



Journal Homepage: - [www.journalijar.com](http://www.journalijar.com)

## INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/11238

DOI URL: <http://dx.doi.org/10.21474/IJAR01/11238>



### RESEARCH ARTICLE

#### ENVIRONMENTAL SUSTAINABILITY AND POLLUTION PREVENTION: THE NEGATIVE IMPACT OF CARBON-CONTAINING DUST ON THE ENVIRONMENT AND HUMANS AND EFFECTIVE MEASURES FOR ITS REDUCING

Maryna Gorobei

PhD student, Master of Science, Senior Researcher at Scientific Park Chornobyl State Institution State Environmental Academy of Postgraduate Education and Management, Kyiv, Ukraine.

#### Manuscript Info

##### Manuscript History

Received: 25 April 2020

Final Accepted: 30 May 2020

Published: June 2020

##### Key words:-

Air Pollution, Carbon-Containing Dust, Environment, Human Health, Dust Prevention And Control, Pollution Prevention, Dust Reduction, Environmental Sustainability

#### Abstract

Environmental pollution with its health impacts is a key issue for a sustainable environment. Coal mining activities have caused serious environmental problems; however, almost 30% of global primary energy demand is met using coal, making it difficult to replace in the near future. Under these circumstances, as it is not possible to completely cease coal mining activities, coal mines need to invest in cleaner production techniques to reduce environmental damage. A review of literature on dust emissions accompanying the main coal mining processes showed that an important environmental problem that accompanies the operation of coal mines, quarries, storage and transshipment terminals is the pollution of atmospheric air with carbon-containing dust, which can be in the air for a considerable time and move over long distances. The analysis confirmed the harmful impact of the carbon-containing dust on the environment: air, water, soil and, in general, on the ecology of the area where coal mining operations exist and confirmed the possibility of transboundary pollution by dust particles as well as negative effects on public health. Analysis of mining-induced carbon-contained dust environmental impact is important to prevent environmental disasters. Therefore, the importance of good dust suppression methods should not be underestimated. Improvement of atmospheric air should be solved by improving existing and introducing new best technologies. It is recommended to localize emissions of carbon-containing dust at the places of its formation using dispersed water in order to reduce the harmful effects on the environment. Mitigation measures of negative effect of carbon-containing dust contribute to the efficient and environmentally sustainable exploitation of coal resources.

Copy Right, IJAR, 2020,. All rights reserved.

#### Introduction:-

##### Statement of the Problem:

Environmental pollution with its health impacts is a key issue for sustainable environment (United Nations General Assembly 1987).

**Corresponding Author:- Maryna Gorobei**

Address:- PhD student, Master of Science, Senior Researcher at Scientific Park Chornobyl State Institution State Environmental Academy of Postgraduate Education and Management, Kyiv, Ukraine.

Global environmental problems of today are connected with anthropogenic air pollution. The protection of atmospheric air is a key problem of improving the natural environment, since air occupies a special position among other components of the biosphere. Atmospheric air also performs the most complicated protective ecological function. The problems of the effects of air pollution on human health are widely studied around the world.

A healthy environment is a decisive factor in human health and development. According to the World Health Organization (WHO), the only air pollution, which is one of the most serious health risks, causes annually 7,000,000 deaths from preventable causes, and more than 90% of people breathing polluted air and the nearly 3 billion people still forced to use polluting fuels [1].

Of all life environments, the air has the greatest impact on humans. Which is not surprising, because the act of breathing is uninterrupted. People pass about 13,000 liters of air through their lungs during the day. At the same time, the human body is sensitive to the slightest changes in the component composition of the inhaled air and responds with natural reactions to the presence of impurities even of natural origin.

A high concentration of suspended particles has a direct fibrogenic effect on the tissues of the respiratory tract. These particles constantly irritate them like sandpaper. Inhalation of air containing a large amount of suspended particles can have negative effects. Carbon-containing dust is a factor in the increase in mortality from heart and respiratory diseases (small particles travel deep into the lungs and pass into the blood, creating a risk of stroke and heart attack), a decrease in pulmonary function with the development of obstructive airways disease, and an increase in the prevalence of symptoms. Health effects are associated with both short-term and long-term dust particles [2].

