

PLC Based Tank Temperature Control using PID Algorithm

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Abstract: *This project presents a PLC-based tank temperature control system using a PID algorithm for maintaining precise temperature. The water temperature inside the tank is measured using a Pt100 RTD sensor and sent to the PLC as an analog signal. The PLC compares the actual temperature with the setpoint and calculates the error using PID control logic. Based on the PID output, the PLC controls a heater through a Solid State Relay (SSR). The system ensures stable, accurate, and efficient temperature regulation suitable for industrial applications*

Keywords: *PLC-based tank temperature*

I. INTRODUCTION

Temperature control is one of the most important parameters in industrial automation systems because many industrial processes such as chemical processing, food production, pharmaceutical manufacturing, and water heating systems require accurate and stable temperature regulation to ensure product quality, safety, and energy efficiency. In this project, a PLC-based tank temperature control system is designed and implemented to monitor and control the temperature of water in a storage tank using a closed-loop feedback control mechanism. The temperature of the water is measured using a Pt100 RTD sensor, which converts temperature variations into corresponding resistance changes and provides an analog signal to the PLC through an analog input module.

The PLC used in this project is Allen-Bradley Micro820, which is a compact and economical controller suitable for small-scale industrial automation applications and supports digital as well as analog input-output modules. The PLC is programmed using ladder logic, and a PID (Proportional-Integral-Derivative) instruction is implemented to continuously calculate the error between the desired setpoint temperature and the actual measured temperature. Based on this calculated error, the PID controller generates a controlled output signal, which is sent to a Solid State Relay (SSR) to regulate the power supplied.

II. SYSTEM OVERVIEW

By The system consists of a PLC, RTD temperature sensor, SSR, heater, and 24V DC power supply.

The RTD sensor measures the tank temperature and sends a 4–20 mA signal to the PLC analog input module. The PLC processes this signal using a PID function block and generates an output signal. This output controls the SSR, which switches the heater ON or OFF accordingly. The system works in a closed-loop manner to maintain the desired temperature accurately.

III. METHODOLOGY

The methodology of this project involves designing and implementing a PLC-based closed-loop temperature control system using a PID algorithm. First, the required components such as PLC, RTD sensor, SSR, heater, and 24V DC power supply were selected based on system requirements. The PLC used in this project is Allen-Bradley Micro820, which supports analog input and output modules required for temperature control.



The Pt100 RTD sensor was installed inside the tank to measure the water temperature accurately. The RTD output signal was connected to the analog input module of the PLC in the form of a 4–20 mA current signal. The PLC was programmed using ladder logic to read the temperature value, compare it with the setpoint, and calculate the error. parking activities.

IV. BLOCK DIAGRAM AND EXPLANATION

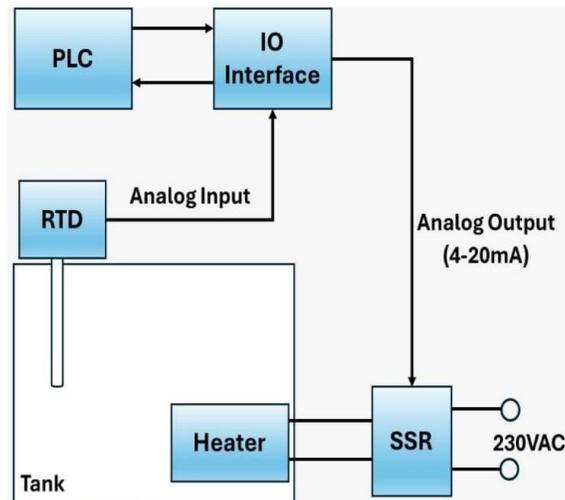


Fig : Block Diagram

1. RTD (Temperature Sensor):
The RTD measures the temperature of the liquid inside the tank and generates an analog signal.
2. I/O Interface (Analog Input Module):
The analog signal from the RTD is sent to the PLC through the input module.
3. PLC:
The PLC compares the measured temperature with the set value and processes it using a PID algorithm to generate a control signal.
4. Analog Output (4–20 mA):
The PLC sends a 4–20 mA analog output signal to the SSR.
5. SSR (Solid State Relay):
The SSR controls the 230V AC supply to the heater based on the PLC signal.
6. Heater:
The heater heats the liquid inside the tank and maintains the desired temperature.



