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INFORMATION AND LASER TECHNOLOGIES FOR ASSESSING THE LEVEL OF RISKS FROM HARMFUL EMISSIONS FROM MAN-MADE OBJECTS

The current stage of development of electricity, chemical, machine-building, and printing production is characterized by the use of a wide range of resource components - coal, oil, gas, paints, and polymers - that are environmentally aggressive. The intense production regimes which are dictated by the market lead to a sharp increase in resource consumption for energy-intensive production processes, causing, in turn, an increase in the concentration of dust and harmful gases and liquid emissions into the atmosphere and water environment, which leads to an increase in environmental pollution, the state of which cannot always be assessed in real time due to the complexity of data collection using standard methods.

The article substantiates the methods of creating sensors for measuring the concentration of dust and harmful substances emissions into the atmosphere and water environments using new physical effects that became the basis for the development of laser concentrators of air and water pollution, optogalvanic effects for creating integrated sensors that can be combined with measurement systems based on ion-selective sensors (OCS 5M), which makes it possible to increase the level of efficiency of environmental safety systems. A comprehensive solution to the problem is based on the creation of global environmental monitoring systems based on information and intellectual technologies and the development of new sensor models. The problem of environmental monitoring has been relevant for more than a century, because of the development of industrial technologies (railroads, weaving) has brought not only prosperity but also environ-mental pollution. The level of environmental pollution has increased especially with the development of thermal power plants and the petrochemical complex, which have become aggressive polluters. The military operations of the First and Second World Wars also contributed to this. Nuclear power and jet aviation have further polluted the global environment, and the war in Ukraine has created a specific environmental impact (explosions of shells and missiles), destruction of energy complexes and oil terminals.

Key words: ecosystem, atmosphere, dust, information technology, control, lasers, environmental safety, sensors.

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ІНФОРМАЦІЙНІ ТА ЛАЗЕРНІ ТЕХНОЛОГІЇ ДЛЯ ОЦІНКИ РІВНЯ РИЗИКІВ ВІД ШКІДЛИВИХ ВИКИДІВ ТЕХНОГЕННИХ ОБ'ЄКТІВ

Сучасний етап розвитку електроенергетики, хімічної, машинобудівної та поліграфічної промисловості характеризується використанням широкого спектру ресурсних компонентів - вугілля, нафти, газу, лакофарбових матеріалів, полімерів - які є екологічно агресивними. Інтенсивні режими виробництва, які диктуються ринком, призводять до різкого збільшення витрат ресурсів на енергоємні виробничі процеси, що викликає, в свою чергу, збільшення концентрації пилу та шкідливих газоподібних і рідких викидів в атмосферу і водне середовище, що призводить до зростання забруднення навколишнього середовища, стан якого не завжди можна оцінити в реальному часі через складність збору даних за допомогою стандартних методів.

Обґрунтовано методи створення сенсорів для вимірювання концентрації пилу та викидів шкідливих речовин в атмосферне та водне середовище з використанням нових фізичних ефектів, які стали основою для розробки лазерних концентраторів забруднення повітря та води, оптогальванічних ефектів для створення інтегрованих сенсорів, які можуть бути поєднані з вимірювальними системами на основі іоноселективних сенсорів (ОСМ 5М), що дає можливість підвищити рівень ефективності систем екологічної безпеки.

Комплексне вирішення проблеми базується на створенні глобальних систем моніторингу довкілля на основі інформаційно-інтелектуальних технологій та розробці нових сенсорних моделей. Проблема моніторингу довкілля є актуальною вже понад століття, адже розвиток промислових технологій (залізниць, ткацтва) приніс не лише процвітання, але й забруднення довкілля. Рівень забруднення довкілля особливо зріс з розвитком теплових електростанцій та нафтохімічного комплексу, які стали агресивними забруднювачами. Цьому також сприяли військові дії Першої та Другої світових воєн. Атомна енергетика та реактивна авіація ще більше забруднили глобальне довкілля, а війна в Україні створила специфічний екологічний вплив (вибухи снарядів та ракет), руйнування енергетичних комплексів та нафтових терміналів.

Ключові слова: екосистема, атмосфера, пил, інформаційні технології, контроль, лазери, екологічна безпека, датчики.