There is a statistically established link between air pollution and the overall morbidity of the population. And in the case of epidemics - the ability of the immune system to resist infectious diseases. Polluted air is clearly associated with the prevalence of chronic respiratory diseases. Thus, infections are easier to “attack” a weakened and affected body than a healthy one. Therefore, long-term environmental pollution in the case of epidemics can also significantly increase the prevalence and consequences of infectious diseases among the population.

According to publications [3–5], the contribution of air pollution to the frequency and severity of the most common diseases of the respiratory system, digestion, skin, allergic reactions, etc. is up to 30% of the total number of factors affecting health.

Recent studies have shown that pollution particles of coal contributes almost 1 million deaths annually worldwide [6].

### **Methodology & Theoretical Orientation:-**

The purpose of the study is to examine in detail the negative effects of carbon-containing dust on the environment and humans, as well as to investigate the effectiveness of the processes of interaction of dispersed water jets with carbon-containing dust in technologies for the prevention of environmental pollution.

To achieve this goal in the study used:

1. analysis and generalization of the results of previously performed researches in this area and the experience of dust suppression in underground mines;
2. laboratory studies to determine the parameters of water curtains;
3. method of experimental measurements of hydropower parameters in the wind tunnel.

### **Discussion:-**

It is well-known that throughout the whole coal handling cycle consisting of shiploading/unloading, stockpiling, reclaiming, truck unloading and linking conveyors, trains and trucks, loading and removal from storage piles and conveyor belt transfer stations, dust emission represents a serious concern.

Coal dust generated during the extraction, transshipment and processing of coal raw materials is the strongest air pollutant, causing a high incidence rate of people in the area where such dust is spread. Inhalation of carbon-containing dust causes a wide range of respiratory diseases, including an incurable disease pneumoconiosis, chronic obstructive pulmonary disease, diffuse fibrosis, chronic bronchitis and other chronic respiratory diseases [7,8].

The problem of air pollution in Ukraine is one of the most important environmental problems. Since the bulk of the population lives in areas where the concentration of pollutants regularly exceeds the maximum permissible levels.

The coal industry occupies a special place among the industries that contribute to dust pollution of the atmosphere [9–13]. The main sources of atmospheric air pollution during coal mining in mines are waste rock dumps, coal depots and the main ventilation shafts of mines.

According to the Institute of Ecological Hygiene and Toxicology of Ukraine [68], more than 95 kg of harmful substances are accounted for every Ukrainian every year. In connection with the activities of coal mining enterprises, the environmental load on the biosphere of region is the largest in Europe [14].

The intensity of the effects of pollution on the environment in the territory of mines and surrounding areas are different in time and space and depends on the volume and mining technology. Emissions from large coal-mining enterprises contain a large percentage of dust particles of various chemical compositions that have the effect of settling on the underlying surface.

Carbon-containing dust is a source of environmental pollution and has a negative impact on the environment and human health [15], what is shown in Table 1, so reducing all its emissions is an urgent problem in current conditions.

**Table 1:-** Impact of carbon-containing dust on the environment and humans.

Natural environment type	Environmental aspects	Sources	Types and / or paths	Potential impact
Air	Dust emissions	Wind erosion of dumps, quarries and storage	Coal and rock particles	Increase in the number of workers' respiratory diseases
		Machine reflection and grinding dust		Increase in the number of respiratory diseases among the population of the surrounding areas
		Loading and transport operations, drilling of wells		Air Pollution
		Existing objects or mobile equipment that breaks the soil layer		
Soils	Move the dust to the ground	Left material	Derivatives of suspended soil particles and rocks, salts, metals and compounds	Soil contamination
		Waste dumps from waste heaps and coal storage sites from coal enrichment and transportation		
		Sediment suspended in water	Organic derivatives of incomplete coal combustion	Decrease in the suitability of adjacent soils for vegetation restoration
		Pollutants dissolved in sewage, filtrate or pumped water		
Surface waters	Dust sediment		Dissolved or entrained tarry derivatives of coal	The negative consequences for public health that are downstream
				Negative impact on aquatic ecosystems, turbidity, dissolved oxygen diminished as a result of increased biological and chemical oxygen demand
				Reduction of municipal water supply (degradation due to

