DOI 10.24412/2181-1431-2023-4-31-35 Botirov T.V., Sodiqov B.Q.

USE OF INTELLECTUAL REGULATORS IN THE PRODUCTION OF POLYVINYL CHLORIDE

Botirov T.V. - Navoi State Mining and Technological University, Doctor of Technical Sciences, Acting Professor of the Department of Automation and Control, E-mail: btv1979@mail.ru, Uzbekistan, **Sodiqov B.Q.** - Navoi State Mining and Technological University, Doctoral student of department Automation and control, E-mail: sodbaxtiyor@yandex.com, Uzbekistan.

Annotation This article describes the principle of operation and constructive types of an intelligent regulator used in the production of polyvinyl chloride. Algorithms of intelligent regulators are studied.
Keywords: PID controller, controller tuning, synthesis algorithms, PVC production control system.

Annotatsiya. Ushbu maqolada polivinil xlorid ishlab chiqarishda ishlatiladigan intellektual rostlagichning ish prinsipi va strukturaviy ko'rinishlari tasvirlangan. Intellektual rostlagichlarning algoritmlari o'rganilgan.
Kalit so'zlar: PID rostlagich, rostlagichni sozlash, sintezlash algoritmlari, PVX ishlab chiqarish boshqarish tizimi

Аннотация. В данной статье описаны принцип работы и конструктивные виды интеллектуального регулятора, используемого в производстве поливинилхлорида. Изучаются алгоритмы интеллектуальных регуляторов.
Ключевые слова: ПИД-регулятор, настройка регулятора, алгоритмы синтеза, система управления производством ПВХ.

Introduction. Polyvinyl chloride (PVC) is one of the most widely used synthetic polymers globally, finding applications in various industries including construction, automotive, and healthcare. As the demand for PVC continues to rise, so too does the need for innovative solutions to improve its production efficiency and environmental sustainability. Intellectual regulators, a group of advanced technologies and systems, have emerged as a promising approach to address these challenges in the PVC manufacturing process. This article explores the use of intellectual regulators in PVC production and their impact on efficiency, sustainability, and quality control.[1].

Use of smart PID controllers.

In the realm of chemical technology, the constant pursuit of efficiency and precision in production processes is paramount. One crucial aspect of achieving these goals is the implementation of advanced control systems. Among them, the PVC (Polyvinyl Chloride) Smart PID (Proportional-Integral-Derivative) controller and PID regulator have emerged as game-changers, revolutionizing chemical production. This article will delve into the significance of these innovative technologies, explore their functionalities, and provide formulas and illustrations to better understand their applications.[2]

1. Understanding the Smart PID Controller: The PVC Smart PID controller is an intelligent device designed to regulate and optimize chemical processes. It combines the principles of proportional, integral, and derivative control to continuously monitor and adjust key variables such as temperature, pressure, flow rate, and composition. By maintaining optimal conditions, the controller ensures enhanced product quality, reduced energy consumption, and increased productivity.

2. The Functionality of a PID Controller: The PID controller utilizes three control actions to maintain desired process conditions:

a. Proportional Control (P): This control action responds to the difference between the desired setpoint and the current process variable. The controller calculates an output signal proportionate to this error, aiming to minimize it.

b. Integral Control (I): Integral control accounts for any sustained error that may persist even after proportional control has been applied. It continuously integrates the error over time and adjusts the output signal accordingly to eliminate steady-state errors.

c. Derivative Control (D): Derivative control anticipates future changes in the process variable by analyzing its rate of change. It helps stabilize the system by reducing overshoots and oscillations.[4]

3. Formulas for PID Controller Calculations: To better understand the mathematical aspects of PID control, here are the formulas used for calculating the output signal:

Output Signal

$$u(t) = Kp \bullet e(t) + Ki \bullet \int[0,t]e(t)dt + Kd \bullet \frac{de(t)}{dt} \quad (1)$$

where:

- K_p, K_i, and K_d are the proportional, integral, and derivative gains, respectively.
- e(t) represents the error between the setpoint and the process variable at time t.
- de(t)/dt denotes the rate of change of the error.

