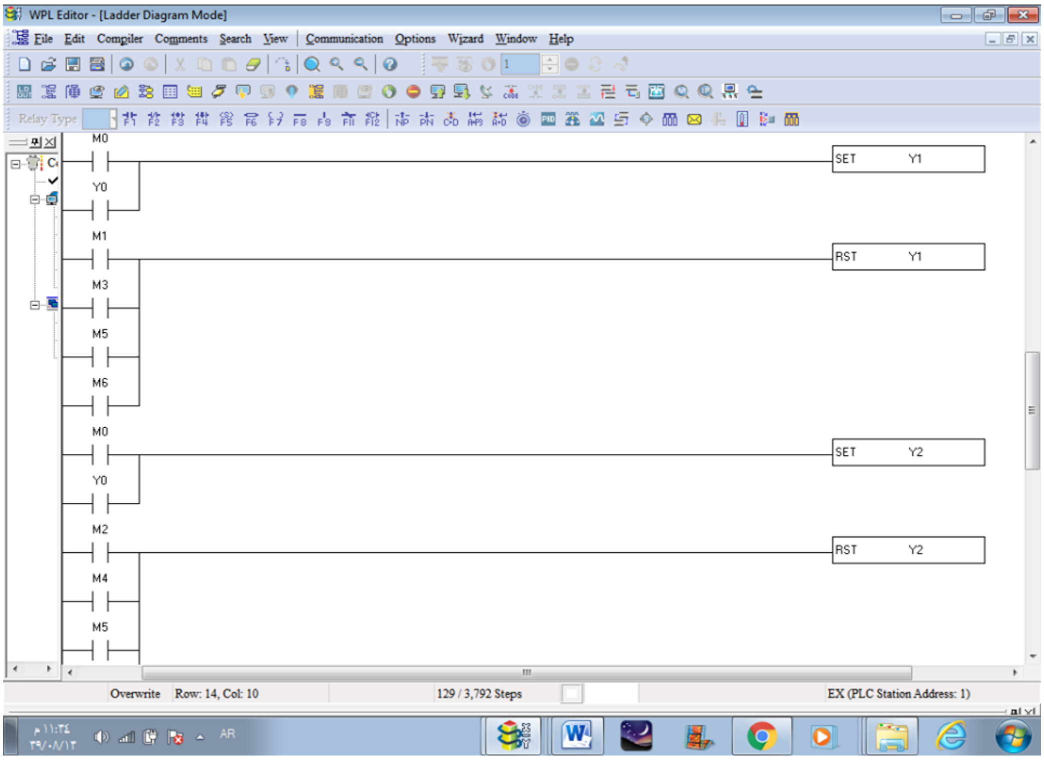

Figure 4.6.c: Ladder Program

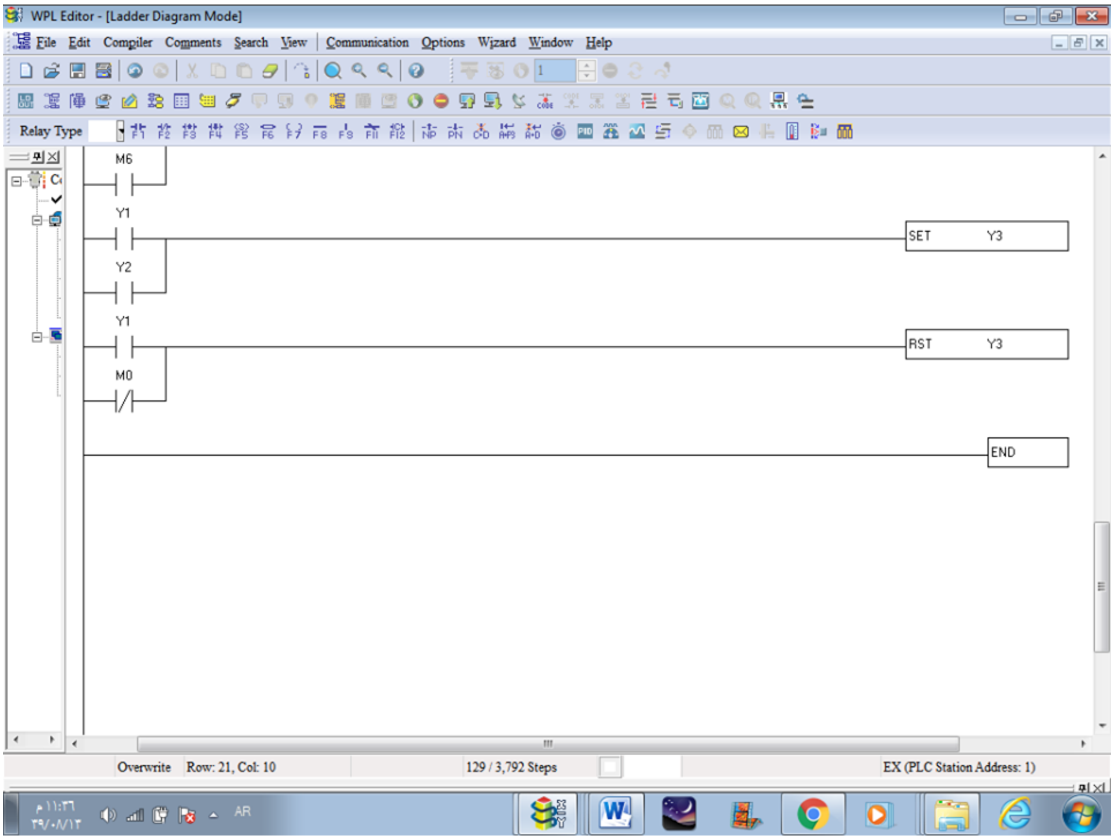

Figure 4.6.d: Ladder Program

4.4 Heater

We are used tow Ac heaters to get the required heating.

The heater is shown in the figure 4.7.

Figure 4.7: Heater

4.4.1 Heater Principle

The electric heater transforms the electric energy to thermal energy, which is used to heat the water. The electric current is applied to a heat conductive material, which is highly resistant to electricity. The electrons in the material shock with the particles of the material. The collision results in thermal energy reflected on the molecules of the material. This temperature is transmitted to water through the load currents. When the required water temperature is reached, the power is automatically disconnected from the heating coil [8].

4.4.2 Heater calculations

The following formula is used to calculate the power of heating element needed to heat a specific volume of water by a given temperature rise in 1 hour.

Heating in kW = V x 4 x T / 3412 [9] **(4.1)**

4: being a factor.

3412: being a given constant.

V: **volume in litters.**

T: **temperature rise in degrees centigrade.**

For our project we want a water volume equal to 10 litters based on our design, to be heated from 25º**C** to 100º**C** , giving a temperature rise of 75º**C** ,Would Give:

Heating in kW = 10 **x** 4 **x 75** /3412 = 0.87 kW per 1 hour

So that in the result we got to use 0.87 kW Heater to increase water temperature from 25º**C to** 100º**C in 1 our but,** we can use this information to heat the same water volume to about 1/4 of the time (12 minutes) , by using

Heating power = 0.87 **x 5 =4.5 kW**

In our design, we used two heaters the first is heater with 2.5kWand the second with 2 kW.

4.5 Sensors

The sensors used to detect the physical peripheral state. It do many task where it transmits signals falling on it to electrical pulses can be measured or counted by a device. This allows us to know the intensity of the effect. There are also types that can be linked to controller, and through programming, it is possible to create a picture of the distribution of measurements, we have four sensors in our project.

