DESIGN OF A CONTROL SYSTEM FOR STABILIZING WATER SUPPLY PRESSURE

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ABSTRACT

In the context of increasing automation demands in both industrial and domestic water supply systems, pressure stabilization control is implemented to build an automatic control model that ensures stable pressure within water tanks.
The system employs a differential pressure sensor, Siemens S7-1200 PLC controller, linear pneumatic control valves, and a Weintek HMI for real-time monitoring and pressure adjustment. Data from the sensors are processed in the PLC using a PID algorithm, which then controls the valve opening to maintain the desired water level.
The model is simulated using Matlab/Simulink and programmed via TIA Portal. Results show that the system operates stably, responds quickly, provides high accuracy, and is suitable for practical applications such as water treatment plants, urban water supply systems, or industrial processes.

Keywords*: Water supply system, pressure control, Siemens S7-1200 PLC, HMI, pneumatic control valve, PID control.*

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1. INTRODUCTION

In the era of industrialization and modernization, automation has become increasingly vital across manufacturing and service systems. Pressure stabilization in water supply systems plays an essential role in various domains such as domestic water supply, industrial production, wastewater treatment, cooling systems, and other technical processes.

Traditional water supply systems often rely on manual control and lack the flexibility to respond to output fluctuations, leading to inefficiencies, unstable pressure, and reduced operational effectiveness. Applying automatic control technologies—especially those involving differential pressure sensors and PLCs—enhances precision, reduces errors, and increases remote monitoring capabilities.

Therefore, this study titled **"Design of a Control System for Stabilizing Water Supply Pressure"** is carried out to research, develop, and test a practical model using the Siemens S7-1200 PLC and PID control algorithm. The goal is to ensure reliable, accurate, and expandable system performance.

2. DESIGN OF A PLC S7-1200 CONTROLLER USING THE PID CONTROL ALGORITHM FOR WATER SUPPLY PRESSURE REGULATION

The Siemens S7-1200 PLC controller is designed to be compact, cost effective, widely used, and equipped with a powerful instruction set, enabling us to develop more optimal and effective solutions.

Figure *3.1:* Siemens S7-1200 PLC Controller

A control algorithm is essentially a mathematical function that describes the relationship between the setpoint and the controlled variable. The control algorithm is used to compute the requirements of various complex control loops..

❖ **Developing the Control Algorithm**

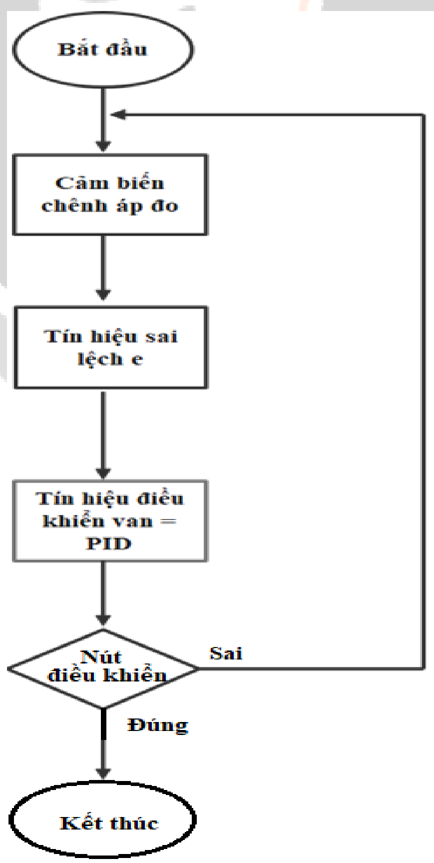


Figure *3.2:* System Algorithm Flowchart

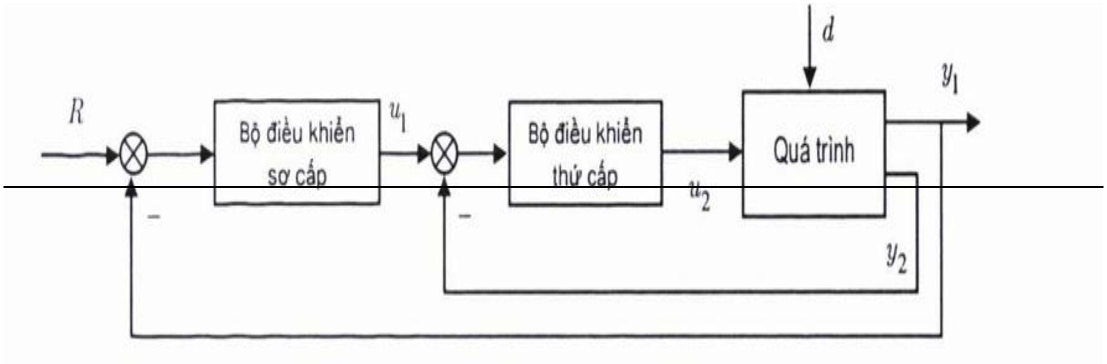


Figure 2.2: Flowchart of the System Algorithm

The transfer function of the system, after transformation and calculation in Matlab, is expressed as follows:

$$G(s) = \frac{9.701s + 1.5996}{3362.08s^2 + 6.06s}$$

The primary controller is calculated as follows:

