Multifunctional Liquid Mixer & Heating System

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DECLARATION

We hereby, declare that the work presented in this project is the outcome of the investigation performed by us under the supervision of Md. Ashikur Rahman, Lecturer of the Electrical & Electronic Engineering Department, Sonargaon University. We also declare that no part of this project report and thereof has been or in being submitted elsewhere for the award of any degree.

We further undertake to identify the university against any loss or damage arising from breach of the forgoing obligation.

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CERTIFICATEION

This is to certify that the project report **"Multifunctional Liquid Mixer & Heating System"**, is the confide record of the work done by-

for partial fulfillment of the requirement of their degree of B.Sc. in Electrical and Electronic Engineering at Sonargaon University.

The project report has been carried out under my guidance and is a confide record of the successful work. I wish them success in future.

Supervised By

…….

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ACKNOWLEDGEMENT

Firstly, we express our sincere thanks and gratitude to the almighty for his divine blessings which made it possible for us to complete this project successfully.

We are grateful and express our deepest gratitude to Md. Ashikur Rahman, Lecturer, Department of Electrical and Electronic Engineering, Sonargaon University. The deep knowledge and keen interest of our supervisor influenced me to carry out this project. His infinite patience, scholarly guidance, constant encouragement, constant energetic supervision, constructive criticism, valuable suggestions at all levels made this project possible.

The successful completion of this thesis would not have been possible without his constant inspiration and constant guidance. Hence, we are extremely pleased to acknowledge our profound gratitude and respect to the maintainer.

We would like to express our gratitude to our Head of Department, as this project was completed under the Head of Department of Electrical and Electronics Engineering, Sonargaon University, Bangladesh.

We would like to thank our entire course mates from Sonargaon University, who participated in this discussion while completing the course work.

The author is grateful to all the respected faculty members of the Department of Electrical and Electronics Engineering for their cooperation and vital assistance in the successful completion of the thesis work.

ABSTRACT

The Multifunctional Liquid Mixer & Heating System is an innovative solution designed to efficiently blend and heat various types of liquids across diverse industries, including food processing, pharmaceuticals, and chemical manufacturing.

This system integrates advanced mixing and heating technologies to optimize both the homogeneity of liquid mixtures and the temperature control of the processed materials. By incorporating features such as adjustable mixing speeds, precise temperature regulation, and energy-efficient heating mechanisms, the system enhances the consistency and quality of end products while reducing energy consumption. The system's modular design allows for scalability and customization based on specific application needs, providing versatility and reliability in a wide range of operational environments.

The ability to simultaneously mix and heat liquids reduces processing time, improving overall productivity and lowering operational costs. This multifunctional approach offers significant advantages in terms of efficiency, cost-effectiveness, and product quality.

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CHAPTER 1

INTRODUCTION

1.1 Introduction:

A **Liquid Mixer & Heating System** is an essential industrial equipment used for the efficient blending and temperature control of liquids in various manufacturing and processing operations. This system combines the functions of mixing and heating to create a homogeneous liquid mixture while maintaining or raising the temperature of the mixture to a desired level. It is commonly used in industries such as food and beverage production, pharmaceuticals, chemicals, cosmetics, and more

1.2 Objectives:

The main objective of this project is.

Efficient Blending: To combine different liquid components or phases (such as liquids with varying viscosities, densities, or compositions) in an efficient manner, minimizing mixing time while achieving a high-quality result.
Controlling Viscosity and Flow: The mixer may need to control the viscosity and the flow behavior of the liquid, especially in systems involving shear-sensitive materials or highly viscous substances.
Temperature Control: Many mixing processes require maintaining or adjusting the temperature of the liquid mixture. This can be a key objective in food, cosmetic, and chemical industries.
Preventing Settling or Separation: For mixtures that are prone to phase separation, such as suspensions, one objective is to keep the components evenly dispersed and prevent settling over time.
Minimizing Energy Consumption: Achieving effective mixing with minimal energy input is a goal in order to improve the overall efficiency and reduce operating costs.
Ensuring Consistent Product Quality: By ensuring thorough and consistent mixing, the goal is to maintain a high standard of product quality, with uniform texture, appearance, and performance across batches.
Scalability and Flexibility: Liquid mixers are often designed to work in various volumes and operational conditions, so scalability (from lab-scale to industrial-scale) and flexibility in handling different formulations are key objectives.
Speed and Reliability: The ability to quickly mix liquids and perform reliably over extended periods is important for commercial-scale production and to ensure high throughput.

1.3 Background of the work:

A **mixing and heating system** refers to a type of industrial or laboratory setup designed to combine different materials (usually liquids or powders) while simultaneously applying heat to facilitate various processes like dissolution, emulsification, or chemical reactions. These systems are crucial in various sectors, including pharmaceuticals, food production, chemicals, and manufacturing industries. Here is an overview of their background and key components:

1. Purpose and Application:

- **Mixing**: The main purpose is to ensure uniformity by combining materials thoroughly. This is particularly important when handling substances with different viscosities, densities, or properties. Mixing can be done using agitators, blades, or turbines, and the primary goal is to ensure that the components are well-blended, whether in small-scale labs or large industrial operations.
- **Heating**: The simultaneous application of heat is often necessary to speed up reactions, change the physical properties of materials (such as melting or dissolving solids), or maintain a desired temperature for the process. Heating can be achieved via hot plates, steam, electrical heaters, or jackets around mixing vessels.[6]

2. Key Components:

- **Mixing Vessel**: This is the container in which the materials are combined. The shape and size of the vessel depend on the materials being processed and the scale of production. It can be cylindrical, conical, or custom-designed based on the industry requirements.
- **Agitators**: These are mechanical devices that promote the movement of materials inside the mixing vessel. Types of agitators include paddle mixers, ribbon blenders, and magnetic stirrers, each suited for different tasks and materials.
- **Heating Elements**: These include electrical heating elements, steam jackets, or other forms of heat sources that maintain or raise the temperature of the mixture. In some systems, temperature control is vital to ensure consistent product quality.
- **Temperature Control System**: A thermostat or automated controller is often integrated to maintain the desired temperature. This system adjusts the heat input based on real-time temperature readings.
- **Sensors and Monitoring Devices**: In advanced systems, sensors measure parameters like viscosity, pressure, and temperature to ensure optimal mixing and heating. This can be important for continuous processes.

3. Applications:

- **Food Industry**: The mixing and heating system is often used in food processing, for example, making sauces, soups, or dairy products, where both blending and heating are essential.
- **Chemical Industry**: In chemical manufacturing, the system is essential for producing various compounds or for reactions that require a particular temperature range.
- **Pharmaceutical Industry**: For manufacturing creams, ointments, or injectable drugs, a precise mixing and heating system is crucial to ensure homogeneity and effectiveness.
- **Paint and Coatings**: Ensures that pigments, binders, and solvents are properly mixed and heated to achieve the correct consistency and properties

1.4 Problem statement:

A **mixing and heating system** involves the simultaneous processes of mixing different fluid streams and heating them to a desired temperature. The primary objective of the system is to ensure that the final output stream achieves both the required composition (due to mixing) and the necessary temperature (due to heating). This type of system is commonly used in industries such as chemical processing, food production, pharmaceuticals, and energy systems.
The problem in designing and analyzing such a system typically includes the following elements:

Key Variables:

1. **Flow Rates**:
- Flow rates of the incoming streams (which could be liquid, gas, or a combination) need to be controlled and measured.
- Flow rates of the output stream are determined by the mixing and heating conditions.

2. **Temperatures**:
- Initial temperatures of the incoming streams (hot and cold streams).
- Desired final temperature of the mixed output stream.

3. **Concentrations**:
- Concentrations of different components (chemical or otherwise) in the incoming streams.
- Desired final concentration after mixing.

4. **Heat Transfer**:
- The heat energy required to raise the temperature of the mixed stream to the desired level.
- Heat exchanger(s) are typically used to supply or remove heat.

5. **Mixing Efficiency**:
- How effectively the streams mix, which may depend on the design of the mixer, temperature, and flow rates.

Objective:

- **Achieving Desired Temperature**: Heat the mixed fluid to a specified target temperature by applying heat energy from an external source (e.g., steam, electrical heating).
- **Achieving Desired Composition**: Control the flow rates and proportions of each stream entering the system to achieve the desired composition in the output.
- **Optimizing Energy Consumption**: Minimize energy consumption (especially in heating) while achieving the required temperature and mixing efficiency.

CHAPTER 2

LITERATURE REVIEW

2.1 Existing System Analysis:

An analysis of an existing mixing and heating system typically involves assessing its efficiency, performance, components, and operational aspects to identify areas for improvement or to determine whether the system meets the required specifications and goals.
Below is an overview of the key components and considerations when analyzing such a system:

Existing System Analysis of Mixing & Heating System

An analysis of an existing mixing and heating system typically involves assessing its efficiency, performance, components, and operational aspects to identify areas for improvement or to determine whether the system meets the required specifications and goals.
Below is an overview of the key components and considerations when analyzing such a system:

1. System Overview

- **Objective:** Understand the purpose of the mixing and heating system, which could range from industrial processes (e.g., chemical manufacturing, food processing) to laboratory applications.
- **Operation:** A typical mixing and heating system combines materials (liquids, solids, or gases) and raises their temperature to a desired level for a specific process. The system could involve:
- **Mixing:** Combining different materials or components to achieve a uniform product.[5]
- **Heating:** Raising the temperature of the mixture to facilitate chemical reactions, sterilization, or dissolution.