4.5.1 Capacitance Level sensor

We select in our project the capacitance level sensor because it operates on the basic principles of the variance of the electrical capacity of a capacitor formed by the sensor the vessel wall and the dielectric material. A capacitor is made of tow conductive plates, which are isolated from each other by dielectric, so we use this sensor to measure the deep of water inside the central box as shown in the figure 4.8[10].

Figure 4.8: Capacitance Level Sensor

4.5.2 Thermocouple Temperature Sensor

This temperature sensor type consists of two wires of different metals connected at two points. The varying voltage between these two points reflects proportional changes in temperature. Thermocouples are non-linear, requiring conversion when used for temperature control and compensation However; they operate across the widest temperature range, from (-40 to 120) °C, and the cable range from (-10 to 95)°C so we need this type to measure the temperature inside the room as shown in the figure 4.9.

Figure 4.9: Thermocouple Temperature Sensor

4.5.3 Pressure Sensor

A pressure sensor is a device, which senses pressure and converts it into an analog electric signal whose magnitude depends upon the pressure applied. Since they convert pressure into an electrical signal, they are also termed as pressure transducers, so we use this sensor (Silicon Pressure Sensors) to measure the pressure inside the room with range from (0 to 1) bar, and the range of power supply from(3.3 to 5)Vdc this sensor as shown in the figure 4.10.

Figure 4.10: Pressure Sensor

4.5.4 Capacitive Humidity Sensor

The humidity sensor is a small capacitor consisting of a hygroscopic dielectric material placed between a pair of electrodes. Most capacitive sensors use a plastic or polymer as the dielectric material, we have this type SHT30 with range from (10% to 90 %)RH and the power supply rang from (2.4 to 5.5) Vdc to measure the humidity inside the room as shown in the figure 4.11.

Figure 4.11: Humidity Sensor

4.6 Circuit Breaker

A circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by excess current, typically resulting from an overload or short circuit. Its basic function is to interrupt current flow after a fault is detected. Unlike a fuse, which operates once and then must be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation. Circuit breakers are made in varying sizes, from small devices that protect low-current circuits or individual household appliance, up to large switchgear designed to protect high voltage circuits feeding an entire city. The generic function of a circuit breaker, RCD or a fuse, as an automatic means of removing power from a faulty system is often abbreviated as ADS (Automatic Disconnection of Supply).

Earth Leakage:

An Earth-leakage circuit breaker (ELCB) is a safety device used in electrical installations with high Earth impedance to prevent shock. It detects small stray voltages on the metal enclosures of electrical equipment, and interrupts the circuit if a dangerous voltage is detected. Once widely used, more recent installations instead use residual current circuit breakers which instead detect leakage current directly. An ELCB is a specialized type of latching relay that has a building's incoming mains power connected through its switching contacts so that the ELCB disconnects the power when earth leakage is detected. The ELCB detects fault currents from live to the Earth (ground) wire within the installation it protects. If sufficient voltage appears across the ELCB's sense coil, it will switch off the power, and remain off until manually reset. A voltage-sensing ELCB does not sense fault currents from live to any other Earthed body.

a- Earth Leakage Circuit Breaker b- Circuit Breaker

Figure 4.12

Circuit Breakers and Cable Values:

In our project we use a tow circuit breaker ,the first as a main circuit breaker **32 A**, and an earth leakage **40 A** with Sensitivity **30 mA**, the second we use a tow sub-circuit breaker **16A** to the heaters, and an **6A** circuit breaker to the control .

4.7 Contactors

A contactor is an electrically controlled switch used for switching a power circuit, similar to a relay except with higher current ratings.

A contactor is controlled by a circuit, which has a much lower power level than the switched circuit.

Contactors come in many forms with varying capacities and features. Unlike a circuit breaker, a contractor is not intended to interrupt a short circuit current. Contactors range from those having a breaking current of several amperes to thousands of amperes and 24 V DC to many kilovolts. The physical size of contactors ranges from a device small enough to pick up with one hand to large devices approximately a meter (yard) on a side. Contactors are used to control electric motors, lighting, heating, capacitor banks, thermal evaporators, and other electrical loads.