Using the PID controller, the parameters are tuned using MATLAB:

With : C_{sc} (s) $= K_p + \frac{K_i}{s} + K_d.s)$

$K_p = 5{,}65$ $K_i = 338{,}32$ $K_d = 79{,}142$

=> C_{sc} (s) $= 5{,}65 + \frac{338{,}32}{s} + 79{,}142.s$

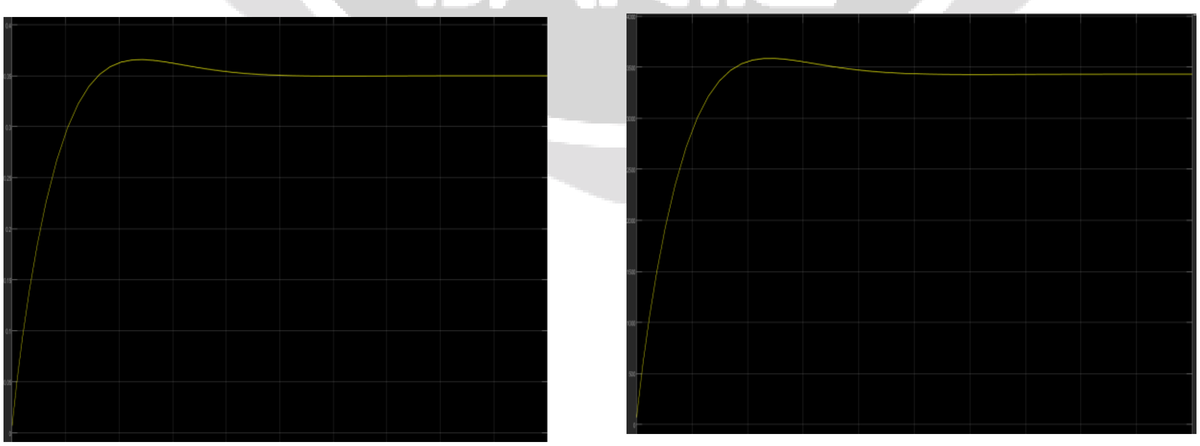
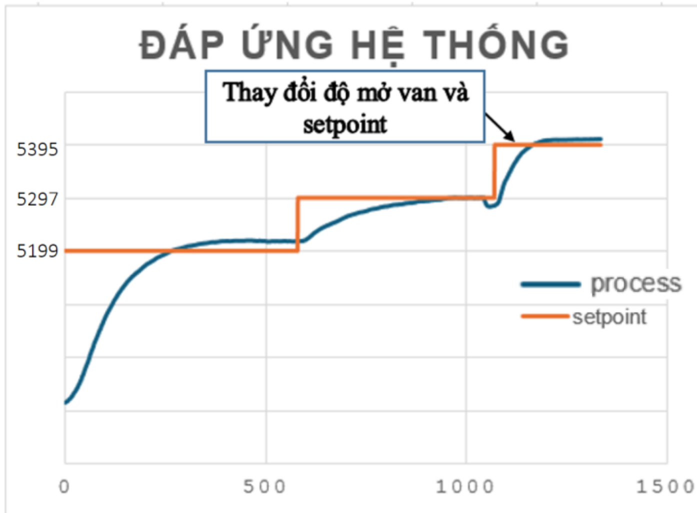


Figure *3.3:* Step Response and PID Parameter Simulation of the System

3. RESULTS OF WATER SUPPLY PRESSURE STABILIZATION CONTROL

The setpoint is SP = 53.3 cm. When the system operates in a stable state, the differential pressure sensor fluctuates within the range of 10.500 to 10.700 Nm^3/min, which can be observed on the differential pressure sensor display.



Figuge 3.4: System Response Results When Changing the Setpoint

4. RESULT

The paper successfully developed a control model using the Siemens S7-1200 PLC and a PID algorithm to maintain stable pressure in the tank. The system operates efficiently, provides fast response, exhibits low error, and demonstrates high applicability in real-world scenarios such as residential or industrial water supply systems..

The integration of PLC hardware with the PID control algorithm has enhanced the system's accuracy and stability. Although there are still some limitations, such as the lack of remote communication integration, this represents a promising direction for future research and improvements.

ACKNOWLEDGEMENT

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5. REFERENCES

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