4. The Benefits of PID Controllers: Implementing PVC Smart PID controllers in chemical production processes offers several advantages:

a. Enhanced Process Stability: The PID control algorithm continuously adjusts the control signal, ensuring stability and minimizing deviations from the desired setpoint.

b. Improved Energy Efficiency: By optimizing control actions, the PVC Smart PID controller reduces energy waste and enhances overall energy efficiency.

c. Increased Product Quality: The precise control provided by PID technology ensures consistent product quality, minimizing variations and defects.

d. Reduced Downtime and Maintenance Costs: The ability to promptly detect and correct deviations helps prevent equipment failures, reducing downtime and maintenance expenses.[3]

5. Visualizing PID Control with Illustrations: Include relevant photos or diagrams depicting PVC Smart PID controllers in action, illustrating their integration into chemical production systems.]

Improving Process Efficiency: Intellectual regulators offer significant improvements in process efficiency, making PVC manufacturing more streamlined and cost-effective. These systems utilize advanced data analytics, artificial intelligence, and machine learning algorithms to optimize various stages of the production process. By monitoring variables such as temperature, pressure, and flow rates, intellectual regulators can quickly identify inefficiencies, deviations, and abnormalities, allowing for timely corrective actions. This not only reduces production downtime and waste but also increases overall productivity and output.[5]

Enhancing Resource Utilization: The integration of intellectual regulators enables better utilization of resources in PVC production, which can contribute to both economic and environmental benefits. By closely monitoring the consumption of raw materials, energy, and water, these intelligent systems can provide real-time insights that can help manufacturers identify opportunities for optimization and waste reduction. By minimizing resource waste, companies can enhance their operational efficiency, reduce costs, and lessen the environmental impact associated with PVC manufacturing.

Ensuring Quality Control: Quality control is a critical aspect of PVC production, as it directly affects the final product's performance and longevity. Intellectual regulators play a pivotal role in maintaining consistent product quality by continuously monitoring key process parameters. By analyzing large sets of data, these systems can identify potential defects, variability, or inconsistencies in real-time, enabling manufacturers to take corrective measures promptly. This results in a higher rate of quality assurance, minimizing the need for costly rework or product recalls.

Environmental Sustainability: The PVC manufacturing industry often faces scrutiny due to its environmental impact. However, the application of intellectual regulators can be instrumental in enhancing environmental sustainability throughout the production process. By optimizing energy consumption and reducing waste generation, these systems help reduce carbon emissions, conserve natural resources, and minimize the ecological footprint associated with PVC manufacturing. [6] Moreover, the improved quality control enabled by intellectual regulators ensures that the produced PVC meets stringent environmental regulations, contributing to a greener industry.

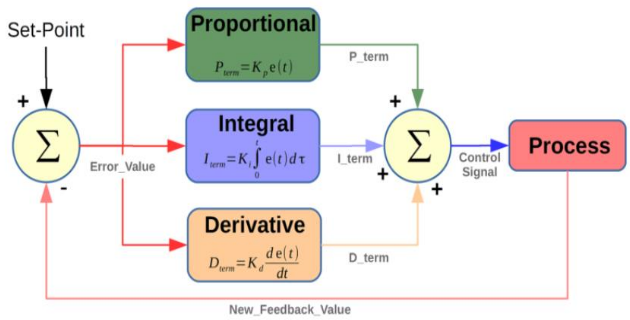


Figure1. Structural diagram of PID controller.

On figure1 shown a PID controller consists of three main components: the proportional, integral, and derivative terms. The proportional term calculates an output signal proportionate to the error between the setpoint and the process variable. The integral term accounts for any sustained error and continuously integrates the error over time to eliminate steady-state errors. The derivative term analyzes the rate of change of the process variable to anticipate future changes and stabilize the system.

