IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

PLC-BASED CONTROL PANEL FOR INDUSTRIAL MIXER

Shital Sawant[1], Divya Ghodke[2], Jyotirmayi Purohit[3], Sayali Sunil Gote[4],
Department of Electrical Engineer, Shree Ramchandra College of Engineeing
Lonikand Pune.

Abstract*— This paper presents the design and development of a PLC-based control panel for an industrial mixer, specifically for bakery applications. The system aims to automate the operation of a 30 kW main mixer motor and a 1.5 kW brake motor using a Programmable Logic Controller (PLC) and Variable Frequency Drive (VFD). The control panel is equipped with industrial components like MCBs, MCCB, SMPS, relay card, MFM, and hooter for safety and real-time monitoring. The proposed system demonstrates improved process control, energy efficiency, and safety. The integration of PLC and VFD ensures smooth operation, while the modular design allows scalability to other industrial applications.

***Keywords*— PLC, VFD, Industrial Mixer, Control Panel, Bakery Automation, Motor Control, Industrial Automation**

I. INTRODUCTION

Industrial mixers are essential equipment used across various sectors such as food processing, pharmaceuticals, chemicals, and construction. Their primary function is to mix, blend, or homogenize materials to achieve uniformity in the final product. In bakery applications, mixers are especially critical for preparing dough and batter, which require consistent texture and composition. These mixers are designed to ensure uniform mixing, reduce human effort, and increase production efficiency. Various types of mixers such as spiral, planetary, and horizontal mixers are used depending on the application. Consistent mixing is critical to maintaining the quality and texture of bakery products. This paper deals with an automatic control panel which is used to control mixing automation. In industry to achieve an automation in mixing process, an automatic control panel require high technology tools like PLC, VFD and HMI to get rise in production rates. The modernization of the conventional system by replacing the command parts like relays, contactors, timers by a modern tool like Programmable logic controller, to run the motor at various speed VFD is used and Monitoring systems get information from a motor.

I. SYSTEM DESIGN AND IMPLEMENTATION

The control panel is designed using key components such as a Programmable Logic Controller (PLC), Variable Frequency Drive (VFD), Miniature Circuit Breakers (MCBs), Moulded Case Circuit Breaker (MCCB), Switch Mode Power Supply (SMPS), Noise Filter, and Relay Card. The PLC executes logic for motor control, while the VFD regulates motor speed. The MFM monitors electrical parameters, and relays interface the outputs for hooters and indicators.

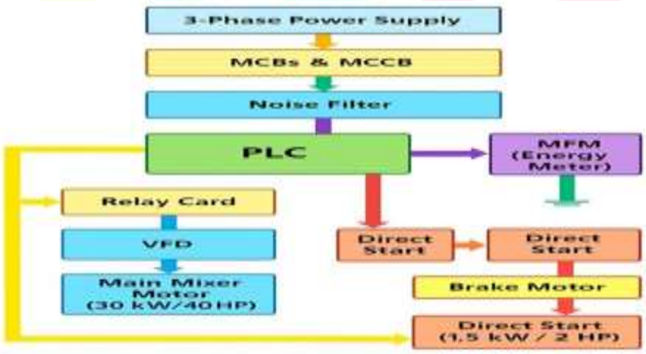

Figure no.1: Block diagram of System

I. BLOCK DIAGRAM AND WORKING

The block diagram of the system illustrates the logical connection and flow of signals and power in the PLC-based control panel. The 3-phase power supply is first passed through MCCB and MCBs for protection and distribution. A noise filter is used to suppress electrical interference. The SMPS converts AC supply to 24V DC for the PLC and control components.

The PLC acts as the brain of the system. It receives inputs such as limit switch signals and MFM readings, processes logic, and sends outputs to control the VFD and Brake Motor. The VFD regulates the speed and torque of the main mixer motor, allowing smooth operation. The brake motor, controlled via relay output from the PLC, ensures rapid stopping of the mixer.

1.1 PROGRAMMABLE LOGIC CONTROLLER (PLC):

PLC is a type of digital computer. Which has been widely used by industries in various manufacturing process .PLC replace the conventional hard-wired relays, timer etc from industries sector This is the core intelligence of the system. The PLC receives inputs (like limit switches, sensors) and controls outputs (VFD, brake motor, alarms, indicators) based on programmed logic.

Table-1: PLC specifications

COMPONENTS

Number of I/O	**20 inputs,12 outputs**
Power supply voltage	**24 V DC**
Power supply inrush current	**24 V DC,15 A for 20 ms**
consumption	**60 W**

1.2 Relay Card:

The relay card interfaces the low-voltage output of the PLC with high-voltage components like indicator lamps, hooter alarms, or contactors. PLC sends control signals to this card, which switches the larger loads ON/OFF through relays

1.3 VFD (Variable Frequency Drive):

The VFD is responsible for controlling the speed and torque of the main mixer motor:

• Receives control signals from PLC or relay card
• Converts fixed frequency AC to variable frequency AC
• Provides soft start, precise speed control, and overload protection

1.4 Main Mixer Motor (30 kW / 40 HP):

This is the primary working motor of the system. It handles heavy-duty mixing operations for bakery ingredients. It is:

• Controlled by the VFD
• Protected via MCCB and VFD settings
• Designed to run continuously or in cycles based on PLC logic

1.5 Direct Start – Brake Motor (1.5 kW / 2 HP):

This motor is connected via a direct start connection from the PLC. It is used to:

• Apply an electrical or mechanical brake
• Stop the mixer quickly and safely after operation
• Prevent overshoot or delay in halting rotation

V. WORKINDG OF INDUSTRIAL MIXER

The working of the system is governed by a programmed PLC and follows these steps:

1. System Initialization: When the power is turned on, the PLC checks all input devices and sets the system to the idle state.
2. Start Command: The operator starts the mixer using the HMI or physical Start button.
3. Safety Interlock Check: The PLC verifies conditions such as door closed, emergency stop not active, and proper level sensor signal.
4. Motor Activation: If all conditions are safe, the PLC signals the VFD to start the motor. The VFD ramps up the motor speed to the set value.
5. Mixing Operation: The mixer runs for a preset time or until a specific sensor condition (e.g., temperature threshold) is met.
6. Monitoring and Feedback: During operation, the PLC constantly monitors sensors. If any fault is detected (over-temperature, overload, etc.), the system halts and triggers an alarm.
7. Stop Command: Once the cycle is complete, the mixer stops automatically or can be stopped manually.