2. Components of the System

- **Mixing Equipment:**

Agitators / Mixers: These devices are designed to stir, blend, or homogenize materials. Depending on the nature of the materials, the mixers can be batch mixers (for small, intermittent production) or continuous mixers.
Blenders / Mills: In some systems, mechanical blending or grinding may be required to break down particles or increase surface area.

- **Heating Equipment:**

Heat Exchangers: These are used to transfer heat between two fluids without mixing them. Common types include shell and tube, plate, or air-to-liquid heat exchangers.
Heaters (Electric, Steam, Gas): Direct heating devices can use electricity, gas, or steam to increase the temperature of the materials.
Temperature Control Devices: Sensors, controllers, and valves to maintain the desired temperature.

- **Pumps and Valves:** Used to transfer materials between tanks, mixers, and heaters, ensuring smooth flow and controlling pressure.

3. Input Variables

- **Feedstock Properties:**

Temperature, viscosity, density, and composition of the materials being mixed or heated.
Varying input characteristics can impact mixing efficiency, heating times, and energy consumption.

- **Environmental Conditions:**

Ambient temperature, humidity, and pressure in the facility that might affect the performance of heating or mixing.

2.2 Literature Review:

1. Overview of Mixing Systems:

1.1 Types of Mixing Systems: Mixing involves the combination of two or more components to produce a homogeneous mixture. There are several types of mixing systems, each suited to different applications:

- **Mechanical Mixers:** These include agitators, stirrers, and blenders that utilize rotating blades or paddles to combine substances. They are widely used in industries such as food production, chemical manufacturing, and pharmaceuticals.
- **Static Mixers:** These systems consist of stationary elements that cause the fluid to mix as it passes through them. They are often used in continuous flow processes.
- **High-Shear Mixers:** These mixers are designed to create high shear forces to mix fluids with significantly different viscosities or to emulsify substances (e.g., creating emulsions in food or cosmetic products).

1.2 Factors Affecting Mixing Efficiency: Several factors impact the efficiency of mixing, including:

- **Viscosity of Materials:** The higher the viscosity, the more challenging it is to achieve homogeneous mixing.
- **Shear Rate:** High shear rates are necessary for fine dispersion or emulsification.
- **Agitation Speed:** The speed of rotation or movement influences the mixing time and uniformity.
- **Fluid Properties:** The density, surface tension, and phase (liquid, solid, gas) of the materials being mixed play a role in determining the type of mixer to be used.
- **Scale-up Considerations:** What works efficiently at a laboratory scale may not be as effective at industrial scale due to differences in flow dynamics and heat dissipation.

1.3 Applications of Mixing Systems: Mixing systems are used in a variety of industries:

- **Food and Beverage Industry:** For blending ingredients, emulsifying oils, or preparing dough.
- **Pharmaceutical Industry:** For creating uniform suspensions or suspending drugs.
- **Chemical Engineering:** For creating reactive mixtures, blending polymers, or suspensions in reactors.
- **Waste Treatment:** To enhance the dissolution of chemicals or ensure the even distribution of reagents.

2. Overview of Heating Systems:

2.1 Heating Methods: Heating systems in industrial processes are typically classified into several types based on the heat transfer method:

- **Conduction Heating:** Heat is transferred directly through a material from one point to another. It is commonly used in metal processing or in ovens.
- **Convection Heating:** Heat is transferred through fluid movement, which can be forced (via fans or pumps) or natural. This method is commonly used in air and water heaters.
- **Radiation Heating:** Heat is transferred via electromagnetic waves. It is commonly used in high- temperature processing such as furnaces and kilns.

2.2 Types of Heating Systems:

- **Electric Heaters:** Utilize electrical resistance to produce heat. These are common in laboratory-scale applications.
- **Steam Heaters:** Use steam to heat the system, offering high heat transfer efficiency and commonly used in large-scale industries.
- **Hot Oil Heating Systems:** These use oil as a heat carrier to transfer heat to process equipment. They are widely used when uniform heating is required.
- **Direct Flame Heating:** Involves the use of a burner to directly heat a substance. It is often used in industrial-scale applications like metal smelting.

CHAPTER 3

METHODOLOGY

3.1 Description of Methodology:

The **methodology of mixing and heating systems** generally refers to the process of combining materials (often liquids, gases, or powders) in such a way that both uniform mixing and controlled heating occur. The system is designed to efficiently combine materials and apply heat in a controlled manner to achieve specific properties or outcomes, such as temperature stabilization, uniform texture, or desired chemical reactions.

3.2 : System Planning:

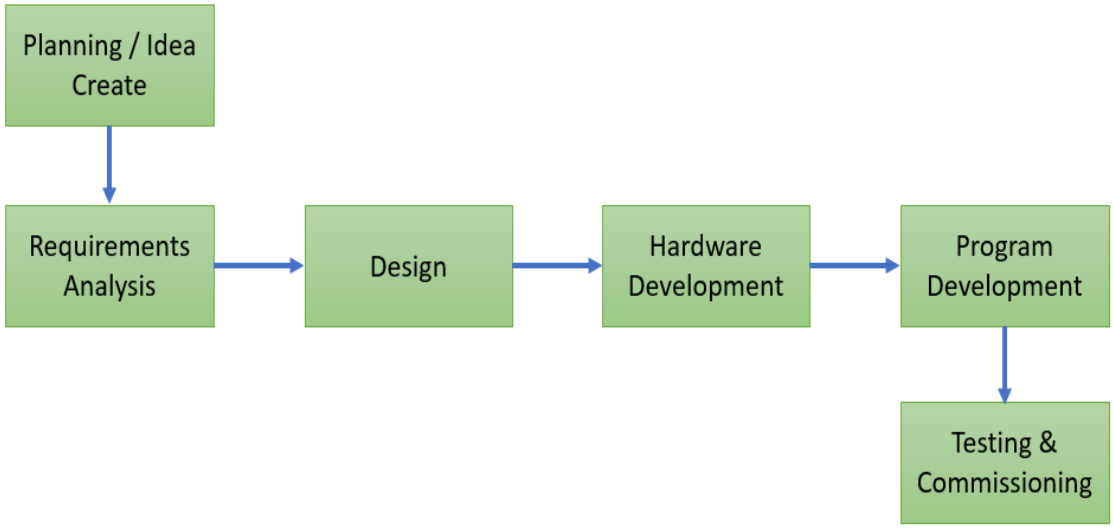


Figure 3.1: System Planning Diagram

3.3 Requirement Analysis:

SL NO:	Particulars	Qty.	Unit
1	Circuit Breaker	1	Nos
2	Power Supply	1	Nos
3	PLC	1	Nos
4	Push Button Switch	1	Nos
5	Photo Sensor	1	Nos
6	Solenoid Valve	4	Nos
7	EMR Relay	9	Nos
8	Indicator Lamp	1	Nos
9	Float Switch	1	Nos
10	Heater	1	Nos
11	Buzzer	1	Nos
12	DC Motor	1	Nos
13	Cable	1	Lot
14	Cable Duct	1	Nos
15	Tank	4	Nos

Table 3.1 List of the Components

3.4 Hardware Requirements:

Among the many raw materials, we have used to make this project. We have used some more electrical & electronics components which we are highlighting below step by

1. **Circuit Breaker**
2. **Power Supply**
3. **PLC**
4. **Push Button Switch**
5. **Photo Sensor**
6. **Solenoid Valve**
7. **EMR Relay**
8. **Indicator Lamp**
9. **Float Switch**
10. **Heater**
11. **Buzzer**
12. **DC Motor**

1. Circuit Breaker:



Figure 3.2 Miniature Circuit Breaker

A circuit breaker is an electrical safety device designed to protect an electrical circuit from damage cause by overload or short circuit. It automatically interrupts the flow of electricity when a fault is detected, helping to prevent fires, equipment damage, or electrical hazards. Here are the key aspects of a circuit breaker:

1. **Function:**

- **Overload Protection:** If a circuit carries more current than it is rated to handle, the circuit breaker trips and interrupts the current flow to prevent overheating and damage.
- **Short Circuit Protection:** If there is a short circuit (when two wires touch and cause a high current flow), the circuit breaker trips to prevent sparks or fires.

2. **Types of Circuit Breakers:**

- **Thermal Circuit Breakers:** These use a bimetallic strip that bends when it heats up due to excess current. After bending sufficiently, it opens the circuit.
- **Magnetic Circuit Breakers:** These use an electromagnet that activates to trip the breaker when the current exceeds a preset threshold.

- **Combination Circuit Breakers:** These combine both thermal and magnetic protection, providing better response to different fault conditions.

4. Applications:

- **Residential:** Circuit breakers are used in homes to protect circuits that power lighting, appliances, and HVAC systems.
- **Commercial & Industrial:** They are also used in larger settings to protect complex electrical systems, motors, and machinery from faults.
- **High-Voltage Transmission Lines:** In power grids, high-voltage circuit breakers are essential to quickly disconnect sections of the grid in case of faults.