Module of PID controller in Matlab program

We use the simulink package of Matlab 2022 to assemble this module and conduct research. Click the Library Browser button to collect the necessary modules in the Simulink package.The module we created consists of two subsystems, where the PID is an intelligent controller and a control object.[7] This module mainly uses the feedback control method(shown in figure2).

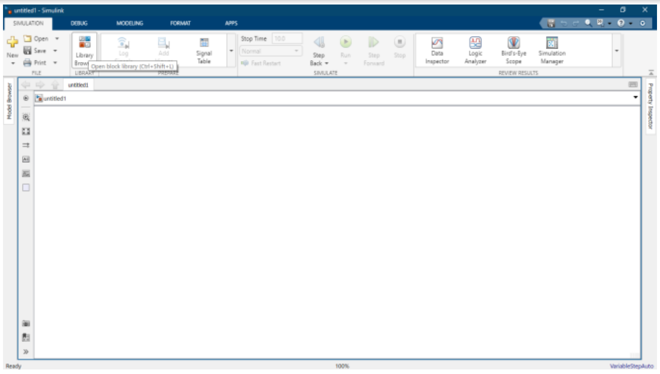


Figure2. How to click Library browser button.

We get the model by assembling two necessary subsystems and it will be as follows**.**

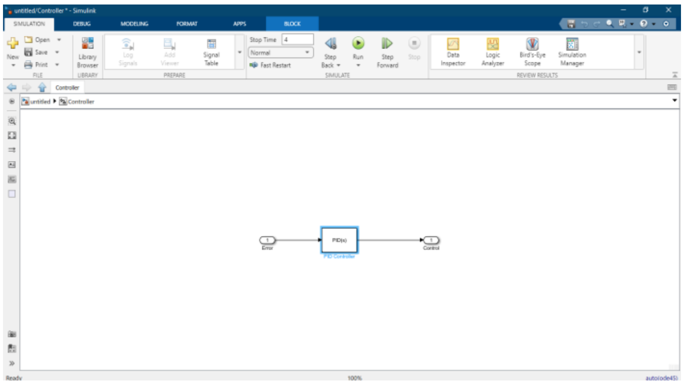


Figure3. First subsystem

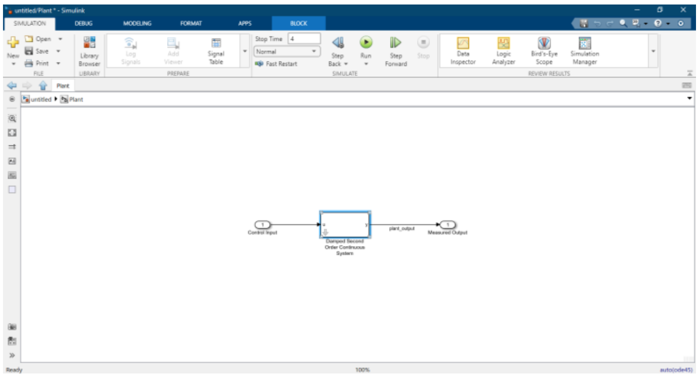


Figure4. Second subsystem

The general assembled model of the PID controller is as follows on feedback control method.

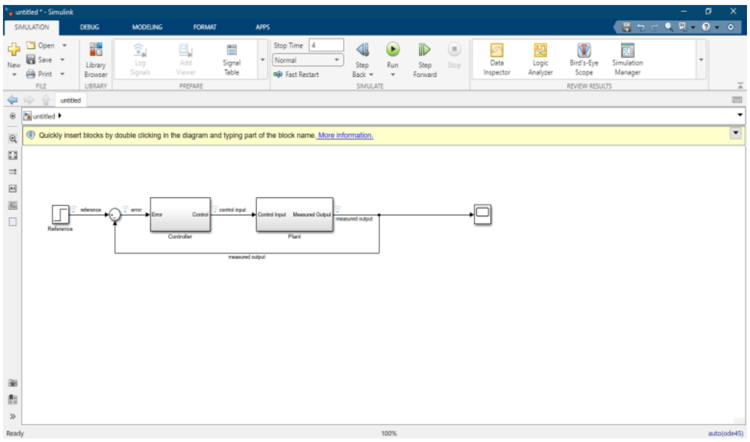


Figure5. Feedback control system example

In the Simulink model, we open the configuration parameters of the first subsystem assembled and enter the following information.