Introduction

The solution for task of developing optimal strategies for managing technological regimes that would ensure high productivity and minimize harmful emissions is based on modern system and information technologies, and the creation of new types of sensors for information and measurement systems. Processing of technological data is the basis for forming an assessment of the situation and the state of decision-making, and selecting additional data that should be supplemented with data involving expert knowledge.

To ensure the quality of environmental monitoring of man-made infrastructure, it is necessary to have instruments and assessment systems of the chemical composition of gas and dust emissions and their concentration, as well as the degree of impact on the atmosphere and water environment.

The problematic task of developing new methods and means for operational control of harmful emissions of industrial dust and gas, which are generated during the technological process and entering the air and water of the environment. Assessment of their composition and concentration is important for determining the risk of an environmental disaster and negative impact on the personnel of the enterprise and the community of the region, as well as the city.

The aim of the study is to assess the state of the ecological environment of man-made production, which is a source of harmful dust and gas emissions into the atmosphere and water environment, their chemical composition and concentration.

To achieve this goal, the following main objectives of the study were identified:

1. To analyze the existing methods and means of building information and measurement systems and sensors for collecting data on the state of energy-active technological facilities and the level of concentration of harmful emissions into the environment (atmosphere and water);

2. To develop methods for generating data flows from sensors for automated control systems and experts based on the structure of the energy-intensive aggregated facility;

3. To substantiate the methods of development of portable analyzers of chemical composition of air, gas and water components based on optical-electronic and laser sensors;

4. To assess the harmful effects of emissions on the life of society, its spatial distribution in the area of industrial and technological infrastructure;

Analysis of literature sources

The analysis of studies on the problem of assessing environmental pollution of man-made infrastructure and literature on the problem of monitoring showed that standard methods of analytical and physical chemistry are used to create sensors, and laser technologies are used for spectral analysis, optogalvanic and laser concentrators are most fully described in the works of the authors.

Accordingly, let’s consider the methodology and technology of physical-analytical and physical-chemical research, which became the basis for the creation of ion-selective sensors and laser optoelectronics methods, which are the basis for the development of a new type of sensors for measuring the concentration of dust and harmful substances in water.

Works [2-5] consider methods of integrated use of measuring systems and devices to improve the efficiency and reliability of measurements and methods and models of data processing algorithms and their processing for assessing the situation in technical systems

The monographs [6-9] substantiate the methods of expert systems and information technology planning of measurement experiments.

The fundamental monographs [10-12] consider the theory and methods of analysis and synthesis of sensors for direct and indirect measurements of physical quantities and their verification.

The fundamental monographs [13,14] outline the theoretical and applied foundations of the theory of processing measurement results in science and technology.

Monograph [15] presents the results of fundamental research on the safety of environmental systems, methods of monitoring, control, and regulatory data.

Papers [16-19] substantiate the methods and theoretical foundations of experiments and the theory and methodology of physical measurements.

The fundamental monograph [20] describes the basic methods of laser technologies for spectroscopy and photochemistry in applied and scientific research.

Monographs [21,22] by the team of authors describe the theory of measuring systems, metrology, and data processing methods.

Monographs [23,24] substantiate the problems of environmental protection and system analysis for water quality management.

Monograph [25] discusses the use of mathematical methods in chemical technology and chemical experimental research.

The monographs [1, 26] substantiate the development of laser information and measurement systems for process control and management in the structure of automated control systems in the energy and glass industry, environmental studies, and assessment of the concentration of harmful process emissions.

The monograph [27] describe the basic concepts of information and laser technologies for selecting and processing data from energy-active objects of technological structures and ecological systems, water and man-made environment, which characterize their dynamic state. The logical and systemic aspects of data processing and their interpretation in the processes of making managerial decisions under conditions of high risk are substantiated and analyzed.

The problem of developing information systems for environmental assessment of the environment state around man-made facilities

The main task of environmental expertise is to determine the degree of risk and safety of industrial activity, organize a program of expert assessment of industrial production facilities, establish compliance of facilities with the requirements of environmental legislation, examine the quality of natural resources, form a balance of quality criteria for the environmental safety of facilities and the environment, assess the negative impact of industrial and municipal structures on the environment, and expertly evaluate programs for the introduction of new technology.

Air monitoring is necessary to detect the effects of pollutants and their impact on: corrosion of structures, erosion of land resources, impact on human health, impact on flora and the environment, water pollution, and food contamination.