Technical Specification:

Model	DZ47-60
Rated voltage (Ue)	230V/400V AC(1P),400V AC(2P, 3P, 4P)
Rated current (In)	1A, 2A, 3A, 4A, 5A, 6A, 10A, 15A, 16A, 20A, 25A, 32A, 40A, 50A, 60A, 63A
Rated insulation voltage (Ui)	500V
Rated impulse withstand voltage (Uimp)	4kV
number of poles	1P, 2P, 3P, 4P
Instantaneous trip type	C Type, D Type
Rated short-circuit breaking capacity	C1-C40 6kA, C50-C63 4kA, D1-D63 4kA
Tightening torque	2.0Nm
pollution level	2
Protection class	IP20
Installation category	II, III
Mechanical life	4000
Electrical life	4000

Table 3.2 Technical Specification of CHNT DZ47-60 Circuit Breaker

In this project we use a two-pole miniature circuit braker (MCB), rating of 16A.

Circuit Breaker Selection:

Total load of this project = 1.5 KW

Load current = 8.52A

Breaker size = 8.52A * 1.25 [1]. NFPA-art-210.20(A)-2017

= 10.65A

These ampere rating is not available in market. So, we select a 16A MCB

2. DC Power Supply:



Figure 3.3 Power Supply

In automation panels, the power supply is a critical component that provides the necessary electrical energy to control systems, sensors, actuators, and other electrical equipment. The type of power supply used depends on the specific requirements of the automation system and the components being powered. Here are some common types of power supplies used in automation panels:

1. AC Power Supply (Alternating Current)

- **Application:** Used when the automation system requires AC voltage for control equipment or machinery.
- **Types**:

Single-phase AC: For smaller systems or residential applications.
Three-phase AC: Used for industrial systems requiring more power, often to drive larger motors or heavy- duty equipment.

- **Voltage levels:** Typically, 110V, 220V, 380V, 480V (depending on regional standards).

2. DC Power Supply (Direct Current)

- **Application:** Used when automation components, such as PLCs (Programmable Logic Controllers), sensors, and actuators, require DC voltage.
- **Common Voltages:** 12V, 24V, 48V DC are common standards for industrial automation.
- **Types:**
  Linear Power Supply: Provides stable and low-noise DC output, but less energy-efficient.
  Switching Power Supply (SMPS): More energy-efficient and compact, suitable for modern automation systems that require a reliable DC supply

We use the DC powers supply in this project for wiring of the PLC main power, input & output wiring.

Technical Specifications:

Brand	MEAN WELL
Item number	NDR-120-24
Series	NDR-120
Description	AC-DC Single output Industrial DIN rail power supply; Output 24Vdc at 5A; metal case
Application	Installation UL 508 ITE EN/UL/IEC 60950
Technology	AC/DC
Power Format	DIN rail
Output Power (W)	120
Output Voltage (V)	24
Output Current (A)	5
Input Voltage (V)	110/230 universal input
IP Rating	No IP assigned

Table 3.3 Technical Specification of MEAN WELL NDR-120-24 DC Power Supply

3. Programable Logic Controller (PLC) :

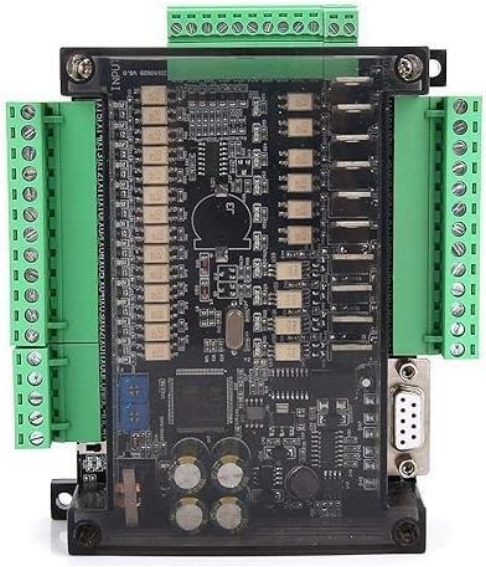


Figure 3.4 Mitsubishi FX3U Programable Logic Controller (PLC)

A **Programmable Logic Controller (PLC)** is a specialized digital computer used for automation and control in industrial environments. It is designed to monitor inputs from sensors, control outputs such as motors or actuators, and execute control processes in real-time. PLCs are critical in industries like manufacturing, energy, and transportation, where precision control of machinery and processes is required. **[2]**

Basic Components of a PLC System:

1. **Central Processing Unit (CPU)**: The brain of the PLC, responsible for executing control programs, processing inputs, and controlling outputs.
2. **Input/Output Modules (I/O)**:

- **Input Modules**: Accept signals from field devices such as sensors, switches, or other input devices.
- **Output Modules**: Control actuators like motors, valves, and relays based on the processed signals.

3. **Power Supply**: Provides the necessary power to the PLC components.
4. **Programming Device**: A laptop or computer used to write, test, and download the control program to the PLC.
5. **Communication Interfaces**: Allows the PLC to communicate with other devices or systems like SCADA (Supervisory Control and Data Acquisition) systems, remote I/O, or other PLCs.

How a PLC Works:

1. **Input Processing**: The PLC continuously reads the status of input devices, such as sensors, switches, or manual inputs.
2. **Program Execution**: The PLC's CPU runs the control program, which processes input signals and determines the necessary output actions.
3. **Output Processing**: Based on the program logic, the PLC sends signals to output devices such as relays, motors, or actuators to control the system's operation.
4. **Scan Cycle**: The PLC operates in a continuous cycle:

- **Input Scan**: Read input values.
- **Program Scan**: Execute the control program.
- **Output Scan**: Update outputs based on the program's logic.
- **Housekeeping**: Perform system diagnostics and internal functions.

Types of PLCs:

1. **Compact PLC**: A small, integrated unit with a fixed number of I/O points. These are ideal for simple control tasks.
2. **Modular PLC**: Allows for expansion with additional I/O modules or communication interfaces. These are used for more complex systems that require flexibility.
3. **Distributed PLC**: Typically used in large systems where I/O points are distributed across a wide area, connected to the central PLC via communication networks.

PLC Programming Languages:

1. **Ladder Logic**: The most common programming language for PLCs, resembling electrical relay diagrams.
2. **Function Block Diagram (FBD)**: A graphical programming language that organizes control functions into blocks connected by flow lines.
3. **Structured Text (ST)**: A high-level textual language similar to programming languages like Pascal or C.
4. **Instruction List (IL)**: A low-level language based on machine code instructions (now largely obsolete).
5. **Sequential Function Charts (SFC)**: Used to describe complex processes with multiple steps, like in batch processing.

We use Mitsubishi FX3U-24MT PLC in this project & programming by using ladder logic.

Technical Specifications:

Brand	MITSUBISHI
Model number	FX3U-24MT
Input Voltage	24V DC
Output Current	1A
Output type	Transistor
Input Point	14
Output Point	10
Analog Input	6AD
Analog Output	2DA
Floating Point	Support
Step Motor	Support
Software	GX Developer OR GX Works2
Material	Plastic

Table 3.4 Technical Specification of Mitsubishi FX3U Programable Logic Controller (PLC)

4. Push Button Switch:



Figure 3.5 Push Button Switch

A **push-button switch** is a type of electrical switch that operates by applying physical pressure, usually with a finger, to a button or actuator. These switches are widely used in various applications, from home appliances and electronics to industrial control systems.

Types:

- **Single-pole, Single-throw (SPST)**: This is the simplest type, where the button either opens or closes a circuit (on/off).
- **Single-pole, Double-throw (SPDT)**: The switch allows a single input to be routed to one of two outputs, depending on whether the button is pressed.
- **Double-pole, Double-throw (DPDT)**: This type controls two circuits simultaneously, often found in more complex applications.

Common Variations of Push Button Switches:

1. **NO (Normally Open)**: The circuit is open until the button is pressed, completing the circuit.
2. **NC (Normally Closed)**: The circuit is closed until the button is pressed, breaking the circuit.

Construction:

- **Button**: The visible part that is pressed, often made from plastic, metal, or rubber.
- **Housing**: The enclosure that holds the internal components of the switch.
- **Contacts**: Internal conductive components that either connect or disconnect when the button is pressed.
- **Spring**: Many push-button switches include a spring mechanism that pushes the button back to its default position after it is released.

Uses:

- **Consumer Electronics**: Push-button switches are commonly used in devices like telephones, remotes, and gaming consoles.
- **Home Appliances**: Washing machines, microwave ovens, and refrigerators often include push-button switches.
- **Industrial Controls**: These switches are used in manufacturing machinery, control panels, and emergency stop switches.
- **Automotive Applications**: Push buttons are used in vehicles for starting engines, controlling lights, and other functions.

Technical Specifications:

Brand	Talmemlnpue
Model Number	ZB2-BE101
Current	10A
Voltage	220V AC
Status	Normally Close & Normally Open
Weight	43g
Terminal	4

Table 3.5 Technical Specification of Talmemlnpue Push Button Switch

5. Photo Sensor:



Figure 3.6 Photo Sensor

A photosensor (also known as a light sensor) is a device that detects and responds to light. It is commonly used to monitor environmental lighting conditions, converting light energy into an electrical signal. Photosensors play a crucial role in various applications, such as in cameras, automotive systems, home automation, industrial processes, and more.