In this project, we used two contactors, first contactor for the Upper AC heater and second contactor for the Lower AC heater. As shown in figure 4.13.

Figure 4.13: Contactor

4.8 Switches

The emergence switch are used to stop the system immediately when something wrong happened with the system as shown in the figure 4.14.a . The start pushbutton switch are used to turn on the project as shown in the figure 4.14.b .The stop pushbutton switch used to turn off the project as shown in the figure 4.14.c.They are used for controlling the system as a part of a control system.

a- Emergence Switch   b- Start Pushbutton Switch   c- Stop Pushbutton Switch

Figure 4.14: switches

5

Chapter Five Experimental Result & Recommendations

5.5 Introduction

5.6 Test Result

5.7 Recommendation

5.8 Conclusion

5.1 Introduction

In this chapter we will show the experimental result and recommendations for this project, and we will list goals which has been completed and obtained in this project.

5.2 Test Result

1. We test the normally open (Sstart) to put the all component ready to work, by pressing it from the control panel.
2. The heaters work if the central box has the desired value of water takes it by the level sensor.
3. The system can generate the steam after the 12 minutes and injection it inside the room after the pressure reach 0.5 bar inside the box.
4. The temperature value in the room reach (40 **°C)** the thermocouple sensors gave the signal to stop the first heater and when it reach (50**°C)** or the humidity get 70% or the pressure reach 0.2 bar inside the room , the tow heaters stop working.
5. We Test the normally closed (Sstop) and the tow emergency to get the system off .

