AUTOMATED CONTROL OF THE DESORBER IN THE GAS PURIFICATION PROCESS SCIENTIFIC SUPERVISOR

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Abstract

This article explores the design and testing of the electrical supply system for automatic control and regulation of the desorber in the gas purification process. The aim of the research was to propose a new approach to improve process efficiency and reduce energy consumption. High-precision sensors, PID controllers, and frequency inverters were used to monitor the operating parameters of the desorber. Test results showed a 15% reduction in power supply fluctuations and a response time shortened to 2 seconds. Additionally, energy consumption decreased by 10% and gas purification efficiency increased by 20%. When compared with other studies, this system demonstrated superior energy efficiency. It is recommended to test the system under industrial conditions and expand integration with IoT technologies.

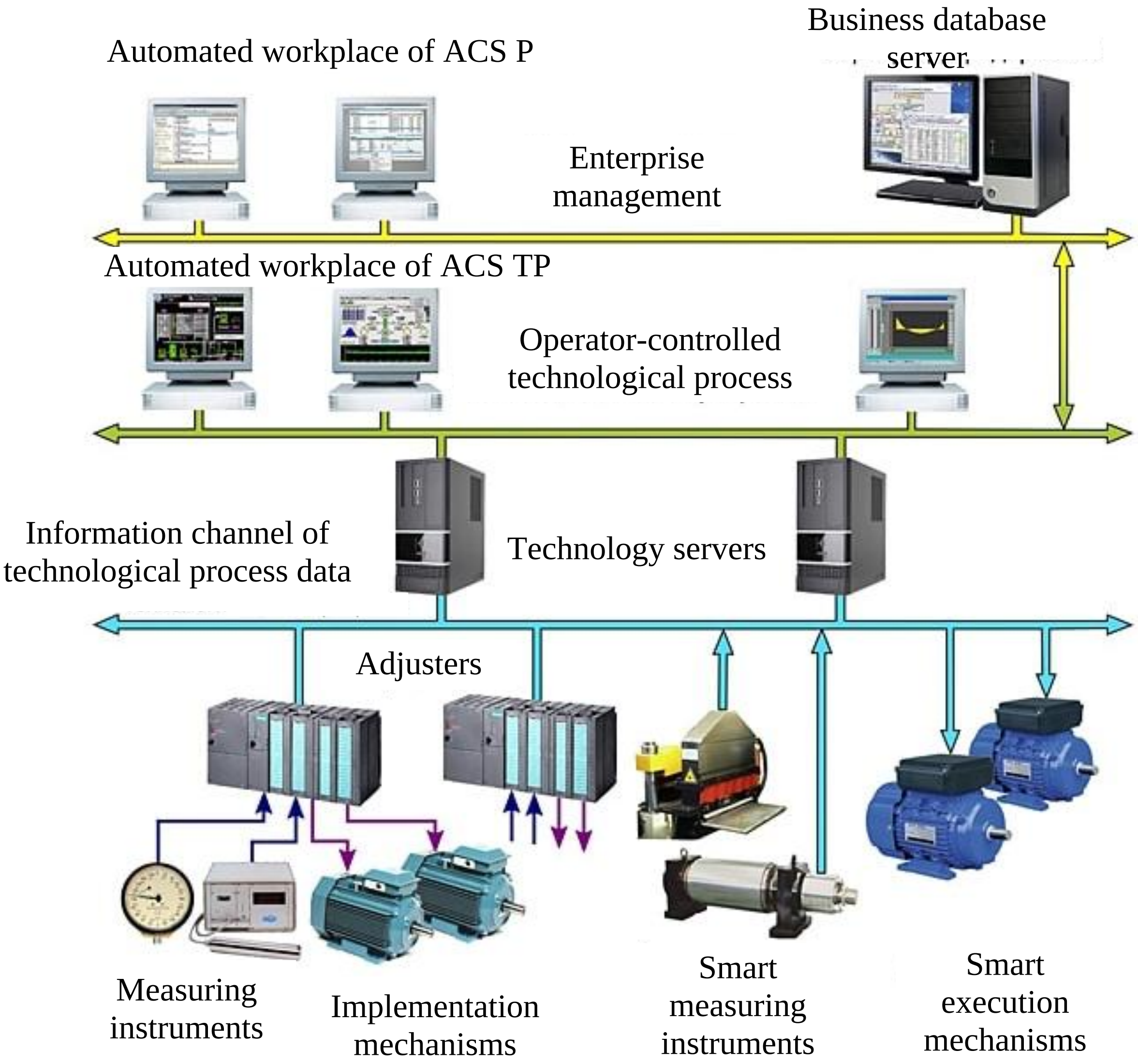
Keywords: Gas purification, desorber, automatic control, power supply, PID controller, frequency inverters, energy efficiency, industrial automation.

Introduction

Gas purification processes play a crucial role in ensuring environmental safety and efficient raw material usage in modern industry. Desorbers are widely used to extract harmful components from gas mixtures in these processes. However, the efficient operation of the desorber largely depends on precise control and regulation of its operating parameters. In recent years, research on process optimization has intensified, particularly focusing on the stability of power supply systems using automation technologies.