Working Principles of Photosensors:

- **Photovoltaic Effect**: In this principle, light striking the photosensor generates a flow of electrons due to the energy imparted by the photons. Photodiodes and some other sensors work on this principle.
- **Photoelectric Effect**: Some sensors, such as photomultiplier tubes, rely on the photoelectric effect, where light causes the emission of electrons from a material's surface, generating an electric current.
- **Photoconductivity**: Light exposure changes the electrical conductivity of materials (like photoresistors), leading to changes in current or resistance. Photoresistors use this effect.

Applications of Photosensors:

1. **Consumer Electronics**:
- In devices like **smartphones** (adjusting brightness based on ambient light).
- **Televisions and monitors** (to adjust screen brightness automatically).

2. **Automotive**:
- **Headlights and taillights**: Sensors detect ambient light to automatically adjust headlight intensity.
- **Rain sensors**: Photosensors detect rain on car windshields, triggering automatic wiper activation.

3. **Industrial**:
- **Automation**: Used in industrial settings for light-based controls (e.g., detecting object presence on assembly lines).
- **Safety**: Photosensors are part of safety systems (such as light curtains) to detect movement or obstruction.

4. **Medical**:
- **Pulse Oximeters**: Measures the oxygen saturation in blood by detecting light absorption at specific wavelengths.

There are three main types of photoelectric sensors:

- Diffuse
- Retro-reflective
- Through-beam

We used a Retro-reflective 5-wire photo sensor in our project to detect the cup of coffee.

Technical Specifications:

Brand	OMRON
Model Number	E3F-DS30N1
Current	200mA
Voltage	250V AC
Sensing Distance	12mm
Wire	5
Output Type	Relay

Table 3.6 Technical Specification of Photo Sensor

6. Solenoid Valve



Figure 3.7 Solenoid Valve

A **solenoid valve** is an electromechanically operated valve that is controlled by an electric current passing through a solenoid coil. It is widely used in various industries for controlling the flow of liquids and gases in a system.

Types of Solenoid Valves

1. **2/2 Solenoid Valve:** A two-port, two-position valve. It controls the flow between two ports (inlet and outlet). The valve either opens or closes, directing or stopping the flow.
2. **3/2 Solenoid Valve:** A three-port, two-position valve that controls the flow between two or more outlets, often used for air or gas control in pneumatic systems.
3. **4/2 Solenoid Valve:** A four-port, two-position valve, often used for more complex systems, such as those controlling actuators in automation systems.
4. **5/2 and 5/3 Solenoid Valves:** Multi-port valves used for controlling double-acting actuators in pneumatic systems.

Basic Components of a Solenoid Valve

1. **Solenoid Coil**: A coil of wire that generates a magnetic field when an electric current passes through it.
2. **Plunger (Armature)**: A movable metal piece inside the solenoid that is attracted or repelled by the magnetic field.
3. **Valve Body**: The casing that houses the valve's components, including the flow channels.
4. **Spring**: A component that helps return the plunger to its original position when the solenoid is de-energized.
5. **Seal or Seat**: A component that prevents or allows the flow of fluid through the valve when in the open or closed position.

Working Principle

The operation of a solenoid valve is based on the interaction between the solenoid coil and the plunger:

- When the coil is energized, the electric current generates a magnetic field that attracts the plunger.
- This movement of the plunger either opens or closes the valve, allowing or stopping the flow of the fluid (liquid or gas).
- When the coil is de-energized, the spring pushes the plunger back to its original position, either closing or opening the valve, depending on the design.

Applications of Solenoid Valves

1. **Industrial Automation:** Solenoid valves are integral in automated systems for controlling air, gases, or liquids in factories, pipelines, and machines.
2. **Water Treatment**: Used to regulate water flow in filtration, purification, and distribution systems.
3. **HVAC Systems:** In heating, ventilation, and air conditioning systems, solenoid valves are used to regulate the flow of refrigerants or air.
4. **Medical Devices:** Used in medical equipment like dialysis machines, oxygen regulators, and pneumatic control devices.
5. **Automotive Systems:** Control the fuel, air, and exhaust in engine systems.

Technical Specifications:

Brand	AOM
Model Number	2W-025-08
Voltage	220V AC
Orifice	2.5mm
TEMP	-5 to 100 Degree Celsius
Pipe Size	1/4"
Pressure	Max 10kg/cm^2

Table 3.7 Technical Specification of Solenoid Valve

7. Electromechanical relay (EMR) Relay:



Figure 3.8 14-Pin EMR Relay

An **Electromechanical Relay (EMR)** is a type of relay that uses an electromagnet to mechanically operate a switch. It is an essential component in electrical and electronic systems for controlling high-voltage circuits with low-voltage signals. Here's a breakdown of its components and operation:

Components:

1. **Electromagnet**: This is a coil of wire that, when energized, creates a magnetic field.
2. **Armature**: A movable lever or piece of metal that is attracted to the electromagnet when energized.
3. **Contacts**: These are the switch terminals that open or close when the armature moves. Contacts can be Normally Open (NO) or Normally Closed (NC).
4. **Spring**: A spring typically returns the armature to its original position when the electromagnet is de-energized.
5. **Frame**: The housing that holds all the components together.

Working Principle:

- When a current flows through the coil of the electromagnet, a magnetic field is created.
- This magnetic field pulls the armature toward the electromagnet, causing the contacts to either open or close.
- In the **Normally Open (NO)** configuration, the contacts close when the armature is pulled in.
- In the **Normally Closed (NC)** configuration, the contacts open when the armature moves.
- When the current is turned off, the magnetic field collapses, and the spring returns the armature to its original position, thus restoring the contacts to their default state (open or closed).

Applications of EMRs:

1. **Automated Control Systems**: Used to control large equipment such as motors, lights, and industrial machines.
2. **Telecommunications**: EMRs can switch telephone circuits or control other communication devices.
3. **Home Appliances**: Used in systems like washing machines, air conditioners, and microwave ovens.
4. **Automotive Relays**: EMRs are widely used in cars to control high-power circuits with low-power signals.

Technical Specifications:

Brand	OMRON
Model Number	MY4N-J
Coil Voltage	28VAC
Switching Voltage	250VAC
Current	5A
Pin Number	14

Table 3.8 Technical Specification of 14-Pin EMR Relay

8. Indicator Lamp:



Figure 3.9 Indicator Lamp

An **indicator lamp** is a type of electrical signaling device that visually indicates the status of a system, machine, or process. It uses light to alert or inform operators or users about certain conditions, such as when a device is turned on, malfunctioning, or in a particular mode.

The main purposes of an indicator lamp are:

- **Status Indication:** To show whether a system or device is operational or not.
- **Fault Detection:** To signal a malfunction or error in a system.
- **Warning and Alerts:** To notify the user about potential hazards or operational anomalies.
- **Mode Indicator:** To indicate different operational modes (e.g., power, standby, heating).

Indicator Lamp Colors

The color of the indicator lamp often communicates the nature of the status it indicates. Here are common color associations:

- **Green:** System is operational or on.
- **Red:** Warning or error, the system is off or malfunctioning.
- **Yellow/Amber:** Caution, a non-critical fault, or a pending condition.
- **Blue:** Indicates a special condition, like the system in a certain mode (e.g., cooling).
- **White:** Generally used to show that the system is on, in standby, or ready to operate.

Common Uses

Electrical Panels and Control Systems: Indicator lamps are often integrated into control panels to show the operational status of machinery, such as power on/off, fault detection, or warning alerts.

- **Vehicles:**
- Indicator lamps in vehicles alert drivers to conditions like low fuel, engine temperature, oil pressure, or turn signal activation.
- **Home Appliances:**
- Many household appliances (like washing machines, dryers, and refrigerators) use indicator lamps to signal power, operational states, or errors.
- **Industrial Equipment:**
- Indicator lamps in industrial settings can signal when a machine or piece of equipment is functioning correctly, is in need of maintenance, or has an active fault.

Technical Specifications:

Brand	Schneider
Model Number	AD22-22DS
Operating Voltage	220VAC
Current	200mA
Color	Green & Yellow

Table 3.9 Technical Specification of Indicator Lamp

9. Float Switch:



Figure 3.10 Float Switch

A **float switch** is a type of sensor used to detect the level of liquids in a tank, well, or another container. It is often used in applications where it's important to control or monitor the liquid level, such as in water pumps, sump pumps, and industrial processes. The device typically consists of a float that moves with the liquid level, and a switch that activates or deactivates based on the float's position.
Here are the key aspects of float switches:

1. Basic Working Principle

- A float switch works on the principle of buoyancy, where a float is placed on the surface of a liquid. As the liquid level rises or falls, the float moves accordingly.
- The float is usually connected to a mechanical or electrical switch. When the float reaches a certain position (either high or low), it activates or deactivates the switch, which can control pumps, alarms, or other systems.

2. Types of Float Switches

Float switches come in several different designs based on the application and the type of liquid being measured. The most common types are:

- **Mechanical Float Switches**:
- These switches use a buoyant float that moves with the liquid level. The float may be connected to a rod or lever, which in turn activates a mechanical switch when a certain level is reached.