Figure 5.1.a: The Final System

Figure 5.1.b: The Final System

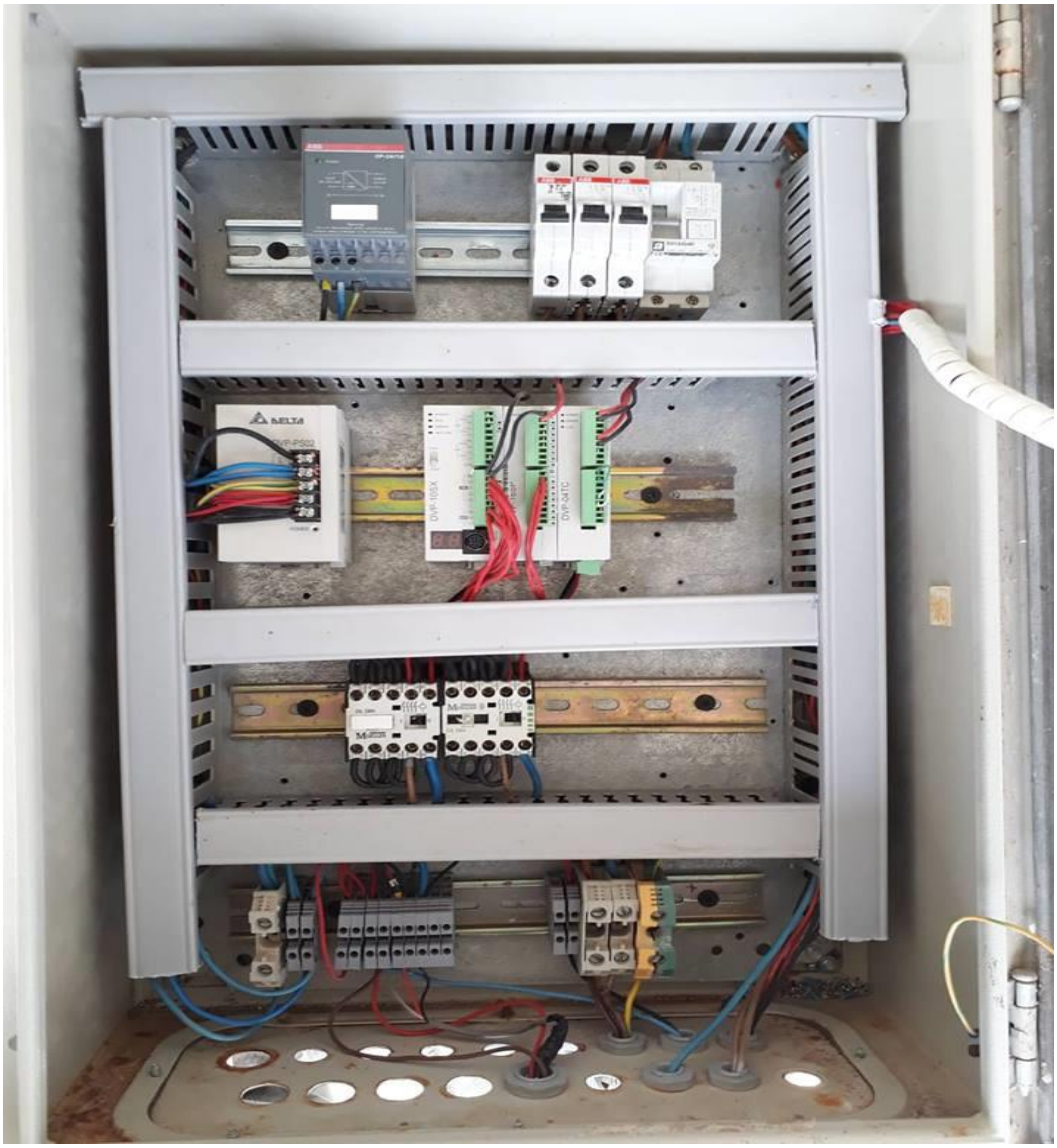

Figure 5.2: Control panel

Figure 5.3: The Room

5.3 Recommendation

The following tasks are suggested as recommendations:

1. Heating the water in two stages by adding a new stage to heat the water to get rid of Sintering where the new stage is easy to clean and access to get rid of Sintering, this way get rid of sintering about 80% .
2. Add a new stage to store steam to be like a UPS when the electrical power is off.
3. Connect the system to the SCADA system or NI-LABVIEW to control it.
4. Spray the water on a hot plate to get the steam at low temperatures and transfer this steam to the Room.

5.4 Conclusion

1. We decreased the amount of sintering by our design and by adding the white vinegar or Sodium carbonate periodically.
2. We improved the quality of steam by regulating it.
3. Our system operates in two alternating heaters, depending on the amount of steam required**.**
4. By Applying this system, the user feels safe and secure because the system has a complete control system.

References

[1] Steamers India Company/ India, This Company designs F-65G Series Model [ONLINE] Available at, http://www.steamersindia.in.

[2] (http://mathcentral.uregina.ca/QQ/database/QQ.09.08/h/tammy2.html)

[3] (https://www.varsitytutors.com/hotmath/hotmath_help/topics/volume-of-a-cylinder).

[4] (EN 13162 (2001), thermal insulation products for buildings-Factory made mineral wool (MW) products – Specification. Brussels: European Committee for Standardization, pp. 8-23).

[5] (https://www.sciencedirect.com/science/book/9780750663854).

[6] http://www.double-glazing-info.com/Choosing-your -windows/Types -of-glass /Low-E-energy-saving-glass

[7] (https://www.cooneybrothers.com/245698/category/steam-safety-valves).

[8] (https://elementsofheating.wordpress.com/2012/09/26/how-to-calculate-the-kw-required-to-heat-a-volume-of-water-in-a-particular-time/)

[9] A.K.Raja, Amit p.Srivastava, Manish Dwived ,Power Plant Engineering New Age International (P) Ltd., Publishers4835/24, Ansari Road, Daryaganj, New Delhi – 110002,p381.

[10] (http://coep.vlab.co.in/?sub=33&brch=91&sim=449&cnt=1).