The problems of monitoring the state of the ecosystem and socio-communal infrastructure in the presence of large industrial man-made energy-active complexes that are polluters are solved on the basis of new information-measurement technologies and the following tasks are being solved:

1. identification of sources and channels of environmental impact (industrial, domestic, natural) based on sampling
2. development of data sampling tools and their accuracy, objectivity, reliability in relation to the target tasks based on information technologies;
3. improved information technologies for data processing and interpretation of the content of environmental situations based on the integration of systems;
4. development of a classification of situation methods based on expert assessments using databases, knowledge and expert systems in the structure of the DMSS (Decision making support systems);
5. development of data management and storage systems (DS - data storage, DDP - digital data processing);
6. development of primary and secondary standards for quality criteria and chemical pollutants (SO_2, NO_2, CO, O_3, Pb) and sampling for active ions $\left\langle SO_4^-, Cl^-, NH_4^+, NO_3^-, Ca^{++}, Mg^{++}, K^+ \right\rangle$.
7. improvement of methods of control and identification of compounds - products of coal combustion in boilers of power units and oxygen residues;
8. monitoring of paper production products (in the technological process and water waste);
9. methods and means of identification of radioactive emissions (located in the coal mass rock) - sampling and control;
10. methods of sampling and new means (sensors) for sampling and control of transport and gas emissions (automobiles, heat, aviation) and assessment of their concentration and composition.

Information and laser technologies for developing environmental monitoring systems and methods for assessing pollution levels

To assess the anthropogenic situation in the environment, monitoring is carried out using tools that include: sampling of water, air, and compounds, methods of physical and chemical analysis and data processing, equipment for physical and chemical analysis, and systematic interpretation of results obtained from various types of sensors.

The monitoring results form the basis for obtaining data and information on the components of the impact and their level: primary data from sensors and information measurement systems (IMS), data on the physical and chemical composition of pollutants, assessment of the level and degree of hazard of pollution impact on the environment, assessment of the composition and volume of pollution emissions.

Air pollutants include waste from energy-intensive processes and dust from grinding of solid components:

- gaseous inorganic substances $\left\langle SO_2, H_2S, NO_2, Cl_2, CO, SiF \right\rangle$;
- mineral acids $\left\langle HCl, HF, H_2SO_4, HNO_3 \right\rangle$;
- Radionuclides (strontium, cesium, iodine, plutonium, radium);
- simple organic substances (formaldehyde, benzopyrene, etc.).

In Ukraine, the document RD 52.04.186-86 (DSTU of Ukraine) regulates methods and tools:

- organization of observations at the regional and local levels;
- methodological and metrological support of the environmental control process;
- methods of chemical analysis of concentrations of harmful substances in the atmosphere (remote methods, operational control);
- methods of collection, processing and statistical analysis of observation results, their algorithmic and software-hardware support;
- Programs of environmental monitoring activities for each man-made environment;
- Quantitative and qualitative analysis and transfer of information to the relevant authorities at both the state and production levels;
- methods of information technology data selection for the development of databases and expert systems.

Laser sensing of harmful emissions into the process environment to collect data on the concentration of dust and combustion products

To collect data on the geometric and physic-chemical parameters of the state of an energy-active object (liquid level, concentration of substances, chemical composition, di-mensions, displacement), when direct conversion measurement tools cannot be used, ac-tive sensing methods are used and combined with methods of physic-chemical analysis and optical and spectral methods.

Let us consider the information structure diagram of the conversion of a laser signal, which is a carrier of information, based on the selection of data on the dynamic state of the object and its technological environment.

Data selection is based on the spatial, temporal, and energy interactions of the laser signal with the sensed object:

$$Z_S(B_F, t, P_S(\theta)) = Z_C\left(B_L^-, t, P_L\right) \otimes M_{SL}\left((B_{0T}, t, \theta), \vec{n}_S, \alpha_S\right)$$

where: $Z_C(\ )$ - sensing signal; B_L - geometric basis; P_L - laser power; M_{SL} - model image of the object location zone by the state parameter; θ - state parameter; $(B_{0T}, \vec{n}_S)$ - basis and orientation of the location zone; α_S - coefficient of energy interaction, $Z_S, (B_F, t, P_S(\theta, \alpha_S, \vec{n}_S))$ - reflected signal from the control environment; $(\otimes)$ - interaction operation.