Common Types:

- Vertical float switches: The float moves vertically with the liquid level.
- Horizontal float switches: The float moves in a horizontal direction.
- **Magnetic Float Switches**:
- These use a float with an embedded magnet, which can activate a reed switch when it reaches a specific position. These switches can be more reliable and durable since they don't rely on moving parts that can wear out.
- **Capacitive Float Switches**:
- These sensors detect changes in capacitance as the liquid level rises or falls. They can work in situations where contact with the liquid is not desired or where mechanical float systems are not suitable.
- **Ultrasonic Float Switches**:
- These sensors use ultrasonic waves to detect the level of liquid. They are non-contact and suitable for more sensitive or complex applications.

applications of flow switches

- **Water Tanks**: To control the filling and emptying of water tanks, ensuring that the water level stays within a certain range.
- **Sump Pumps**: To control the operation of sump pumps in basements or other low-lying areas, preventing water overflow.
- **Aquariums**: To regulate water levels automatically in fish tanks or aquariums.
- **Oil and Fuel Tanks**: To monitor and control the fuel or oil levels in tanks.
- **Wastewater Management**: To control the operation of pumps in sewage or wastewater systems.

Technical Specifications:

Brand	No Brand
Model Number	
Operating Voltage	100/ 220VAC
Current	0.5A
Color	White

Table 3.10 Technical Specification of Float Switch

10. Water Heater:



Figure 3.11 Water Heater

A water heater is an essential appliance that heats water for domestic and commercial use, including bathing, cooking, cleaning, and space heating. There are various types of water heaters, each with different heating methods, technologies, and fuel sources. Here's a detailed breakdown of water heaters:

Types of Water Heaters

a) Tank (Storage) Water Heaters:

- **How It Works:** These are the most common type of water heaters. A tank holds a large amount of water (usually between 20 to 80 gallons) that is kept heated by an energy source like electricity, gas, or propane.
- **Pros:** Relatively low upfront cost, simple to install, and can supply multiple outlets simultaneously.
- **Cons**: Higher energy consumption because the water is constantly heated and stored, even when not in use.

b) Tankless (On-Demand) Water Heaters:

- **How It Works:** These units do not have a storage tank. Instead, water is heated on-demand as it **flows** through the unit. When you turn on the hot water tap, cold water enters the unit and is heated by electrical elements or gas burners.
- **Pros:** Energy-efficient, as water is heated only when needed, which eliminates standby heat loss. It also takes up less space.
- **Cons:** Can only supply hot water to one or two faucets at a time, depending on the unit's power, and may require an upgrade to your electrical system or gas line.

c) Heat Pump Water Heaters (Hybrid):

- **How It Works:** These use electricity to move heat from the air or ground to heat the water, rather than generating heat directly. This makes them more energy-efficient than traditional electric water heaters.
- **Pros:** Extremely energy-efficient and environmentally friendly, as they use renewable energy sources (ambient heat).
- **Cons:** Higher initial cost, requires installation in areas with consistent ambient temperature, and can be noisy.

Heating Methods

- **Electric Water Heaters:** Use electrical resistance to heat the water. They are easy to install and do not require venting but are generally more expensive to operate.
- **Gas Water Heaters:** Use natural gas or propane to heat the water. They heat the water faster than electric models but require proper venting.
- **Propane Water Heaters:** A gas-powered option suitable for homes that are not connected to natural gas lines.
- **Oil Water Heaters:** Less common, these use oil to heat water and are typically found in rural areas or where natural gas is unavailable.

11. Buzzer:



Figure 3.12 AC Buzzer

A buzzer is a signaling device that produces a buzzing sound, typically used to indicate a warning, alert, or to grab attention in various situations. It is an essential component in various contexts, including alarms, machines, games, and more.

Types of Buzzers

Buzzers can be classified into several categories depending on their design, function, and technology. Some common types include:

- **Electromagnetic Buzzers**: These use an electromagnet and a diaphragm to create vibrations, which produce sound. The electromagnet's coil is energized, pulling the diaphragm to create a buzzing noise.
- **Piezoelectric Buzzers**: These buzzers use piezoelectric materials that deform when subjected to electrical voltage, causing a mechanical vibration that produces a sound. These buzzers are compact and efficient, making them popular in modern electronics.
- **Mechanical Buzzers**: These rely on a mechanical mechanism, such as a rotating part or a reed, to produce sound. Though more traditional, they are still found in older applications.
- **Magnetic Buzzers**: Similar to electromagnetic buzzers, but using magnetic force to produce the buzzing sound.

Applications of Buzzers

Buzzers are used in a variety of industries and contexts:

- **Alarm Systems**: Used in security systems, fire alarms, and smoke detectors to alert people to a problem or emergency.
- **Appliances and Machines**: For notifying users of specific conditions, such as when a microwave or washing machine finishes its cycle, or when an error occurs in electronic devices.
- **Games and Quizzes**: In quiz shows or game shows, buzzers are used by participants to signal when they want to answer a question. They are also used in educational settings or other competitive environments to mark responses.
- **Cars**: In modern vehicles, buzzers alert drivers about various safety issues like seatbelt reminders, open doors, or engine problems.
- **Toys**: Many children’s toys or learning devices use buzzers for feedback and interactivity.

Technical Specifications:

Brand	No Brand
Model Number	ILMP047
Operating Voltage	220VAC
Current	30mA
Color	Read

Table 3.11 Technical Specification of Buzzer

12. DC Motor:



Figure 3.13 DC Motor

A DC (Direct Current) motor is an electrical machine that converts electrical energy (DC electricity) into mechanical energy through the interaction of magnetic fields. These motors are widely used in various applications where variable speed and precise control are important.
Until the 1980s the conventional (brushed) d.c. machine was the automatic choice where speed or torque control is called for, and large numbers remain in service despite a declining market share that reflects the general move to inverter-fed a.c. motors. D.C. motor drives do remain competitive in some larger ratings (several hundred kW) particularly where drip-proof motors are acceptable, with applications ranging from steel rolling mills, railway traction, through a very wide range of industrial drives.**[7]**

Working Principle (Detailed)

When the DC motor is powered, the armature, which is placed in the magnetic field, carries current. This current interacts with the magnetic field of the stator (created by either permanent magnets or electromagnets), causing a force to act on the armature. The armature starts to rotate due to this force, which is also known as Lorentz force.

The commutator periodically reverses the direction of current flow in the armature to ensure the motor continues to rotate in the same direction.

As the armature rotates, the mechanical energy produced is transferred to the attached load through the shaft.

Types of DC Motors:

1. **Brushed DC Motor**: The most common type. It uses brushes and a commutator to reverse the direction of current flow in the armature.
   Advantages: Simple design, easy to control speed and direction, inexpensive.
   Disadvantages: Brushes wear out, which requires maintenance.
2. **Brushless DC Motor (BLDC)**: A motor that does not use brushes or a commutator. Instead, it uses an electronic controller to switch the current in the windings.
   Advantages: Higher efficiency, less maintenance, and longer lifespan due to the absence of brushes.
   Disadvantages: More complex control circuitry is required.
3. **Shunt-Wound DC Motor**: The field windings are connected in parallel (shunt) with the armature.
   Characteristics: Constant speed, regardless of load variations.
4. **Series-Wound DC Motor**: The field windings are connected in series with the armature.
   Characteristics: High starting torque but speed decreases as the load increases.
5. **Compound-Wound DC Motor**: A combination of series and shunt-wound motors, offering a balance of characteristics.

Applications of DC Motors

DC motors are used in a wide range of applications, including:

1. **Electric Vehicles**: For propulsion and speed control.
2. **Fans and Blowers**: For adjusting airflow.
3. **Conveyor Belts**: For variable speed and torque applications.
4. **Machine Tools**: In CNC machines, for precise speed control.
5. **Power Tools**: In drills, grinders, and other hand-held devices.
6. **Robotics**: For precise movement and positioning.

Technical Specifications:

Brand	No Brand
Model Number	MDC007
Operating Voltage	12/24V DC
Current	1.27A/2.55A
RPM	4000/8000RPM

Table 3.12 Technical Specification of DC Motor

Motor selection [4]

3.5 Software Requirements:

1.GX Works2.

GX Works2 software:

GX Works2 is a software suite developed by **Mitsubishi Electric** for programming and configuring its PLC (Programmable Logic Controller) systems. It is primarily used for programming, commissioning, and debugging Mitsubishi Electric's PLC models like the **MELSEC iQ-R** and **MELSEC-Q** series.

Key Features of GX Works2:

1. **Programming and Configuration**:
- GX Works2 supports a variety of programming languages such as ladder diagrams (LD), structured text (ST), and function block diagrams (FBD).
- It provides an integrated environment for both hardware configuration and software programming, making it suitable for developing complex automation systems.

2. **Debugging and Monitoring**:
- GX Works2 offers tools for real-time monitoring and troubleshooting, including the ability to monitor variables, inputs, outputs, and the status of the PLC.
- The software allows the programmer to test and debug programs step-by-step, ensuring the correct behavior of the PLC before full deployment.

3. **Graphical Interface**:
- The user interface is designed to be intuitive with drag-and-drop features, making it easier for programmers to create and manage complex systems.
- The software supports graphical programming which is especially helpful for beginners or engineers who prefer a visual approach to programming.

4. **Offline and Online Operation**:
- You can create and test your programs offline, without being connected to the PLC hardware, which is useful for initial program development and simulation.
- Once the program is ready, you can download it to the PLC and run it in online mode, making changes in real-time

5. **Data Logging and Analysis**:
- The software can log various data, allowing users to analyze and record PLC operation, which is particularly useful for diagnostics and optimization.