				potential agricultural or industrial use)
			Carbon-containing dust	Loss of waterways (eg recreational, fishing)
				Increased costs for water treatment
				Acidification and eutrophication (algae overgrowth) of water bodies.
Ground water	Drainage of polluted waters	Dumps - surface drainage	Dissolved or trapped tarry derivatives of coal	Negative impacts on downstream populations and host ecosystems due to increased biological and chemical oxygen demand
		Dump filters		Reduction of municipal water supply (degradation due to potential agricultural or industrial use)
		Drainage of lands with disturbed soil layer and drainage of objects	Carbon-containing dust	Loss of waterways (eg recreational, fishing)
		Drainage of groundwater pumped from different geochemical aquifers discharged to the surface		Increased costs for water treatment

The most obvious impact is the deterioration of air quality. People living near coal mines are exposed to carbon dust, which causes respiratory illness and allergies.

Emissions from large coal-mining enterprises contain a large percentage of dust particles of various chemical compositions that have the effect of settling on the underlying surface.

Even if their content in the air does not exceed the established standards, they can accumulate in depositing environments (soils, snow cover). Therefore, on the one hand, the dust availability reflects air pollution, and on the other hand, it characterizes the processes of the secondary influx of pollutants into the natural environment (for example, when snow melts).

Over the past decade, dust and gas emissions into the atmosphere from coal industry enterprises have increased more than twice. Due to weathering of rocks, a large spectrum of pollutants enters the air.

The coal industry affects not only the territory of coal mining enterprises, but also the environment of nearby settlements. The lightness of the fine dust particles allows them to remain suspended for long periods, and fly from hundreds to thousands of kilometers, depending on the wind and other meteorological conditions. The transport of dust particles over a considerable distance makes the nature of the pollution transboundary. Therefore, such industries must take effective mitigation measures.

The high costs of protecting the environment and the loss of coal in the process of storage and transportation require the development and implementation of new cost-effective and efficient technologies to prevent significant reduction of air pollution.

In the 21st century, the protection of the ecological and geological environment has attracted increasing attention in the field of mining in order to implement the UN sustainable development strategy.

Integration of the development of mineral resources and environmental protection has become an important development trend in the international mining industry. Reduction of pollutant emissions into the atmosphere is one of the priorities of environmental safety in the coal industry.

Prevention of carbon-containing dust formation and entering to the atmosphere is an important and integral part of coal mining.

The main activity in the field of dust control is the prevention of its formation or entry into workrooms.

The most common dust control tool in this case is hydro dedusting. Water dedusting in mining enterprises includes the prevention of dust formation during the destruction, processing and transportation of dusty material and the suppression of dust generated;

Water dust suppression is used in almost all mining processes and in all climatic conditions, even at low temperatures.

In order to prevent the negative impact of coal dust on population, it is necessary to develop and put into practical use an effective system for minimizing the spread of carbon-containing dust outside enterprises. To reduce the environmental hazard level of dust emissions from coal mines, it is recommended that they be localized using dispersed water. This requires finding new ways and means of dust removal of increased efficiency and reliability based on further theoretical and experimental studies.

**Experiment:**

The study of dust suppression regimes included consideration of two interrelated tasks: defining the performance of new dust suppressants and determining their effectiveness under different conditions.

The experiment was conducted on a specially designed laboratory facility Scientific Research Institute of Mining (SRoM) (Fig. 1), which is a model of horizontal and inclined workings continuous cut (80 \* 80 cm.), A scale of 1 to 4 natural size workings of mine named Bazhanov, where subsequently conducted full-scale experiments of new nozzles and dust suppression system as a whole.

From a special device - dust dispenser, (SRoM design), coal-dust pre-prepared at the mill with a given particle dispersion was fed into the installation depth, where its required concentration was created by mixing with the calculated amount of air. Volumetric concentration was determined using standard instruments (ejector aspirator AER-5). After the test run modes dust turns included new water nozzle. Their effectiveness was compared with standard dust suppression sprays.