In accordance with the method, let’s present a conceptual diagram of the process of sensing the concentration field of anthropogenic environment

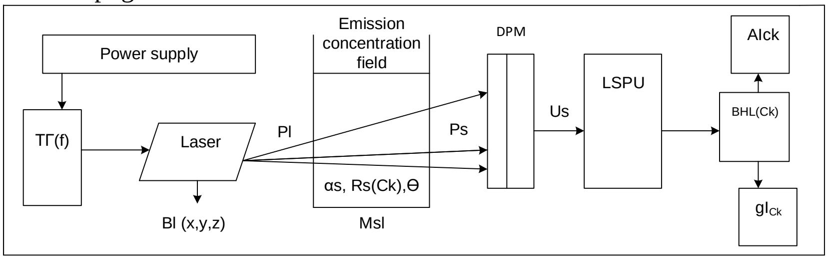

Fig. 1. Conceptual diagram of the concentration field sensing process

In Fig. 1 the following notations are introduced: $T\Gamma(f)$ - clock pulse generator of laser modulation, $\alpha_S, R_S(C_к), \theta$ - a set of parameters of the controlled environment or samples of water, liquids in calibrated glass cuvettes; PM - photomatrix (2- or 4-section photo-detector; DPM - matrix for digital processing of the laser beam image; $U_S(t, TC_к)$ - voltage of the signal of the converted laser beam after passing the sample at the matrix output; LSPU - laser signal processing unit; $BHL(C_к)$- unit for normalizing the laser signal and scaling the impurity concentration scale, AI_{CK} , $\mathrm{gI}_{Cк}$ - indication of the impurity concentration parameter in analog and digital forms, PL - laser power.

According to the task of measuring the concentration of pollution for various media (air, water, process liquids, coal dust, process dust and other types of emissions of harmful substances):

● select the basic structure of the laser concentrator (measurer) and the method of its integrated use with other measuring systems to assess the concentration of dust in air and water:

● physicochemical sensors that use optical-galvanic sensors sensitive to certain chemical compounds whose output potential depends on the level of concentration of substances in water or air;

● physicochemical sensors for assessing harmful components in the air, selective to certain compounds (OXY 5M gas analyzers), respectively - { $SO_2, NO_2, CO, NO, NO_2, CO_2$ } and their concentration.

Accordingly, each class of sensors is used for different types of concentrators of water pollution, air pollution, determination of chemical components of combustion products, technological processes, flue gas emissions from thermal power plants, control of coal dust concentration for boilers of power units, dust pollution of the atmosphere.

Sampling methods have been developed for each type of control:

● forced extraction of air and gases with appropriate parameters $\{C_K, T^0C, W_m\}$;

● water samples in calibrated glass cuvettes for optical and laser methods;

● stationary and portable laser concentrators for assessing the concentration of fine dust in air and combustion products of various types of fuel.

Analysis of characteristics for measuring the concentration of impurities in solutions and dust flows

The graduation characteristics of the sensors of impurity concentration in solutions and dust streams have the same model. The graduation characteristics (laser - photode-tector) are represented as a system, where $P_л[mBB] \in [0-500]mBB$ is the laser power; $I_{ФП}[mA] \in [0-500]mA$ photodetector current at different loads Ri.

In laser sensing, the reflected laser signal depends on the laser power and the level of impurity concentration in the process medium in the area of its sensing (liquid or dust). Conversion characteristic $I_{FP} = \varphi(P_L, C_K, R_n)$, where P_L - laser power; C_K - concentration; Rn - load resistance of the photodetector.

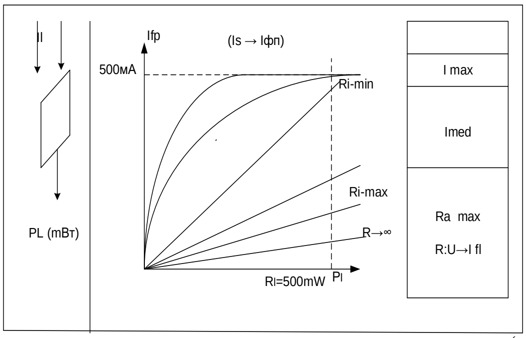

Fig. 2. Graph of the function of dependence $I_F = K(P_L)$ (current – power)

As can be seen from the study, the characteristics are nonlinear. For a linear approximation of the transformation function, it is necessary to increase the laser power, which leads to an increase in the energy of sensing the medium.