6. **Device and Memory Management**:
- GX Works2 makes it easy to manage devices, addresses, memory allocation, and parameters related to the PLC and connected equipment.

7. **Multiple PLC Support**:
- It allows users to work with multiple PLCs in a single project, simplifying the process of managing complex automation systems.

8. **Code Reuse and Libraries**:
- The software supports the creation and use of function libraries, allowing for code reuse across different projects and reducing development time.

Benefits:
- **Efficiency**: GX Works2 increases programming efficiency through various tools like structured programming, debugging support, and automated functions.
- **Integrated Environment**: Having both hardware configuration and software programming in the same environment reduces setup time and possible errors.
- **Ease of Use**: The graphical user interface makes it more accessible for engineers who may not be familiar with traditional programming languages.

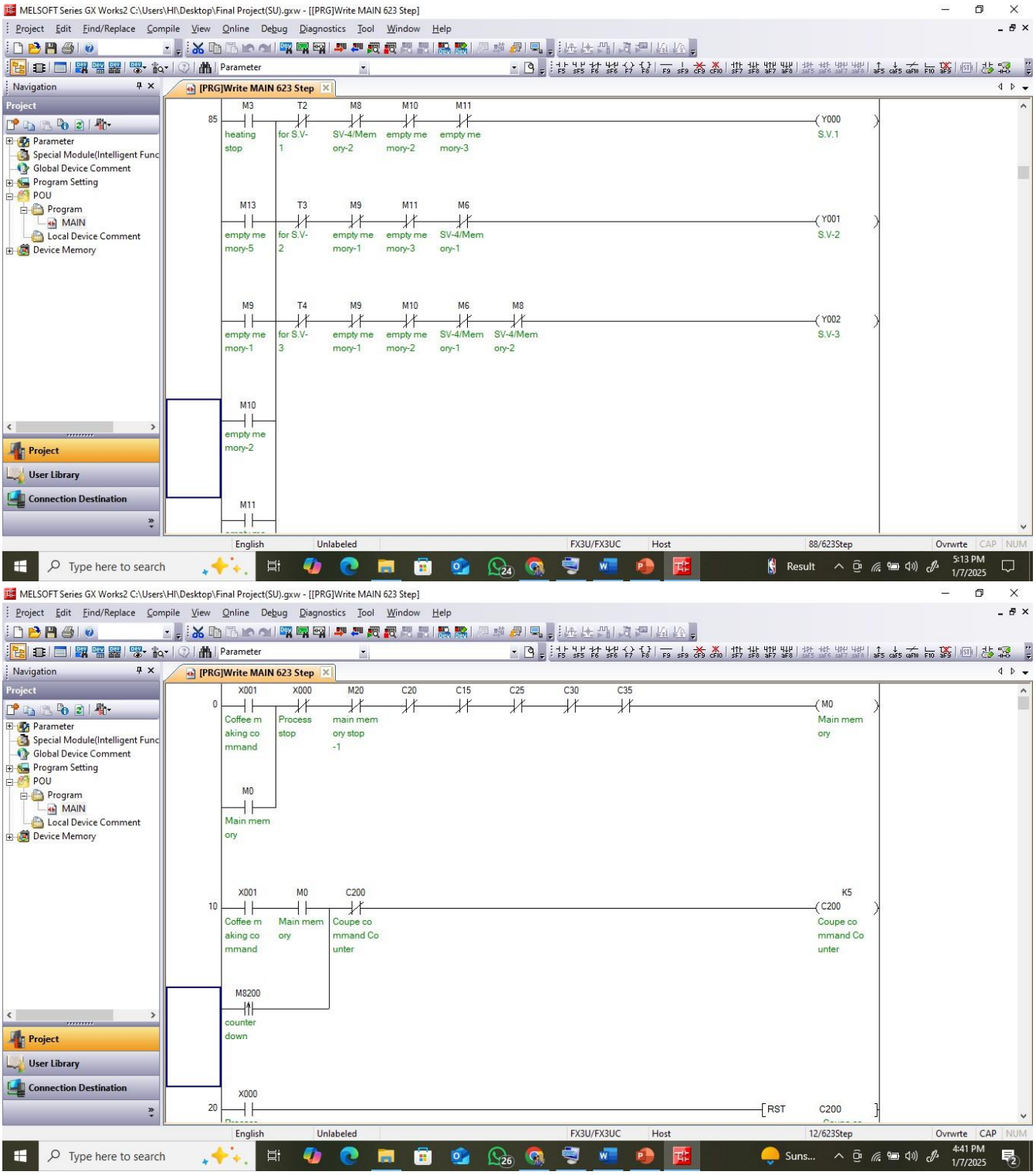


Figure 3.14 Small Part of Ladder Logic Program

Ladder logic programming is a graphical programming language commonly used in industrial automation, where a program is visually represented using a ladder-like diagram with vertical rails and horizontal rungs, resembling electrical circuit diagrams, to control machines and processes through a Programmable Logic Controller (PLC).**[3]**

CHAPTER 4

DESIGN AND DEVELOPMENT

4.1 System Design:

Designing a **Liquid Mixer and Heating System** involves creating a system that can mix different liquids while simultaneously heating them to a desired temperature. This kind of system can be used in various industries such as chemical processing, food production, pharmaceuticals, and more **[4]**. The design can be divided into several stages, which we will outline below.

1. System Requirements

The system should fulfill the following basic requirements:

- **Mixing of liquids**: Ensuring that different liquid components are uniformly mixed.
- **Heating of liquids**: Maintaining or reaching a specific temperature for the mixture.
- **Control**: Automated or manual control over temperature, mixing speed, and other factors.
- **Safety**: Over-temperature, over-pressure, and flow regulation safety systems.

2. Key Components

a. Tank/Vessel

The liquid mixer will be housed inside a mixing tank or vessel. The choice of material for the tank is important, especially in industries where the liquids can be reactive or sensitive to corrosion (e.g., stainless steel, glass-lined, or polymer tanks). The vessel can be:

- **Batch type**: For mixing a specific quantity of liquid.
- **Continuous type**: For constant flow mixing (more complex).

Design considerations:

- **Volume**: Based on the required throughput.
- **Shape**: Cylindrical or conical depending on space and efficiency.
- **Insulation**: For maintaining heat and reducing energy loss.

b. Mixer

The mixer is used to ensure that the liquids are evenly blended. This can either be a mechanical or pneumatic mixer depending on the application.

Types of mixers:

- **Agitator**: For standard mixing operations, it can be a paddle, propeller, or turbine.
- **Shear Mixer**: For emulsifying or homogenizing.
- **Static Mixer**: For continuous mixing where minimal moving parts are desired.

Design considerations:

- **Speed control**: Variable speed motor control.
- **Mixing efficiency**: Proper selection of the impeller shape and size.

c. Heating System

The heating system can consist of various components depending on the requirements of the process:

- **Electric Heating Elements**: Direct heating, relatively simple, and fast.
- **Steam Coils**: More efficient for large systems.
- **Hot Water Circulation**: Can be used in closed-loop heating systems.

Design considerations:

- **Temperature control**: A temperature sensor (RTD or thermocouple) is needed for maintaining the desired temperature. It's great for professionals working in industries where precise temperature control is critical, like semiconductor manufacturing or chemical production.**[6]**
- **Heat transfer rate**: The size of the heating surface and heating capacity should be optimized.
- **Insulation**: The system should be insulated to minimize heat loss.

d. Control System

A control system is necessary to monitor and control the mixer and heating system, which includes:

- **PLC (Programmable Logic Controller)** or **SCADA system**: For automation.
- **Sensors**: Temperature, flow, pressure, and level sensors.
- **Control Panel**: For manual operation and emergency shutdown.

