MONITORING AND MANAGEMENT OF TECHNOLOGICAL PROCESSES FOR QUALITY ASSESSMENT OF FINISHED PRODUCTS AND ENVIRONMENTAL AIR POLLUTION

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Abstract: *This paper analyzes possible approaches to the development of systems for monitoring, diagnostics, control, and management of technological processes aimed at energy and resource conservation while ensuring the required quality of final products and compliance with environmental protection standards.*

Keywords: *Monitoring and diagnostics, control and management of technological processes, environmental protection, quality of final products.*

Economic growth is associated with the efficiency, losses, and speed of industrial production, which are focused on improving product quality, reducing production costs, shortening production time, and, equally important, minimizing the negative impact on the environment. To achieve this, it is necessary to find proper synchronization between individual production units and select the optimal parameters for machines and equipment operation.

Mathematical and computer modeling of real technical and technological objects of various physical nature is a necessary and fundamental part of modern scientific and technological development. The accumulated experience enables the creation of new models of such objects. The connection between modeling and the management of technological processes underpins innovative developments in this subject area.

Creating a system for monitoring and controlling production processes that will reduce energy consumption and harmful emissions while achieving the required product quality according to accepted standards is a relevant task of contemporary science and technology development.

In modern technical systems, one of the most critical issues is the efficiency of the functioning of the studied objects. The main indicators of economic efficiency include productivity, effectiveness, and profitability. The essence of efficiency lies in achieving the maximum economic result per unit of resource used.

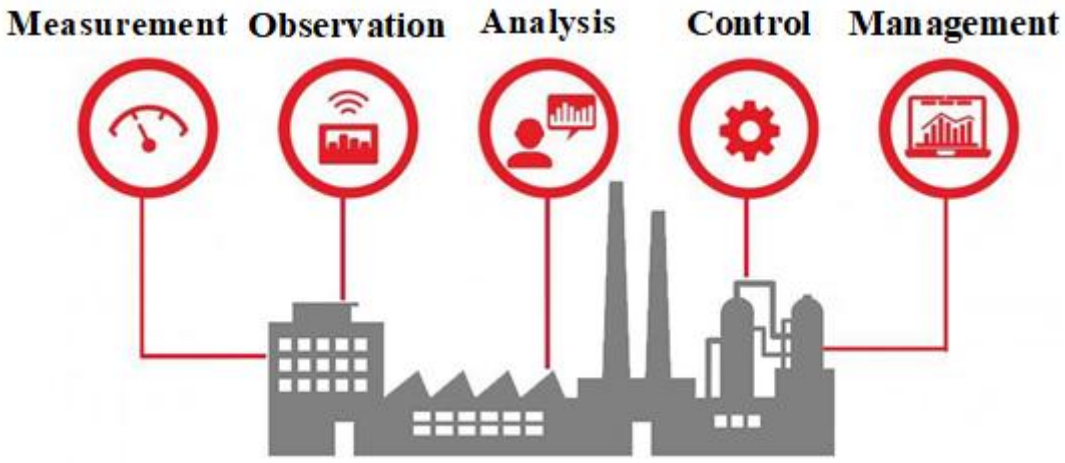
To improve the efficiency of an individual technological unit, the quality of input resources entering the production process plays a significant role. When higher-quality raw materials and components are used, the final product tends to demonstrate significantly better quality indicators. Moreover, the presence—or rather, the absence—of defects in production is considered one of the key indicators of product quality.

Typically, production optimization focuses on investments in high-quality materials to produce high-quality final products with minimal costs, minimal energy consumption, and minimal waste. At the same time, it adheres to the principles of corporate social responsibility (CSR), which involves maximizing positive and minimizing negative impacts on society. In particular, the philosophy of CSR includes the protection of the environment and natural resources. This includes programs for the efficient use of natural resources, recycling and reuse, pollution prevention, and environmentally friendly production processes.

In the context of production optimization, one of the key areas to focus efforts on is the environment. Pollution can be avoided—or at least significantly reduced—through the application of a comprehensive set of production process optimization methods.

To be effective, organizations require a well-integrated management system. The ultimate goal of such a management system is to ensure quality, monitor environmental protection, and meet techno-economic requirements. One of the directions pursued within the management system is the implementation of an electronic system for monitoring and managing production processes.

The development of a control and management system aligned with the first four stages of the industrial revolution—Industry 4.0—aims to enhance production efficiency and minimize the negative impact on the environment through fast, convenient, safe, and non-destructive technological measurements.



Let us consider two approaches to reducing harmful emissions resulting from technological processes.

The global approach involves measuring the levels and concentrations of harmful substances outside the enterprise and linking them to the production process in real time through an electronic system for monitoring and controlling production processes.

The local approach focuses on the development of an electronic system that includes specialized peripherals directly controlling the production process. This approach is significantly more effective, as it either prevents or substantially reduces the formation of pollutants and mitigates the negative environmental impact of production processes.

Thus, the specialized literature lacks a comprehensive solution and a unified system for collecting information on pollution, processing and measuring pollutant concentrations, forecasting the spread of pollutants in the environment, and detecting dangerously high concentration levels.

Data collection is not standardized, and it is either impossible or extremely difficult to integrate additional measurement systems into existing solutions, which complicates the tracking of real-time pollution fluctuations caused by production processes.

Technological processes have a significant impact on the environment, and it is essential to establish both quantitative and qualitative assessments of pollution when constructing industrial facilities. This enables rapid data processing while ensuring the accuracy of the results obtained.

This study focuses on the development and investigation of an electronic system for monitoring and controlling the production process, with the aim of improving expert evaluation in the qualification of industrial production and final products.

The research is carried out in the following main stages:

studying the problem of pollution resulting from technological processes,

selecting materials and devices for measurements,

choosing data analysis algorithms, and preparing conclusions and strategic recommendations.

The solution involves the use of sensor measurement modules, processors, and materials integrated into an electronic system for monitoring and controlling the production process.

The goal is to develop an innovative hardware and software system—a network of physical devices interconnected through electronics, software, sensors, and actuators—which collect and exchange data with one another, providing flexibility in implementation, mobility, and low power consumption.

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