The construction of the current-power dependence function when the photodetector is illuminated by a laser is based on the experiment. $U_1[B]$ is the voltage on the photomatrix of the laser beam photodetector $P_Л[mBm]=[0-500]mBm$ laser beam power $P_Л = \int_\Omega I(x,y)W_I(x,y)d\Omega$ is the power integral of the laser beam projection on the surface plane of the photodetector.

The function of dependence $\Psi(Roi, \mathrm{PL}, \mathrm{Rn})$ of the photodetector voltage on the values of calibration resistors is built on the results of measuring the photodetector voltage in accordance with the laser power for each value of the calibration resistor of the concentration scale (Rn) at a given level of component concentration in both the gas and liquid environments of the technological system under control (Fig. 2). At different powers of the semiconductor laser and calibration resistors at the output of the photodetector

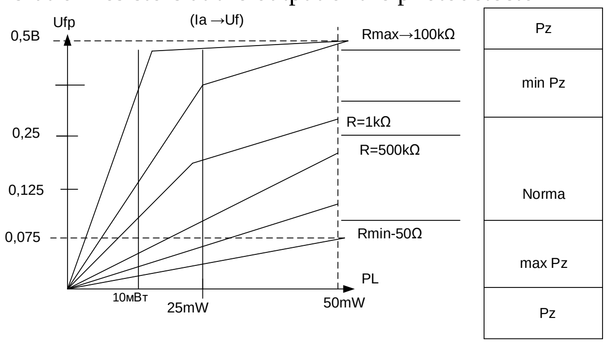

Fig. 3. Function of photodetector voltage dependence given laser power based on photosignal measurement results

Here is a schematic diagram of the cell of the laser signal photodetector matrix. The constructed voltage-power dependence under laser illumination of the silicon matrix of the photodetector has the form (Fig. 3), where Rfp is the resistance of the internal photodetector, Rn is the load resistance of the photodetector, PL is the photon flux power generated by the laser.

The analysis of the photodetector characteristics $\Psi(Roi, \mathrm{Pl}, \mathrm{Rn})$ for the construction of laser sensors shows that for each normalized laser power, it is necessary to measure the parameters of the signal at the output of the photodetector (which are generated on the matrix under the action of a laser beam) at different values of the load resistance.

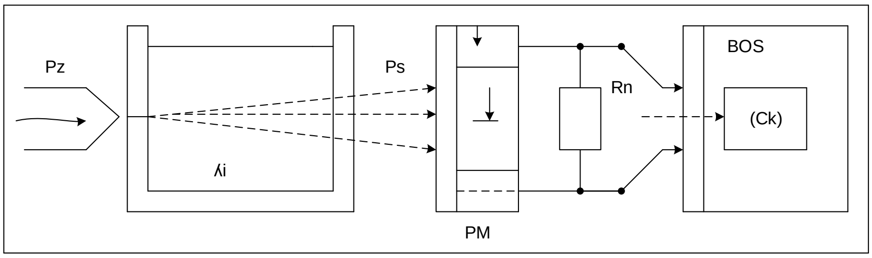

Fig. 4. Schematic diagram of a photomatrix for receiving a laser signal after probing a sample in a cuvette with a solution

In accordance with the structure of the matrix, it is necessary to substantiate the model of spatial alignment of the laser beam (cross-section) with the size of the photomatrix window (Fig. 5)

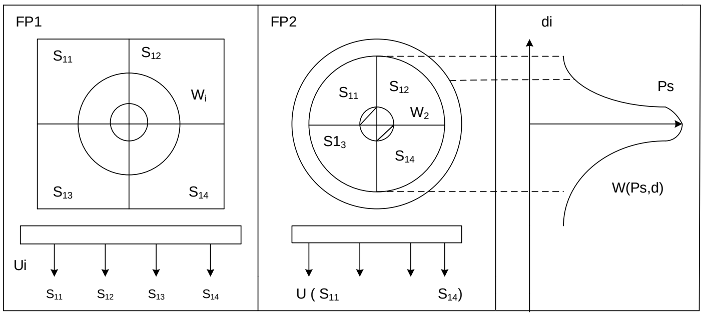

Fig. 5. Structure of Matrix Laser Signal Photodetector B for Concentrator

Abbreviations: FP1 - photodetector with siliconized photoplates, FP2 - round sector photodiode, $W(P_S, d)$ - function of distribution of the probing signal over the sector of the photomatrix.