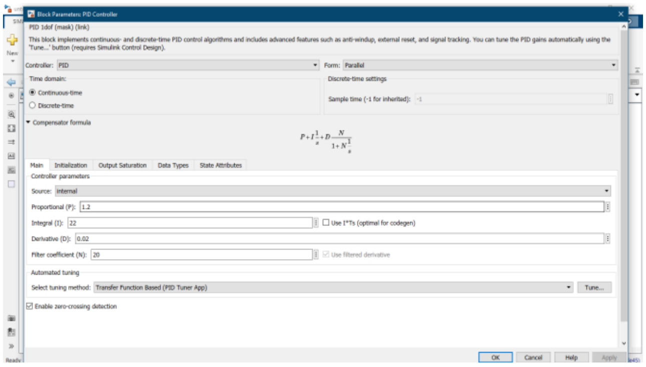
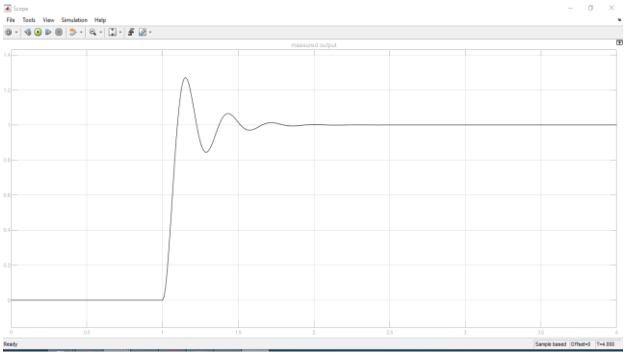


Figure6. Tuning for PID controller block.

By setting the stop time in the program to 4 seconds, we analyze the quality indicators of this built control system.



Conclusion.

This intelligent PID controller is highly desirable for use in the production process of polyvinyl chloride. It is shown in the graph that the quality indicators are very high. Innovations in the field of intellectual regulators have proven to be transformative in the PVC manufacturing sector. By optimizing process efficiency, resource utilization, quality control, and environmental sustainability, these advanced systems bring numerous benefits to PVC manufacturers. Implementation of intellectual regulators enables companies to achieve higher productivity, reduce operational costs, meet quality standards consistently, and contribute to a greener and more sustainable industry. As the demand for PVC continues to grow, the adoption of intellectual regulators will play an increasingly vital role in improving production processes and meeting the evolving needs of various industries.

References:

[1]. Sodiqov Baxtiyor. "Boshqarish prinsiplarining turlari va ahamiyati." *Yosh Tadqiqotchi Jurnali* 1.7 (2022): 85-87 p.

[2]. Botirov, T., Abduazizov, N., Sodiqov, B., & Khusanov, Z. (2023). Mathematical model of the movement of dust-contained air flows in the air filter of hydraulic systems. In *E3S Web of Conferences* (Vol. 390). EDP Sciences.

[3]. Botirov, T.V., Sodiqov B. Q. (2022). SYNTHESIS OF INTERVAL SELF-ADJUSTING REGULATORS IN ADAPTIVE CONTROL SYSTEMS. In *Научное обозрение: актуальные вопросы теории и практики* (pp. 58-59).

[4]. Botirov T.V, Karpovic D.S, Sodiqov B.Q, Latipov Sh. B Monography "Adaptive control systems and their application" Navoi 2022.

[5]. Yeong Koo Yeo (2018). Chemical Engineering Computation with Matlab. CRC Press Taylor Francis Group 629 p.

[6]. Katsuhiko Ogata. Modern Control Engineering. Pearson Higher Ed USA. 5 editions. 2019. -912 p.

[7]. Norman S. Nise. Control Systems Engineering. New York, John Wiley, 7 editions, 2017. – 944 p.