Laboratory facility (Fig.1.) is equipped with the following instruments and equipment, hygrometer, temperature sensor, portholes, lamps, fans, pressure gauge, micromanometer, tube Pitot - Prandtl. In addition, there are 3 water nozzles along the section, with the possibility of their simultaneous or alternate switching on with the change of the direction of water jets (in the course of air flow, against the course of the air flow and perpendicularly).

1. A device for starting and dosing dust;
2. Facility control panel;
3. Wind tunnels that simulate mine workings;
4. Porthole for monitoring the process of dust suppression;
5. Lighting lamps for the inside of wind tunnels;
6. Removable technological hatches;
7. Nozzle control unit;
8. The fan of the mine network;
9. The fan motor.

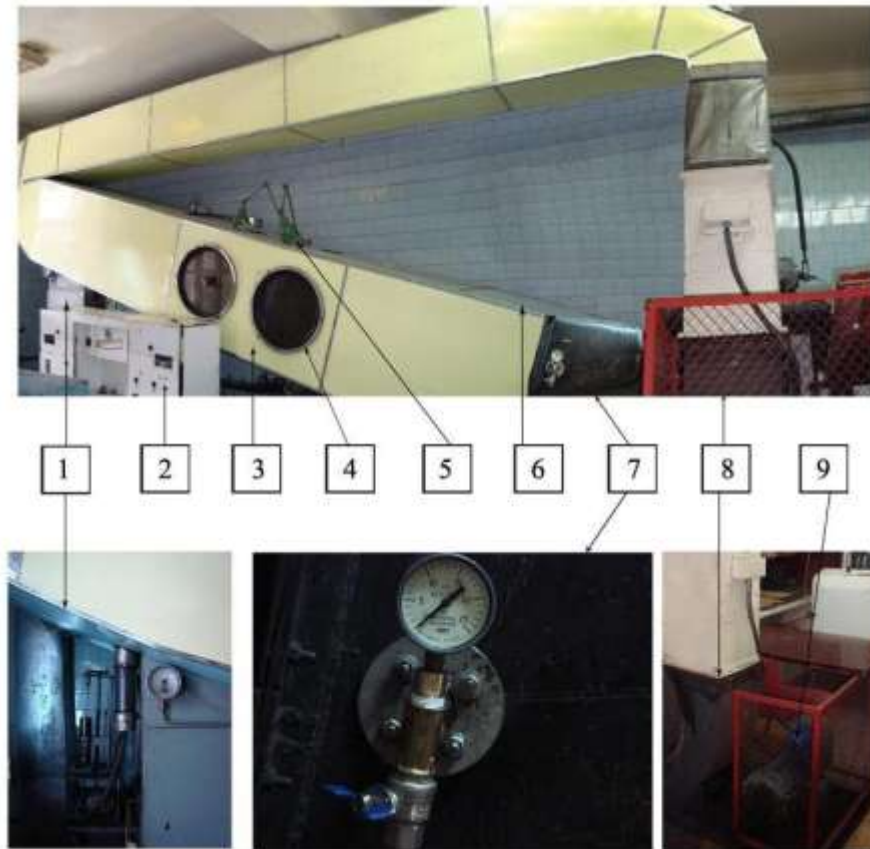


Fig 1:- Laboratory facility for research on the development of dust suppression modes.

