INTERNATIONAL MULTIDISCIPLINARY JOURNAL FOR RESEARCH & DEVELOPMENT
SJIF 2019: 5.222 2020: 5.552 2021: 5.637 2022:5.479 2023:6.563 2024: 7,805
eISSN :2394-6334 https://www.ijmrd.in/index.php/imjrd Volume 12, issue 06 (2025)

STUDYING THE VENTILATION SYSTEM OF PRODUCTION ENTERPRISES AND PROVIDING RECOMMENDATIONS

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Annotation. This article covers the study of effective ventilation systems in industrial enterprises and the development of improved recommendations based on them. At the same time, the influence and relevance of the ventilation system on the production environment are shown. Also, based on observations and calculations, important results on air exchange, energy efficiency, and microclimate management are presented. As a result, recommendations were given for the implementation of modern, environmentally friendly, and cost-effective ventilation systems to increase production efficiency and improve working conditions, which have proven effective.

Introduction. Modern production enterprises pay great attention not only to high efficiency, but also to a safe and healthy work environment. In particular, air exchange at industrial facilities, microclimate stability, and maintaining ecological balance are among the most important issues today. Ventilation systems are one of the main technological means in this regard, through which high-quality air circulation in buildings, emission of harmful gases, and regulation of humidity and temperature are ensured. Especially in such industries as chemistry, metallurgy, food processing, and the production of building materials, ventilation systems have a direct impact not only on human health but also on the stable operation of the production process.

Various gases, dust, heat, and other harmful factors are released during production processes. If such factors are not eliminated in a timely manner, they can negatively affect the health of workers, labor productivity, and even the service life of equipment. This, in turn, leads to an increase in production costs, an increase in the number of malfunctions and unemployed days. Therefore, the creation and constant improvement of effective ventilation systems at modern production enterprises is a requirement of the times.

Analysis of scientific sources shows that the effectiveness of ventilation systems depends on several factors: the architecture of the enterprise building, the characteristics of production processes, the level of internal heat release, environmental conditions, the technical parameters of ventilation equipment and their control system. In particular, energy efficiency and automated control systems are becoming one of the important criteria for ventilation systems today.

The Law of the Republic of Uzbekistan "On Labor Protection" and other relevant regulatory documents stipulate the obligation to ensure safe working conditions at production enterprises. In accordance with these legislative norms, each industrial enterprise must implement ventilation systems that correspond to its technological processes and meet environmental and sanitary-hygienic requirements. However, in practice, in many enterprises, these systems are outdated, malfunctioning, or do not exist at all. This leads to a decrease in labor productivity and an increase in health risks[1].

In solving this problem, research work, experimental results, and technical and economic calculations are of great importance. When developing ventilation systems, it is necessary not only to analyze the current situation, but also to create an optimal system, taking into account the technological and economic capabilities of the enterprise. In addition, the introduction of energy-saving technologies, integration with air purification equipment and automatic control systems is also one of the modern requirements.

The scientific novelty of this research lies in the fact that it compares existing systems with modern technologies and shows how to implement an optimized system in the conditions of a specific enterprise. During the study, analyses were carried out based on the methodology for measuring microclimate parameters (temperature, humidity, air velocity, dust concentration), calculating air exchange, and assessing the effectiveness of ventilation equipment. Individual solutions corresponding to the architecture of production facilities were also proposed.

METHODOLOGY

The issue of organizing effective ventilation systems at industrial enterprises has been widely studied in many scientific studies and applied projects. Analysis of the literature shows that research in this area is mainly focused on three areas: standardization of air quality in the industrial environment, design of energy-efficient ventilation systems, and development of systems operating on the basis of automatic control.

In studies on the dynamics of airflow in industrial buildings, developed by Academician A.G. Smirnov (2019), the location of buildings and the condition of internal equipment are noted as important factors for increasing the efficiency of air exchange. In his opinion, ventilation serves not only to refresh the air, but also to prevent the accumulation of heat and harmful gases by correctly directing the airflow[2].

Local researcher O.M. Juraev (2021) studied the technical and energy condition of existing ventilation systems at industrial enterprises of Uzbekistan and noted that many enterprises use old and low-efficiency systems. He substantiated the possibility of reducing energy consumption by 20-30% through the introduction of modern, energy-saving ventilation devices [3].

Referring to international experience, in a report published by VentSys in Germany in

Also, the World Health Organization's (WHO) 2022 manual "Indoor Air Quality in Industrial Environments" provides complete information on the negative impact of air pollution in the industrial environment on the health of workers. According to him, in poorly ventilated rooms, there is a high risk of allergic diseases, inflammation of the respiratory tract, and a decrease in labor productivity [5].