VI. LADDER LOGIC DIAGRAM

The ladder logic diagram represents the control logic programmed into the PLC to operate the industrial mixer safely and efficiently. It consists of several rungs, each implementing specific functions such as starting/stopping the mixer, timing the mixing cycle, and managing safety interlocks.

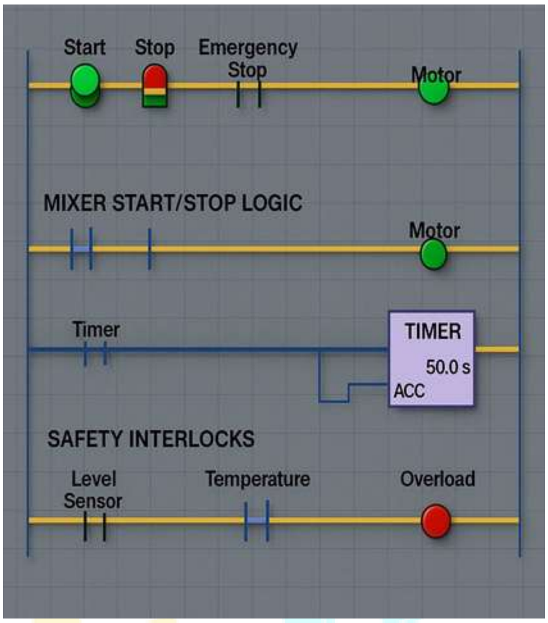

Figure 2.: Ladder logic

EXPLANATION:

1. **Mixer Start/Stop Logic**

• Start (NO): Initiates mixer operation.
• Stop (NC): Halts the mixer manually.
• Emergency Stop (NC): Immediate shutdown during faults.
• Motor Coil: Energized if Start is pressed and all interlocks are safe

2. **Timer-Based Control**

• TON Timer (50s): Automatically runs the mixer for 50 seconds.
• Purpose: Ensures uniform mixing duration.
• Deactivates motor after preset time is reached.

3. **Safety Interlocks**

• Level Sensor (NO): Ensures material is present.
• Temperature Sensor (NO): Prevents overheating operation.
• Overload Relay (NC): Trips motor in case of overcurrent.

FUTURE SCOPE

The future of PLC-based control panels in industrial mixers holds tremendous potential as industries continue to evolve towards greater automation, efficiency, and intelligence. With rapid advancements in technology, PLC systems are expected to become even more integrated with smart manufacturing concepts, such as Industry 4.0 and the Industrial Internet of Things (IIoT). This will enable real- time monitoring and remote control of mixers, allowing operators to optimize mixing processes dynamically based on data-driven insights.

Energy efficiency is another key area where PLC-based systems will advance. Future control panels will implement more sophisticated energy management strategies, such as variable frequency drives (VFDs) and optimized motor controls, to minimize power consumption without compromising performance.

Customization and scalability will further improve, allowing manufacturers to tailor control panels to specific mixing requirements with ease. User-friendly human- machine interfaces (HMIs) will evolve to provide more intuitive control and diagnostics, reducing training time and human errors.

In addition, safety features will be enhanced through smarter PLC logic and integration with emergency response systems, ensuring safer working environments. As sustainability becomes increasingly important, PLC systems will also support eco-friendly operations by enabling better waste management and cleaner processes.

CONCLUSION

The implementation of a PLC-based control panel in bakery applications significantly enhances the automation, precision, and efficiency of baking operations. By providing real-time control over mixing, baking, and conveyor systems, it ensures consistent product quality, reduces manual labor, and improves overall productivity. The system's flexibility allows for easy adjustments to recipes and processes, catering to dynamic production demands. Despite the initial investment and the need for technical expertise, the long-term benefits—such as reduced downtime, improved safety, energy efficiency, and data logging—make PLCs a reliable and cost-effective solution for modern bakeries. With proper design, programming, and maintenance, a PLC-based control panel serves as a robust and scalable platform for the automation needs of the bakery industry.

REFERENES

[1] Frank D. Petruzella, Programmable Logic Controllers, McGraw-Hill Education.
[2] Application Guide: VFDs in Food Processing, ABB Whitepaper, 2020.
[3] Design and Implementation of PLC-based Mixing Control System, IEEE, 2020.
[4] IEC 60204-1: Safety of machinery – Electrical equipment of machines – Part 1.
[5] Siemens PLC Programming Manuals, Siemens AG, 2021.
[6] HMI Programming Guides, Human Machine Interface Design and Development, Schneider Electric, 2020.
[7] Food and Drug Administration (FDA), Guidance for Industry: Food Processing Safety, U.S. FDA, 2017.
[8] R. G. Askin and C. R. Standridge, Modeling and Analysis of Manufacturing Systems, Wiley, 2015.
[9] VFD Application Notes, Variable Frequency Drives for Industrial Motors, ABB, 2020
[10] IEC 60204-1, Safety of Machinery – Electrical Equipment of Machines – Part 1: General Requirements, International Electrotechnical Commission, 2016.