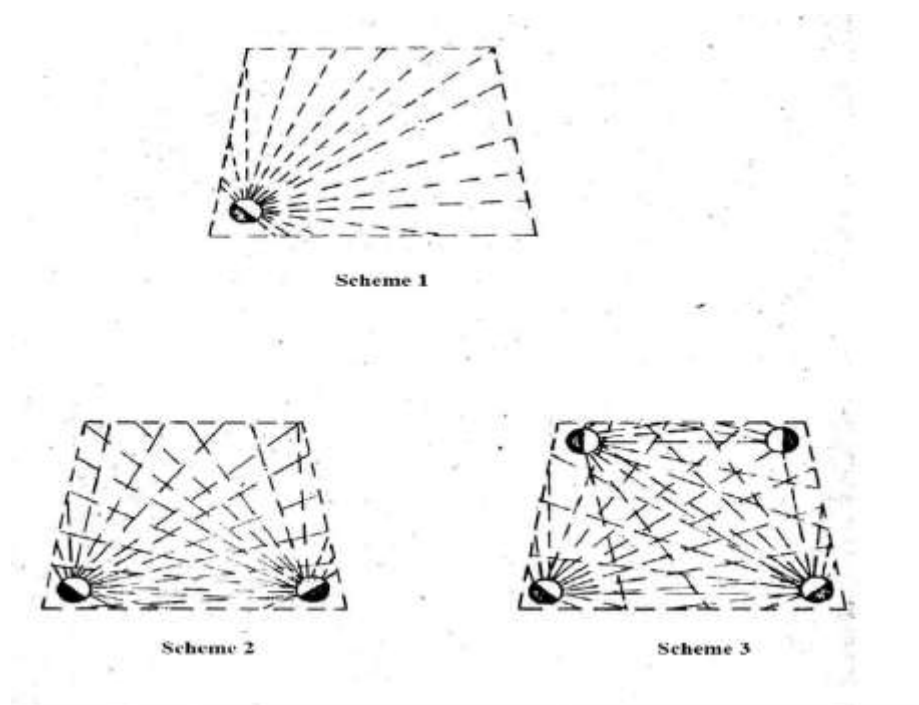


Fig 2:- Typical sprinkler test schemes.

Then a set of tests was carried out in real conditions of mines, based on the results of theoretical research and laboratory experiments.

**Findings:**

1. A unique experimental facility for determining the parameters of dust suppression using traditional and new dust suppression devices has been developed and manufactured.
2. The program and methodology of laboratory research and mine testing have been developed.
3. The calculation is performed and the matrix of the required number of experiments using modern methods of mathematical planning is presented.
4. Carried out checking and calibration of experimental equipment.
5. Determined the required number of nozzles for full-scale mine testing.
6. As a result of laboratory and field tests it is established that in the active zone due to the overlap of the entire section, it is possible to reduce the dust concentration by 50 - 80%, and outside the core of the torch due to gravity forces by 40 - 60% with a diameter of droplets of 200  $\mu\text{m}$  fluid and diameter of dust particles 10 - 20  $\mu\text{m}$ . Moreover, with a decrease in the diameter of dust particles, the probability of dust collection increases. In addition, due to electrostatic forces, the dust concentration can be reduced by 80 - 90%.

**Conclusion & Significance:-**

Thus, an analysis of the scientific literature on the effects of atmospheric suspended particles on humans allows to conclude that solid particles can pose a significant risk depending on their size, morphometric and physico-chemical characteristics.

It can be concluded that a serious danger is represented by a variety of respiratory diseases arising under the influence of suspended particles of carbon-containing dust.

In order to increase the technical level of atmospheric air protection and improve the situation in the locations of coal industry enterprises, the following measures are necessary:

1. equipping carbon-containing dust emission sources with effective dust and gas cleaning plants;
2. replacement of dust and gas treatment plants that do not provide emission cleaning to established standards with more effective analogues;
3. using of existing effective methods and technical means for the prevention of and reduction of dust formation and the emission of carbon-containing dust particles into the atmosphere during technological processes of mining and coal preparation;
4. production control of the technical condition of dust and gas treatment plants and their performance.

Air pollution and environmental changes have a slow, cumulative effect of adverse effects on the environment and human health [16].

Carbon-containing dust destroys ecosystems and poses a threat to human health, and therefore, the importance of good dust suppression methods should not be underestimated. Improvement of atmospheric air should be solved by improving existing and introducing new best technologies.

Analysis of mining-induced carbon-contained dust environmental impact is important to prevent environmental disasters. And mitigation measures of its negative effect contribute to the efficient and environmentally sustainable exploitation of coal resources.