As noted in the literature, when designing ventilation systems, it is important to consider the following factors: the nature of the industry (chemical, metallurgical, food, etc.), the degree of heat release, the size of the room, the location of the technological equipment, and external climatic conditions. For example, in experimental studies conducted by V. Petrov (2020), it was noted that the combination of natural and forced ventilation in high-temperature industrial workshops yielded the most optimal result [6]. Based on the sources analyzed above, it can be said that the design of an effective ventilation system is a multifactorial problem, requiring a comprehensive solution that combines a scientific approach, modern technologies, and energy efficiency requirements. Therefore, the introduction of environmentally and economically efficient systems based on innovative approaches at industrial enterprises of Uzbekistan is a pressing issue.

RESULT AND DISCUSSION

During the study, the existing ventilation systems of three types of production enterprises (metallurgical, food, and chemical industries) were analyzed. At each enterprise, air temperature, relative humidity, the amount of carbon dioxide (CO2), and the degree of air exchange (ACH - Air Changes per Hour) were selected as criteria. The following table shows the preliminary measurement results:

- ✓ At metallurgical and chemical enterprises, the air temperature and CO2 content exceeded the norm, and inefficient ventilation systems were observed.
- ✓ At the food enterprise, due to higher air exchange, the parameters are close to the norm.
- ✓ In many enterprises, systems operate on the basis of local fans, far from automatic control.

After identifying the problem, a modernized ventilation system project was developed for each enterprise. For them, a decrease in energy consumption, air refresh rate, and CO2 level was calculated. The following table compares performance indicators:

As can be seen from the analysis, with the help of the proposed systems:

- ✓ The air circulation level at all enterprises was brought to ≥3.0 ACH.
- ✓ The possibility of saving up to 10-25% of energy has appeared.
- ✓ Harmful gases in the working environment (in particular, CO2) decreased to 18-40%.
- ✓ The temperature and humidity in the room have been brought close to normal, which directly affects the health and productivity of employees.

During the discussion, it was revealed that the following factors are important for creating an effective ventilation system:

1. Correct assessment of the architecture and size of the building;
2. Identification of local heat and dust sources;
3. Integration of ventilation equipment with an automatic control system;
4. Use of sensory control systems that optimize energy consumption.

It has also been determined that it is possible to further increase environmental and economic efficiency through the use of renewable energy sources (solar batteries, heat recuperators).

In this article, the state of existing ventilation systems at production enterprises was studied, their main shortcomings were analyzed, and effective solutions based on modern technologies were proposed. Studies have shown that in many industrial enterprises, ventilation systems are outdated, have low energy efficiency, and do not provide adequate air circulation. This leads to a deterioration of the working environment, the accumulation of harmful gases, and high temperatures and humidity. Such situations negatively affect the effectiveness of production and the health of employees.

The study conducted measurements using the example of enterprises in the metallurgical, food, and chemical industries, and assessed the effectiveness of the systems. The results showed that by modernizing ventilation systems, it is possible to reduce the amount of CO2 in the air by up to 40%, bring the air circulation level to the standard level, and reduce energy consumption by 10-25%. Thanks to the proposed systems, the microclimate in buildings has been normalized and environmental safety has been significantly improved.

Based on this research, the following conclusions and recommendations can be made:

1. Monitoring of the effectiveness of the ventilation system should be carried out at each production enterprise. Existing systems should be evaluated based on a technical audit, and parts that need to be updated should be identified.
2. When designing new systems, automatic control capabilities, sensory control systems, and energy-saving technologies (e.g., recuperation, inverter motors) should be implemented.
3. Considering the architecture of the enterprise buildings and the location of technological lines, it is advisable to choose a combination of local and central ventilation systems.
4. The use of environmentally friendly and renewable energy sources, for example, partial ventilation using solar panels, will bring economic and environmental benefits in the long term.
5. Design and certification of the system should be carried out on the basis of current state standards in the field of labor protection and ecology (SanPiN, GOST, SNIP). Ventilation systems should be viewed not only as a means of releasing heat or gases, but also as a means of creating a healthy and safe environment for employees.
6. The establishment of a service and maintenance system related to ventilation systems is important for their uninterrupted operation.

In conclusion, the introduction of an effective ventilation system at industrial enterprises not only improves the working environment, but also plays a decisive role in ensuring production productivity, energy efficiency, and employee health. This creates an important basis for development in accordance with the principles of sustainable production and environmental safety.

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