4.2. Block Diagram:

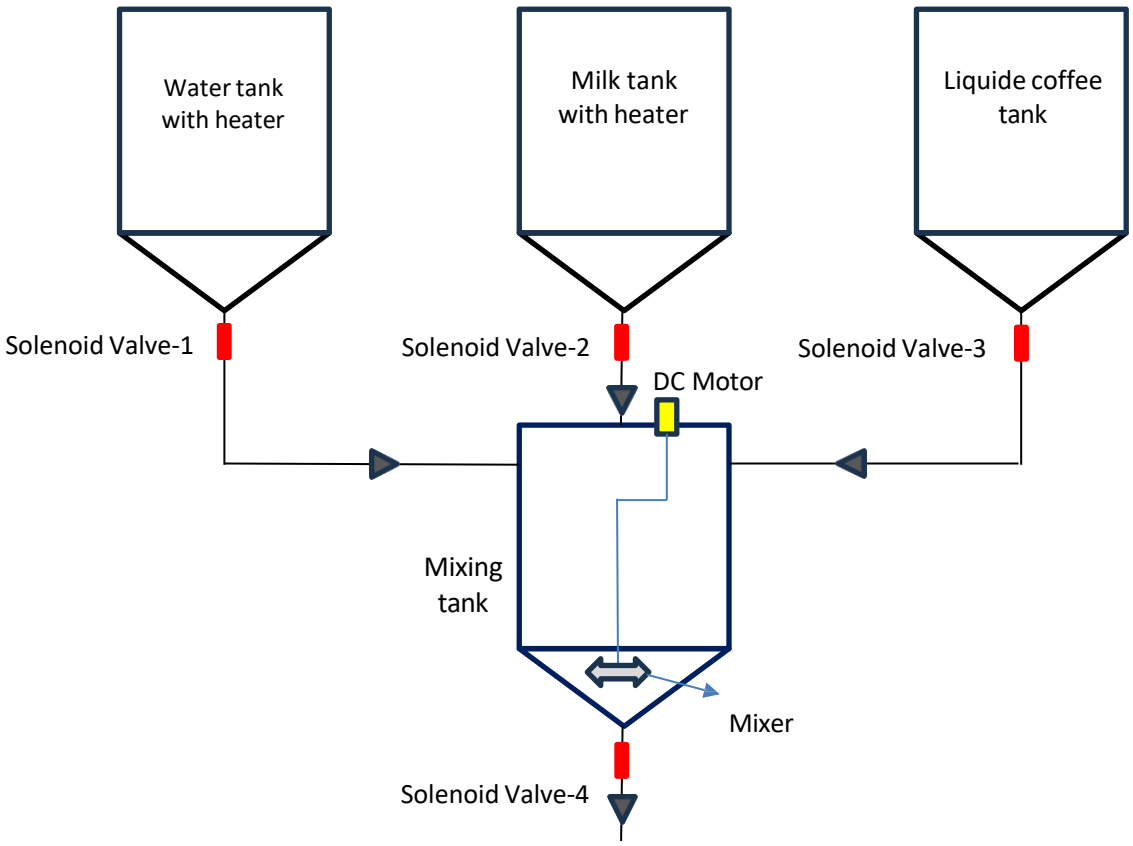


Figure 4.1 Block Diagram

4.3 Data Flow Diagram:

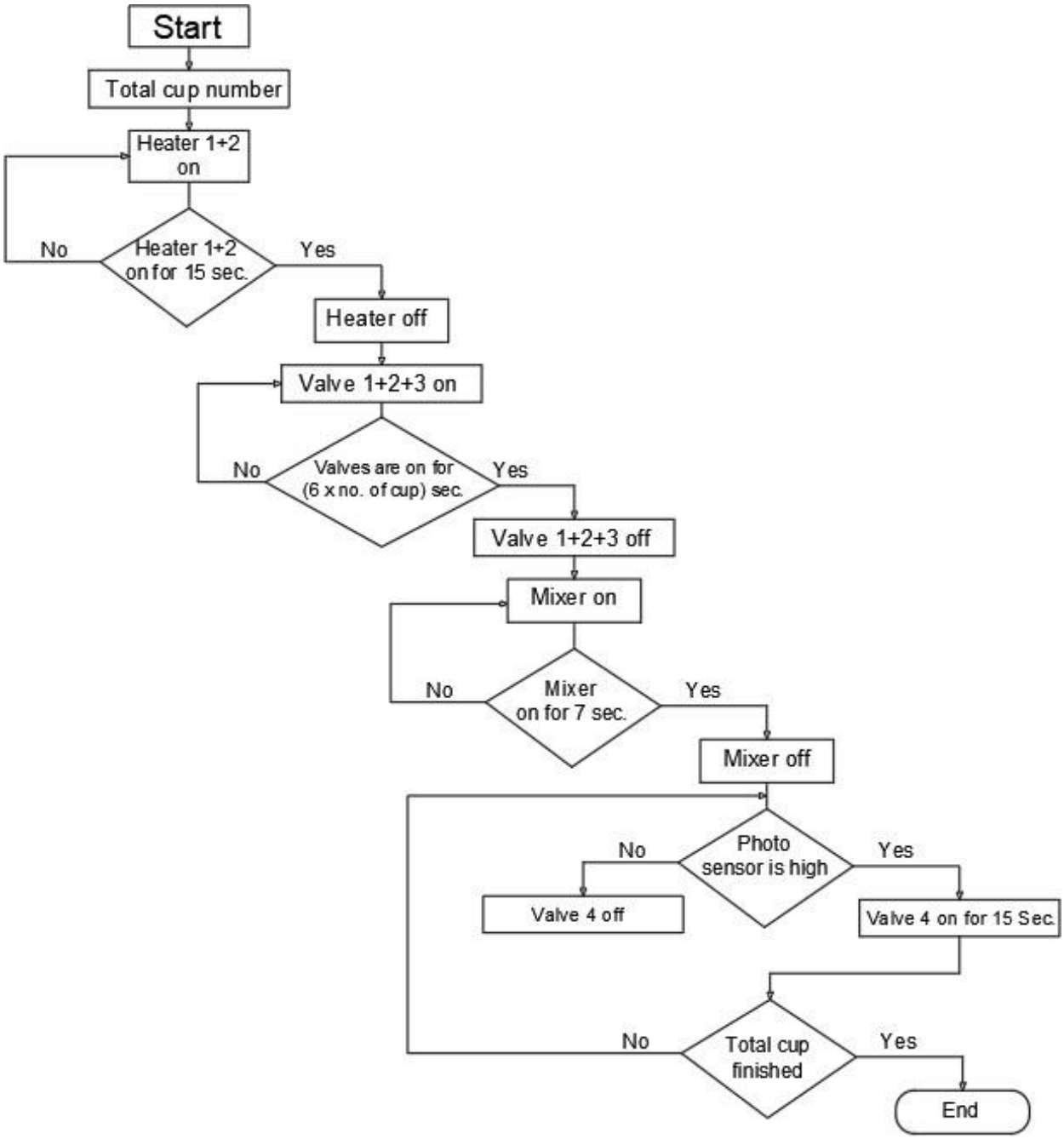


Figure 4.2: Data Flow Diagram

4.4 Circuit Diagram:

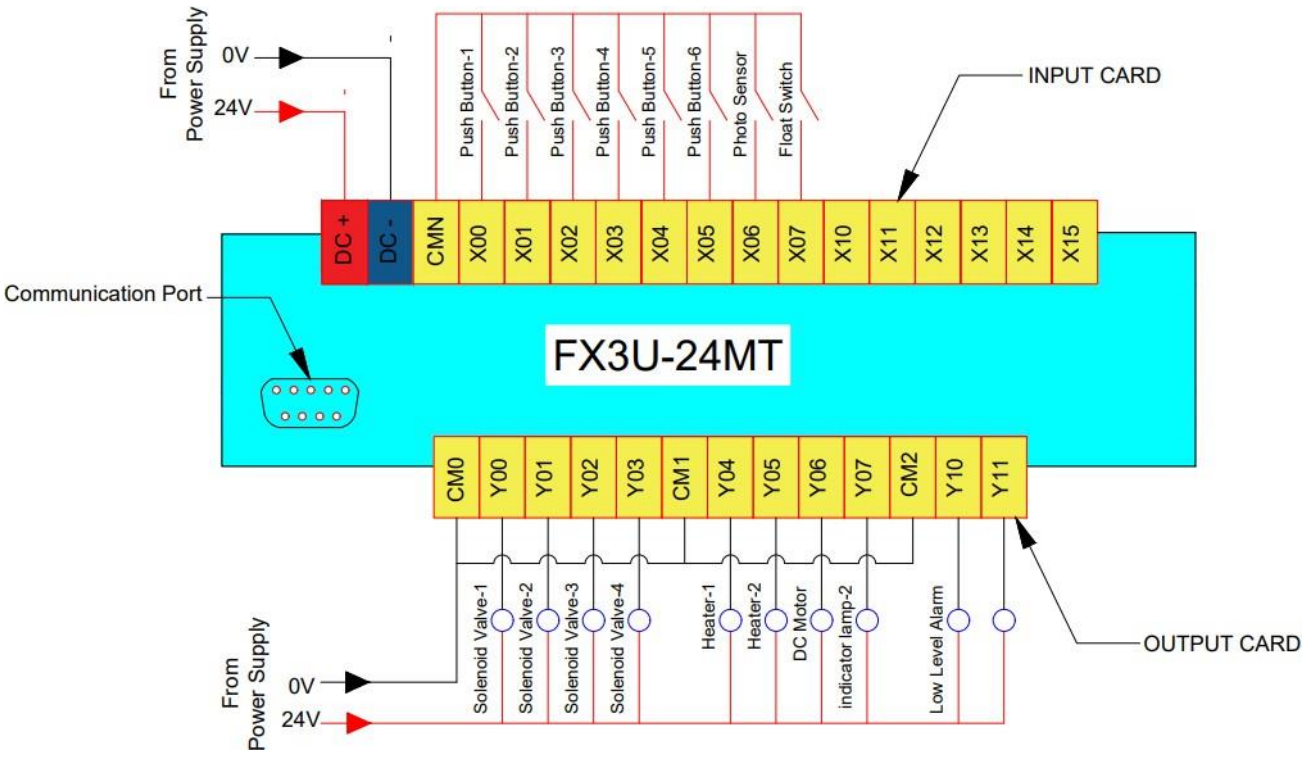


Figure 4.3: Controller Connection Diagram

4.5 Working Procedure:

- A green indicator lamp will be on, when the main system power in present.
- When we press the push button-2 (X001) only once time in 8 seconds (only one cup of coffee), then heating system (Y4 & Y5) will start for 10 seconds & will stop when 10 seconds will be completed. When process is running, a yellow indicator lamp (Y7) will be on.
- For cancelling the cup of coffee making command we need to press the push button-3 (X002), before ending the heating process.
- If all tanks level is not higher or equal than marked level, where the level sensors are (X007) located & we start push button-2 (X001) then an alarm (Y10) will be on for 3 seconds.
- System will not start, if any tanks level is coming to the marked level & after that we make 5 coupes.
- When heating process will off, then solenoid valve-1(Y0), solenoid valve-2(Y1) & solenoid valve-3(Y2) will be on at the same time. solenoid valve-1 will on for 2 seconds, solenoid valve-2 will on for 3 seconds & solenoid valve-3 will on for 3 seconds.
- When all solenoid valves will off again, then mixing system (Y06) will start for 5 seconds.