Here are digital photographs of the laser beam after probing a cuvette (in cross-section and length) with a sample contaminated with a liquid solution along the la-ser signal path.

Structure of the probing laser beam at the cuvette outlet for different types of process aqueous solutions

Concentrators are built on the basis of electrochemical sensors to control the combustion products of various types of fuel in boilers.

The Ukrainian industry produces gas analyzers of the [Oxy 5M - 5ND] series, which use membrane electrochemical measuring transducers of the components of combustion products of various types of fuel as sensors. Primary sensors generate electrical signals due to the electrochemical quantum interaction of combustion gas components with the sensor surface, which pass through the membrane. To control temperature and pressure, respectively, electro-mechanical sensors for converting physical quantities are used - thermocouples and piezoresistive sensors.

The photos of the laser beam show the following situations:

1. a clean solution with a low concentration level;
2. contaminated solution;
3. longitudinal beam track with a minimum concentration of contamination of the solution;
4. longitudinal beam track with a high level of contamination.

Fig. 6. Passing a laser beam through a clean, low-concentration solution

Fig. 7. Passing a laser beam through a contaminated solution

Fig. 8. Longitudinal beam track with minimum concentration of solution contamination

Fig. 9. Longitudinal beam track with high levels of contamination

Concentrators that are built on the basis of electrochemical sensors for monitoring various types of fule combustion products in boilers

The gas analyzer is designed for environmental and technological measurements of the volumetric concentration of gases (fuel combustion products) in dust ducts and flue gases of boiler equipment, as well as temperature and pressure and meets the requirements of GOST 1297 and DSTU OIHLD11 standards.

1. Residual oxygen (O2);
2. Carbon monoxide (CO);

3. Nitrogen oxide (NO);
4. Nitrogen dioxide (N2O);
5. Sulfur dioxide (SO2).

Accordingly, the gas analyzer provides control parameters for the components of combustion products according to the data in Table 1.

Table 1

Balance of acceptable level of risks of selection of design and operational personnel

№	Value	Range	Error
1.	Volume share O_2	0-21 %	0,2 %
2.	Volume share CO	0-5000 mln $^{-1}$	5 %
3.	Volume share NO	0-2000 mln $^{-1}$	10 %
4.	Volume share N_2O	0-2000 mln $^{-1}$	10 %
5.	Volume share SO_2	0-5000 mln $^{-1}$	10 %
6.	Gas temperature	0-600^0 C	0,5 %
7.	Gas pressure	-(0 -+7000) Pa	0,5 %

For gas sampling, a flow-type normalizing gas sampler is used, which provides a limit factor for the concentration of components by 200%. The duration of the cycle for measuring the concentration of components in the gas flow Tc < 40 minutes.

The information process for collecting data on the concentration and composition in suitable gas streams with a temperature (0^0 C - 600^0 C) is based on electrochemical quantum effects associated with the transformed intensity and volume of components with the surface.

To assess the level of pollution by components of waste gases, a multifactorial analysis of the concentration level was carried out according to the method of information transformation. Accordingly, formulas and algorithms for calculating the components in the standard form of representation by the data processing processor were developed, taking into account the flow temperature and pressure and excess O_2 in the gas flow for each type of fuel.

Accordingly, the types of fuel used by the gas analyzer (fuel oil, natural gas, coke oven gas, liquefied gas, locally produced gas) were determined.

Analysis of the research results

Control of the concentration of coal dust after grinding in the mill and feeding it into the dust ducts of the power unit's boilers is the basis for determining the level of combustion products depending on the power unit's load mode. The quality of grinding (micro-dispersed) depends on the type of coal supplied from different coal mines. Coal from different sources has a rock content (10-40%), which forms dust emissions as air pollutants, while a high level of rock content reduces the energy efficiency of coal. The source of energy is the combustion of coal itself and, accordingly, a stream of harmful gases is formed that are released into the atmosphere. The energy level of the combustion process depends on the concentration of coal dust, which, accordingly, provides the boiler's energy output during the combustion process. If the quality of coal changes with different deliveries, a sharp increase in the concentration of the coal component can lead to an emergency or boiler explosion. Therefore, it is necessary to monitor the concentration of coal dust in the dust ducts and signal the occurrence of emergency conditions.

