"SCIENTIFIC FOUNDATIONS FOR IMPROVING INDUSTRIAL GAS WASTE FILTRATION TECHNOLOGY"

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Introduction

Gas emissions from industrial enterprises—including dust particles, sulfur dioxide, nitrogen oxides, and other harmful substances—pollute the atmosphere. This pollution causes climate change, acid rain, respiratory diseases, and other negative environmental and health problems. Regulations regarding emissions of harmful substances into the atmosphere are becoming increasingly stringent. The Law "On Environmental Protection" of the Republic of Uzbekistan and various international agreements are urging industrial enterprises to implement new and effective technologies for managing gas emissions. Rapid urbanization and industrial development have made the improvement of air purification technologies an urgent task [7].

Meeting the growing need for advanced air purification technologies requires modern and innovative methods for the effective treatment of industrial gas emissions. Electrostatic precipitators (electrofilters) are recognized as one of the most efficient devices for this purpose. However, further improvement of their performance and energy efficiency remains a relevant issue. Enhancing the operation of electrofilters will enable effective filtration of waste gases, reduce the emission of harmful substances into the atmosphere, and help restore environmental balance [1].

Relevance:

The relevance of this work lies in improving the technology for filtering, neutralizing, and utilizing harmful technogenic gases released directly into the environment from thermal power plants and various types of metallurgical furnaces. The goal is to enhance energy efficiency. Each result obtained has been analyzed and validated in laboratory conditions, meets environmental standards, and contributes to achieving energy efficiency.

Objective:

To improve the technology of technogenic gas purification by enhancing electrofilter systems and increasing energy efficiency, thereby reducing environmental pollution.

Methods:

Capturing harmful particles in the air under the influence of a magnetic field;

Utilizing high-frequency fields and direct current fields in electrofilters;

Removing moisture from the composition through heating;

Applying electrochemical methods for gas filtration.

Results:

Reduction of electricity consumption in industrial enterprises;

Production of secondary products;

Increase in the efficiency coefficient of the equipment;

Complete control over the purification process.

LITERATURE REVIEW AND METHODOLOGY

Foreign researchers have proposed various innovative technologies for purifying industrial gas emissions. For example:

Electrostatic Precipitators (ESP): Widely used in the USA and European countries for gas purification. Research has focused on increasing energy efficiency through the application of high-voltage electric fields and optimizing filter materials.

Improvements in ESP technologies generally follow two main directions:

Materials Science: Enhancing filter materials, such as using electrically conductive polymers or metallic fibers. Chinese researchers are leading in developing heat-resistant materials.

Energy Efficiency: In the USA, integrating energy-saving control systems into ESPs has been explored, resulting in a 15–20% reduction in energy consumption.

China and India are global leaders in applying ESP technologies. China has implemented state subsidies and strict monitoring to reduce industrial emissions. India is focusing on airflow optimization and developing low-cost, energy-efficient ESPs.

Notable international researchers in the field include Dr. J.R. White (USA), Dr. E. L. Cussler (University of Minnesota, USA), Dr. Jianhua Guo (China), and Arvind Kumar, who have all made significant contributions. Numerous international studies are ongoing [2].

RESULTS

Research is currently being conducted in the following areas to improve gas filtration technology and increase ESP efficiency:

Energy Efficiency: Reducing energy consumption in ESPs and developing energy-efficient control systems. This involves minimizing energy use, maximizing performance, and reducing environmental impact.

Key technical and technological approaches include:

a. High-Efficiency Power Supplies:

Modern inverter technologies ensure effective power distribution and reduce energy losses during charge generation in ESPs.

b. Flow Optimization:

Ensuring uniform gas flow within the ESP reduces energy usage. This requires redesigning gas paths and analyzing gas flow hydrodynamics.

c. Electric Field Optimization:

Adjusting voltage and field density within ESPs minimizes power consumption.

d. Smart Control Systems:

IoT-based systems allow real-time data analysis and automatic adjustment for energy-saving operation modes.

DISCUSSION

Study of the theoretical principles of ESP technologies used for purifying industrial gas emissions.

Identification of factors influencing ESP performance.

Review of international experience with energy-efficient ESPs.

Analysis of the composition of industrial gas emissions and the potential for purification using ESPs.

Evaluation of technological solutions to reduce harmful emissions into the atmosphere.

Development of optimized methods to improve ESP energy efficiency.

Introduction of innovative technologies for enhancing ESP performance.

Use of digital and computer-based control systems for evaluating and monitoring ESP efficiency.

Analysis and optimization of the relationship between gas flow and electric field parameters.

Evaluation of air pollution prevention achieved through ESP modernization.

Measurement of environmental effectiveness of ESP application in industrial enterprises.

Development of guidelines for using energy-efficient and environmentally safe ESPs in industrial facilities.

Proposal of regulatory documents aimed at minimizing harmful emissions from enterprises.

Real-time control of electric field strength to improve efficiency.

Experimental studies using high-frequency power sources.

Investigation of key characteristics of improved industrial gas-purifying ESPs [3].

CONCLUSION

In conclusion, integrating modern technologies into production processes allows not only for increased efficiency and energy savings but also for full automation of production operations. Enhancing the energy efficiency of electrofilters requires the use of advanced technologies. The use of energy-saving control systems and high-performance technologies significantly improves the industrial gas purification process.

Although this issue has been widely studied globally, a comprehensive and systematic scientific approach is still lacking in Uzbekistan. In-depth research in this field will contribute to reducing industrial gas emissions into the environment and lowering electricity consumption.

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