- When mixing system (Y06) will off & photo sensor (X006) detect a cup then & solenoid valve- 4(Y3) will be on for 5 seconds. solenoid valve-4(Y3) will not on, if photo sensor (X006) doesn't detect any coupe.
- If we want to increase the quantity to making cup of coffee, then we need to push the button-5 (X004) multiple times (Maximum 5 times) before 2 seconds of solenoid valve-1,2 & 3 energize & we cannot put the cup of coffee making command after stop the heating process.
- When multipole cup of coffee making command is active, after releasing the 1st cup we need to remove the cup from front of the sensor & put another cup for 2nd coupe releasing. Suppose 1st cup of coffee releasing done but we don't remove the cup from the sensor & another coupe don't put the front of the sensor, then the & solenoid valve-4(Y3) will not on.
- If we want just heating the liquid-1, then we need to press the push button-4 (X003). When we press the button then heater-1 (Y4) will be on (Maximum 5 minutes) & also off by X000. after that solenoid valve-1(Y0) & solenoid valve-4(Y3) will be on 1 minute.
- If we want just heating the liquid-2, then we need to press the push button-5 (X004). When we press the button then heater-2(Y5) will be on (Maximum 5 minutes) & also off by X000. after that solenoid valve-2(Y0) & solenoid valve-4(Y3) will be on 1 minute.
- When we want to empty the all tanks manually, then we need to press the Push button switch-6(X005) five times in 8 seconds, then the solenoid valves-1,2, 3 & 4 will on at the same time. This process will stop when we press the stop push button switch-1.
- If we press the Push button switch-6(X005) one times in 8 seconds, then only water release process will start & solenoid valve-1 & 4 will on. This process will stop when we press the stop push button switch-1.
- If we press the Push button switch-4 two times in 8 seconds, then only milk release process will start & solenoid valve-2 & 4 will on. This process will stop when we press the stop push button switch-1.
- If we press the Push button switch-4 three times in 8 seconds, then only coffee release process will start & solenoid valve-3 & 4 will on. This process will stop when we press the stop push button switch-1. if four times in 8 seconds, then solenoid valve-4 will be on.

CHAPTER 5

IMPLEMENTATION AND TESTING

5.1 Implementation of the Project:

1. Project Overview and Objective

- **Goal**: The primary goal is to design and implement a system that effectively mixes two or more substances while simultaneously heating them to a required temperature.
- **Purpose**: Identify the reasons for mixing and heating (e.g., chemical reaction, pasteurization, product formulation).
- **Scope**: Determine the capacity (volume), required temperature, heating time, and mixing consistency.
- **Timeline**: Set milestones for each stage of the project (design, testing, deployment).

2. System Design

Mixing Method:

Choose the mixing mechanism depending on the material to be processed (e.g., paddle mixers, agitators, or blenders).

Ensure that the mixer provides the desired shear, turbulence, or laminar flow to mix the substances effectively.

Heating Method:

Decide the heating method (e.g., electric heating, steam heating, direct flame, or jacketed vessels).

Ensure that the heating system is designed to provide consistent and even temperature distribution across the mixture.

Control Systems:

Use a temperature controller to maintain the target temperature (PID control for precision).

Integrate sensors like thermocouples or RTDs to monitor the temperature.

Include flow meters for accurate material input control.

Automation may be considered to monitor and adjust the mixing and heating process in real- time.

3.Implementation & Deployment

Full-scale Construction: Based on the prototype testing, build a full-scale system with all components integrated.

Installation: Install the system on-site (e.g., factory, lab, or processing plant).

Calibration: Calibrate temperature sensors, flow meters, and control systems.

Operator Training: Train operators to use the system safely and efficiently, with emphasis on the temperature controls, mixing techniques, and maintenance.

5.2 Results:

- We can mix different types of liquid by using the project.
- We make a cup of coffee by using the project.
- Heating liquids separately.
- Empty the all tanks individually

Project Picture:



Figure 5.1 Project Picture

CHAPTER 6

DISCUSSION & CONCLUSION

6.1 Discussion:

In the Discussion section, you'll interpret the results of the experiment or project. This is where you analyze the outcome, explain any patterns observed, and relate your findings to the hypotheses or objectives. You may also discuss any unexpected results or limitations of the study. Here's what to include:

1. **Overview of Results**:

Reactions and Changes Observed: Describe what happened when mixing and heating the substances. For example, did any phase changes occur (solid to liquid, liquid to gas)? Was there a chemical reaction (e.g., formation of a precipitate, color change)?

Expected vs. Actual Outcomes: Compare what you anticipated to happen with the actual results. Were there any discrepancies? If so, why do you think they occurred?

2. **Interpretation of Results**:

Scientific Explanation: Offer explanations based on scientific principles. For example, if heating caused a phase change, explain how temperature affects the intermolecular forces. If a chemical reaction occurred, discuss the chemical principles involved (e.g., exothermic or endothermic reactions).

Effect of Variables: Discuss how temperature, time, and the types of substances mixed affected the outcome. Did heating accelerate the reaction, or did it alter the physical properties (e.g., viscosity, solubility)?

3. **Challenges or Deviations**:

Unexpected Findings: If something surprising or unusual happened, explain why. Could it be due to impurities, inaccurate measurements, or environmental conditions?

Errors: Were there any errors or limitations in the experiment? This might include temperature control issues, inconsistencies in the mixing process, or measurement inaccuracies.

6.2. Conclusion:

A liquid mixer is a device designed to blend or combine different liquid substances to achieve uniformity, consistency, or a desired chemical reaction. The conclusion of a liquid mixer typically involves evaluating its efficiency, effectiveness, and performance in the given application.

6.3.Future Scope:

The future scope of mixing and heating systems holds significant potential across various industries due to advancements in technology, the growing need for energy efficiency, and the continuous demand for process optimization**.** Below are key trends and developments expected to shape the future of mixing and heating systems:

1.Energy Efficiency and Sustainability

Green Technologies: As industries aim to reduce their carbon footprint, there will be a growing shift towards energy-efficient heating systems, such as heat pumps, solar-powered systems, and waste heat recovery systems. This shift will help reduce reliance on fossil fuels.

Smart Heating and Mixing: Advanced control systems, powered by AI and IoT, will make it possible to optimize energy use in real time by adjusting temperatures and mixing speeds based on dynamic parameters. This will significantly reduce energy consumption.

Sustainable Materials: The use of environmentally friendly materials in the construction of heating and mixing systems, like recycled metals or non-toxic coatings, will become more widespread.

2.Automation and Smart Technologies

AI and Machine Learning: Integration of AI to predict and optimize the mixing and heating processes. Machine learning algorithms will continuously monitor parameters, adjusting controls in real time for more precise results and less waste.

IoT Integration: Sensors and connected devices will allow remote monitoring and control of mixing and heating systems, ensuring optimal performance, predictive maintenance, and system health monitoring.

Industry 4.0: The introduction of digital twins, cloud computing, and advanced analytics will allow manufacturers to simulate and optimize their processes in virtual environments before implementation.

3.Precision and Quality Control

Enhanced Mixing Technologies: The development of high-shear mixing and ultrasonic mixing technologies will allow for more efficient and precise blending of materials, crucial for industries like pharmaceuticals, food & beverage, and chemicals.

Advanced Temperature Control: The future will bring systems that provide more precise control over temperature gradients, which is vital for applications like polymer processing, biotechnology, and material science**.**

Process controllers are control system components which basically have an input of the error signal, i.e. the difference between the required value signal and the feedback signal, and an output of a signal to modify the system output. The ways in which such controllers react to error changes are termed the control laws, or more often, the control modes.**[5]**

4.Cost Reduction and Efficiency

Modular Systems: The demand for modular mixing and heating systems that can be customized for specific needs is increasing. These systems are easier to scale, maintain, and upgrade, reducing operational costs.

Hybrid Systems: Combining different heating technologies such as inductive heating and infrared heating may provide more efficient energy use and faster processing times.

5.Industry-Specific Advancements

Food & Beverage: The use of more gentle heating technologies like microwave or induction heating for temperature-sensitive products will increase, ensuring better quality without compromising the final product.

Pharmaceuticals: Highly controlled mixing and heating systems will be crucial in the production of drugs, vaccines, and biologics, where precision and hygiene are paramount. Continuous mixing systems could become the standard.[7]

Chemicals and Petrochemicals: Integration of reaction engineering into mixing and heating processes will allow for more efficient chemical reactions, leading to faster production cycles and reduced energy costs

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Thank You