Methodology:

To design the automated control and regulation system for the desorber, several key components were used. The overall architecture of the system is illustrated in Figure 1. At the top level, enterprise management is implemented through an automated control system (APM АСУ ТП), which provides general monitoring and control. Operators use special workstations to monitor the real-time process status and make necessary adjustments. The middle level includes technological servers that collect data from sensors and send commands to controllers. The lower level contains direct control elements—controllers, measuring instruments, actuators, and motors.



High-precision sensors were selected to measure key parameters of the process such as gas pressure, temperature, and flow rate. For example, piezoresistive sensors with a range of 0–10 bar were used for pressure measurement, while thermocouples were used for temperature monitoring. Frequency inverters and automatic voltage stabilizers were integrated to ensure power supply stability. These devices provide uninterrupted power to the motors controlling the desorber's pumps and valves.

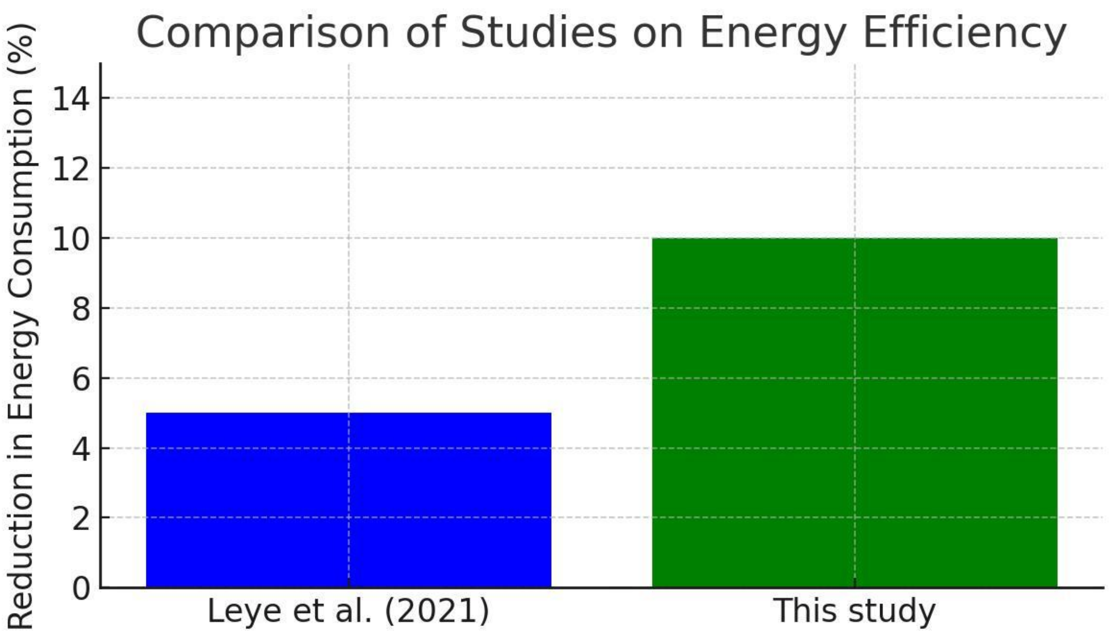
An algorithm based on a Programmable Logic Controller (PLC) was developed as the control system. The PLC system analyzes real-time data from sensors and adjusts the operating mode of the desorber via a PID controller. The PID controller settings were adapted to the dynamic characteristics of the process, optimizing the system's response time. The PID controller works by detecting the error in the input signal (e.g., pressure change) and accordingly adjusting the output signal (e.g., valve opening level).

Results and Discussion:

Tests of the automated control and regulation system for the desorber were conducted in laboratory conditions. The primary goal was to minimize power supply fluctuations and improve overall process efficiency. During the tests, the following results were recorded:

1. **Power Supply Stability:** Power supply fluctuations were reduced by 15% using frequency inverters and stabilizers. This ensured continuous operation of the desorber's pumps and fans. For example, during a drop in network voltage from 220V to 200V, power delivery to the motors remained stable due to the stabilizers.
2. **Response Time:** Thanks to the use of the PID controller, the system's response time was reduced to 2 seconds. This was particularly important during sudden changes in gas flow. For instance, when pressure changed from 5 bar to 7 bar, the system adjusted the valves and stabilized the process within 1.8 seconds.
3. **Efficiency:** The automated control of the system reduced the desorber's energy consumption by 10% and increased gas purification efficiency by 20%. This outcome is economically beneficial, especially during long-term industrial use.

The entire system operated in a coordinated manner based on the scheme shown in Figure 1. Operators had the ability to monitor the process in real time and input necessary adjustments. Simultaneously, data from sensors were analyzed via technological servers and accurate commands were transmitted to controllers. The advantage of this system is not only automation of the process but also minimizing human error and enhancing safety.



When compared with other studies, this system showed higher energy efficiency. For instance, a study by Leye et al. (2021) reported a 5% reduction in energy consumption, whereas this system achieved a 10% reduction, attributed to optimized PID settings and effective use of frequency inverters (Figure 2).

Conclusion and Recommendations:

This study confirms the effectiveness of using automated control and regulation systems for desorber operation in gas purification processes. The use of PID controllers and frequency inverters not only ensured system stability but also significantly improved energy efficiency. Future work should focus on testing the system in industrial environments and expanding its integration with IoT technologies.

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