V. CIRCUIT DIAGRAM

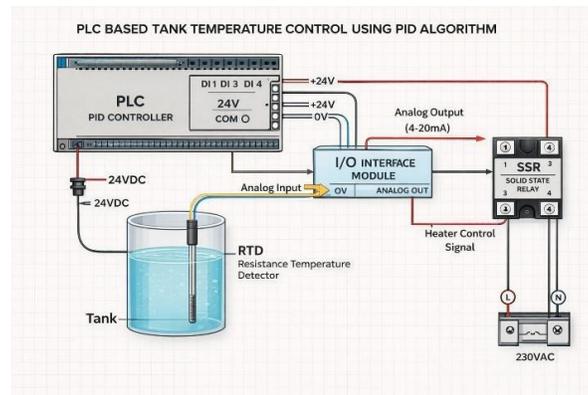


Fig : circuit diagram

VI. ADVANTAGES

1. High Accuracy and Precision
The PID algorithm continuously adjusts the heater output to maintain the set temperature accurately with minimal error.
2. Stable Temperature Control
The closed-loop system reduces overshoot and steady-state error, providing smooth and stable temperature regulation.
3. Flexibility in Programming
The PLC program can be easily modified to change temperature range or control parameters as per requirement.
4. Energy Efficiency
The system supplies power to the heater only when required, which helps in reducing unnecessary energy consumption.
5. Reliable Operation
PLC-based systems are highly reliable and suitable for continuous industrial operation.
6. Easy Maintenance
Fault detection and troubleshooting are simple due to PLC monitoring and diagnostic features.
7. Scalability
Additional sensors or control sections can be added easily without major system changes.

VII. LIMITATIONS

High Initial Cost

The implementation of a PLC-based temperature control system requires investment in PLC hardware, analog modules, sensors, SSR, and programming software. This makes the initial setup cost higher compared to simple conventional control systems.

Requirement of Skilled Personnel

Programming the PLC and tuning the PID parameters (K_p , K_i , K_d) require technical knowledge and experience. Maintenance and troubleshooting also need trained personnel, which may not always be easily available..

VIII. HARDWARE COMPONENTS LIST

1. PLC Controller – Allen-Bradley Micro820
2. RTD Temperature Sensor (Pt100)
3. Solid State Relay (SSR)
4. Electric Heater Element
5. 24V DC Power Supply



6. Analog Input Module (4–20 mA)
7. Analog Output Module
8. Water Tank
9. Connecting Wires and Terminal Blocks

IX. FUTURE SCOPE

1. Integration with IIoT

The system can be integrated with Industrial Internet of Things (IIoT) technology to enable real-time data monitoring and cloud-based storage. This will allow users to access temperature data remotely and improve process analysis.

2. Advanced HMI Development

A graphical Human Machine Interface (HMI) can be added to display temperature trends, alarms, and system status. This will improve user interaction and make operation easier.

3. Remote Monitoring and Control

By using Ethernet or wireless communication modules, the system can be monitored and controlled from a remote location. This increases flexibility and reduces the need for on-site supervision.

4. Energy Management System

Advanced control strategies can be implemented to optimize heater power consumption. This will help reduce energy usage and operational costs.

5. Implementation of Smart Control Techniques

Artificial intelligence or machine learning algorithms can be introduced for predictive temperature control. This will enhance system performance and adaptability

6. Expansion to Multi-Tank Control

The system can be upgraded to control multiple tanks using additional input-output modules. This will make it suitable for larger industrial applications..

X. CONCLUSION

The PLC-based tank temperature control system using PID algorithm provides an efficient and reliable solution for maintaining accurate temperature in industrial applications. In this project, the temperature of water is measured using a Pt100 RTD sensor and continuously monitored by the PLC. The PLC processes the temperature signal and applies the PID control algorithm to minimize the error between the setpoint and actual temperature.

The control output from the PLC operates the heater through a Solid State Relay (SSR), ensuring stable and smooth temperature regulation. The closed-loop feedback system helps in reducing overshoot, steady-state error, and temperature fluctuations. The system demonstrates good accuracy, flexibility, and energy efficiency

Although the system requires proper programming and skilled personnel for implementation, it offers reliable performance and easy modification for future expansion. Overall, the project successfully proves that PLC and PID control techniques can be effectively used for precise and stable tank temperature control in industrial environments.

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REFERANCES

- [1]. Y. C. Kim et al., "Development of a Heater Control System using PLC," IEEE Conference, 2006.
- [2]. Frank D. Petruzella, Programmable Logic Controllers, 2016.
- [3]. Frank Lamb, Industrial Automation: Hands- On, 2013.
- [4]. Max Rabiee, Programmable Logic Controllers: Hardware and Programming, 2009.
- [5]. Norman S. Nise, Control Systems Engineering, 2010.