For concentration of harmful dust emissions into the atmosphere by man-made systems, laser concentrators (single and dual channel) based on laser photometer and laser control method are used, as well as devices used to measure the concentration of coal dust in polo wires. Laser photometers measure the concentration of aqueous solutions and the level of their contamination using samples in optical cuvettes. To control the level of dust concentration, remote sensing is used according to the scheme of a laser concentrator with measurement bases along the length (0.5-10 m), which ensures sufficiently effective control of dust pollution.

The chemical components of air emissions are monitored using an Oximeter 5M in accordance with standard methods for standardized chemical compounds. Here are the graphs of chemical compounds emissions at various enterprises from 2019 to 2023, ob-tained using the Oximeter 5M measuring device.

The graphs of harmful substances emissions for the period 2019-2023 are presented.

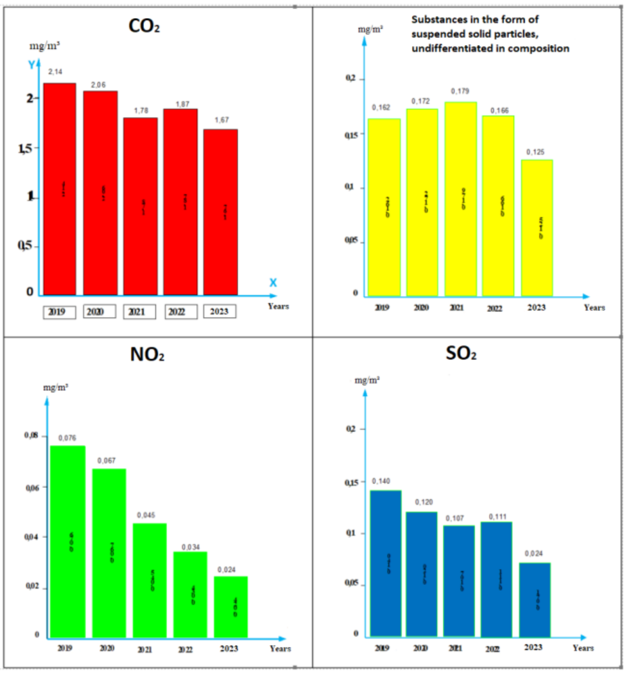

Fig. 10. Graphs of emissions of harmful substances into the atmosphere for the period 2019-2023: (a) carbon monoxide emissions; b) substances in the form of suspended solid particles, undifferentiated in composition; c) nitrogen dioxin; d) sulphur dioxide

The graphs of emissions of harmful substances by various enterprises for 2023 are presented, namely: sugar factories; paper mills; elevators; poultry farming; sawmills; quarries.

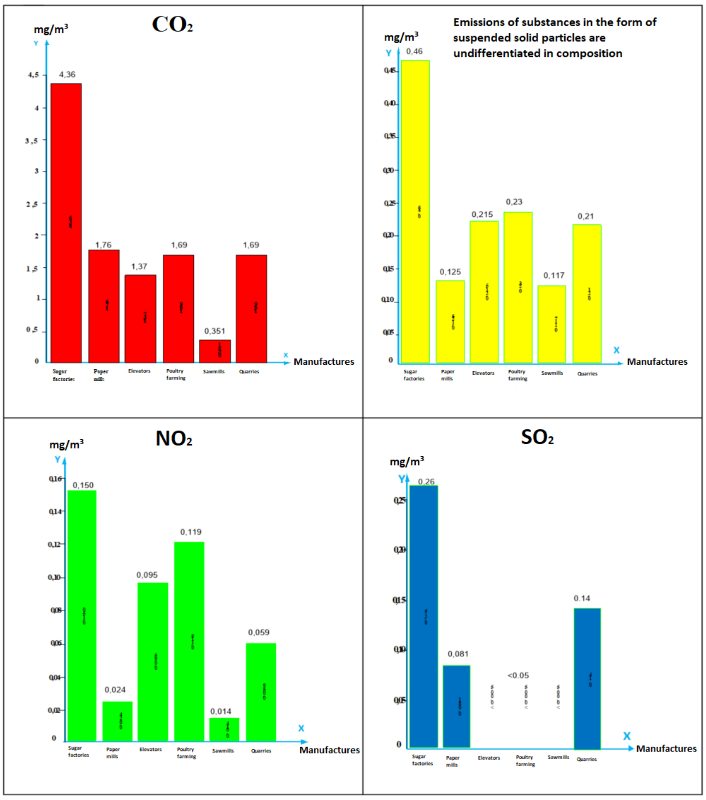

Fig. 11. Graphs of emissions of harmful substances by various enterprises for 2023: a) carbon monoxide emissions; b) emissions of substances in the form of suspended solid particles are un-differentiated in composition; c) nitrogen dioxin emissions; d) emissions of sulphur dioxide

The following graphs show the gross emissions of harmful substances by various enterprises in 2023: sugar factories; paper mills; elevators; poultry farming; sawmills; quarries.