**Author Contributions:**

The personal contribution of the author consists in the formation of the idea, independent analysis of literary sources on the field of dust suppression, carbon-containing dust impact, and methods of dust control, defining the purpose and setting of research tasks, development of the plan of research, theoretical substantiation and experimental testing, data analysis and comparison, hydro-dedusting technology improvement proposal.

**Acknowledgments:-**

The basis for the research is the Scientific Research Work "Highly efficient equipment for the extraction and processing of minerals" (state registration number D 9-12) and Scientific Research Work "Determination of the

impact of waste disposal (storage of residues) LLC" Euro-Reconstruction "on air pollution, soil, surface and groundwater. Carrying out experimental works on de-dusting of the cinder block "(state registration number 0118U001430).

### References:-

1. World Health Organisation/ Official web-site./ [Electronic resource]. – Access mode: [https://www.who.int/health-topics/air-pollution#tab=tab\\_1](https://www.who.int/health-topics/air-pollution#tab=tab_1) (Date of access to the site 26/04/2020)
2. Yu. Drachuk, Donetsk, Directions for reducing the negative impact on the environment in the coal region, Donbass Economic Bulletin 2007 - 1. - P. 33-37.
3. A.S. Kholodov, K.Y. Kirichenko, K.S. Zadornov, K.S. Golokhvast/ Effect of particulate matter in the air of residential areas on human health/Periodical Bulletin of Kamchatka State Technical University/2019 - P. 82.
4. V.M. Gilmundinov, L.K. Kazantseva, T.O. Tagaeva, K.S. Kugaevskaya/ The effect of environmental pollution on the health of the population of the regions of Russia // Region: economics and sociology. - 2013. - No. 1. - P. 209–228.
5. Kiku P.F., Beniova S.N., Gelzer B.I. Habitat and environmentally dependent human diseases. - Vladivostok: Far Eastern Federal University, 2017. - P. 390
6. Coal Dust: Environmental Impacts And Good Coal Dust Management Practices . – [Элек- тронный ресурс]. – Access mode: <https://www.environment.co.za/environmental-issues/coal-dust-environmental-impacts-and-good-coal-dust-management-practices.html> (Date of access to the site 28.01.2019).
7. Petsonk E.L., Rose C., Cohen R. Coal mine dust lung disease. New lessons from old exposure // American Journal of Respiratory and Critical Care Medicine. – 2013. – № 187(11). – P. 1178–1185.
8. Laney A.S., Weissman D.N. Respiratory diseases caused by coal mine dust // Journal of Occupational and Environmental Medicine. – 2014. – № 56(10S). – P. 18–22
9. Surber S., Simonton D. Disparate impacts of coal mining and reclamation concerns for West Virginia and central Appalachia // Resources Policy. – 2017. – V. 54. – P. 1–8. 9.
10. Yu X. Coal mining and environmental development in southwest China // Environmental Development. – 2017. – V. 21. – P. 77–86.
11. Hota P., Behera B. Coal mining in Odisha: an analysis of impacts on agricultural production and human health // The Extractive Industries and Society. – 2015. – V. 2. – № 4. – P. 683–693.
12. Ghose M., Majee S. Characteristics of hazardous airborne dust around an Indian surface coal mining area // Environmental Monitoring and Assessment. – 2007. – V. 130. – № 1–3. – P. 17–25.
13. N. A. Osipova [et al.] Coal producer effect on snow cover pollution at adjacent urban territories (case study of Mezhdurechensk)// Bulletin of the Tomsk Polytechnic University [Bulletin of TPU]. Geo-Resource Engineering. - 2017. - T. 328, No. 12. - P. 36-46.
14. I.V. Vasilyeva, Topical issues of monitoring of waste heaps of coal mines and environments protection/ // Mineral resources of Ukraine. - 2015. - No. 3. - S. 39-45
15. Gorobei MS, Bondar OI. Problem issues of the negative impact of carbon-containing dust to atmospheric air and ways of their solving. Scientific journal "Problems of environmental safety" -2019 - P.181-186
16. N.M. Kachurin, L.L. Rybak, V.I. Efimov, S.A. Vorobyov / Distribution of resources for the prevention of air pollution in the mining region // Labor safety in industry. 2015. No. 2. P. 24-27.