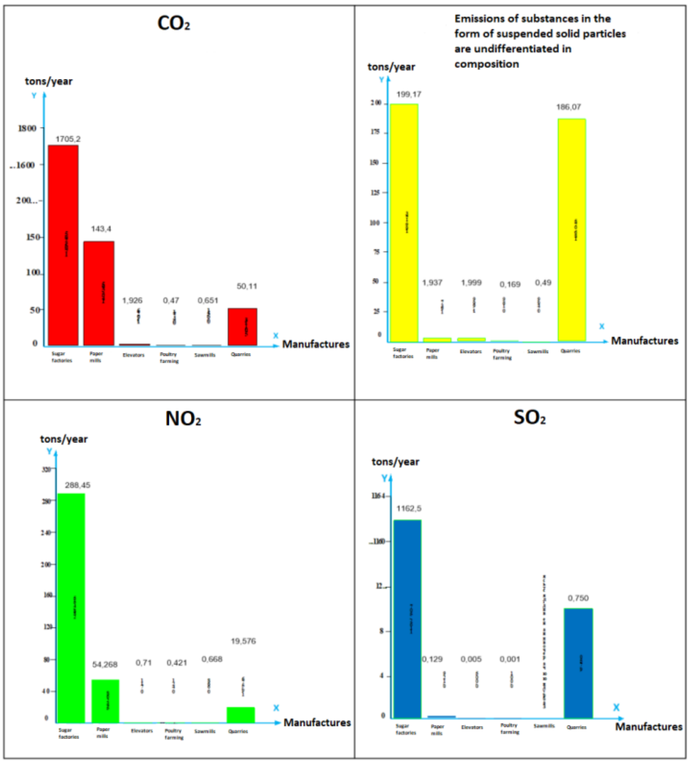

Fig. 12. Graphs of gross emissions of harmful substances by various enterprises for 2023 a) carbon monoxide emissions; b) emissions of substances in the form of suspended solid particles are undifferentiated in composition; c) nitrogen dioxin emissions; d) emissions of sulphur dioxide

Conclusion

The problem of environmental monitoring for assessing the level of pollution by harmful substances, when the pollutants are different types of industries: energy, machine-building, transport, agriculture, aviation create a threat to human life and society. Over the past 50 years, a set of laboratory, analytical, chemical and physical methods for controlling components has been developed, but the problem of measuring the concentration of dust and flue gases has not been fully resolved. The paper substantiates the relevance and problematic situation in the development of sensor measurement methods and formulates the tasks of developing sensors for the construction of information and measurement systems for environmental monitoring.

The research methods based on the theory of hierarchical systems, system analysis in the process of managing energy-active objects (sources of pollution), and methods of laser remote sensing theory are substantiated.

The choice of sensor type is substantiated in accordance with the task of measuring the concentration of pollutants in the air, water, soil, and environment. An analysis of the process of sensing the concentration field of coal dust in the dust wires of thermal power plants and flue gases in the atmosphere is carried out.

The method of sensing the liquid medium for assessing the degree of its pollution on the basis of optoelectronic sensors is substantiated and a model of the scale for assessing the level of concentration is built.

The method of laser sensing of aqueous solutions of manmade emissions is substantiated and developed. A stand for studying laser effects in assessing the state of water samples of a contaminated reservoir based on a laser photometer was developed. The scheme of the optical-galvanic sensor was developed and the corresponding photometer was designed for data collection to measure harmful impurities in the reservoir water, and the laser signals were analyzed and transformed from the interaction with the components of the liquid medium. Characteristics for concentration calibration were constructed. The choice of lasers and photodetectors was substantiated. The theoretical foundations of the development of electrochemical sensors for the analysis of pollutant emission components are substantiated and the structure of the serial gas analyzer of harmful emissions "Oxy 5M" is analyzed.

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