

ON THE NEGATIVE IMPACT OF ACID RAIN ON PUBLIC HEALTH

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Abstract: This article discusses the problem of acid rain and its negative impact on public health. The analysis of the problem of acid rain is given from the point of view of what consequences this factor can cause in the human body. The article considers the factors that cause acid precipitation in the atmosphere, and also analyzes the problem of acid rain and its negative impact on the environment and public health.

Key words: hydrogen chloride, carbon dioxide, toxic metals, sulfur dioxide and nitrogen dioxide, aggressive acids, genetic mutations, methyl mercury acetate, Minamata disease.

INTRODUCTION

By the term "acid rain», science means any meteorological precipitation (including snow and hail), during which a strongly acidic reaction occurs. Among the sources of this phenomenon are the activities of heavy industry enterprises (especially metallurgy), which emit large amounts of nitrogen oxide and sulfur into the atmosphere. In addition, acid rain is caused by the activity of thermal power plants and the exhaust gases of motor vehicles.

The process of formation of such rains is simple: when hydrogen chloride and nitrogen or sulfur oxides get into the air, they react with solar radiation and water droplets floating in the air. As a result, acid is formed - sulfuric, sulfurous, nitric or nitrous. After that, the acid falls to the ground in the form of precipitation. The acid can take the form of rain, snow, hail, fog and cause serious damage to fauna, flora and open water bodies in all regions of planet Earth. Acid rain appearing in the atmosphere causes damage to forests comparable to deforestation.

As a rule, it is not possible to visually distinguish acid rain from rain with a normal pH level. But if you live in a large city with a lot of vehicles and industrial enterprises, then be sure that the rain, fog or snow that is observed in your city is most likely saturated with toxic acids. But even if you are a happy inhabitant of the countryside, and the nearest city is hundreds of kilometers away, then you should not count on the safety of precipitation.

LITERARY RESEARCH

Acid precipitation is a real problem for almost all countries in the world at the present stage. The normal pH of precipitation is 5.6, while acid rain and fog have a level within the pH range of 2.5-5. The main sources of acid precipitation are sulfuric (H₂SO₄) and nitric (HNO₃) acids, which are contained in such precipitation. Acids, in turn, are formed as a result of the chemical reaction of sulfur oxides and nitrogen oxides with water. The above oxides are an obligatory component of any atmospheric air in large cities, as they are components of emissions from industrial enterprises and motor vehicles.

As is known, ordinary rain water is a slightly acidic solution. This is due to the fact that natural substances in the atmosphere, such as carbon dioxide (CO₂), react with rainwater. The optimal



pH value for rainwater should fluctuate within 5.6 ... 5.7, but in real life, the acidity of rainwater in one area may differ from the acidity of rainwater in another area. This primarily depends on the composition of gases contained in the atmosphere of a particular area, such as sulfur oxide and nitrogen oxides.

During the operation of automobile engines, thermal power plants, and other plants and factories, nitrogen and sulfur oxides are emitted into the air in large quantities. These gases undergo various chemical reactions and, as a result, droplets of acids are formed, which fall as acid precipitation or are carried as fog. Acid precipitation can fall not only as rain, but also as hail or snow. Such precipitation causes 5-6 times more harm, since it has a higher concentration of acids.

The term "acid rain" [1] was first introduced in 1882 by the English scientist Robert Smith in his book "Air and Rain: The Beginning of Chemical Climatology". His attention was drawn to the Victorian smog in Manchester. Although scientists at that time rejected the theory of the existence of acid rain, today no one doubts that acid rain is one of the causes of the death of forests, crops and vegetation. In addition, acid rain destroys buildings and cultural monuments, pipelines, makes cars unusable, reduces soil fertility and can lead to the seepage of toxic metals into aquifers.

Taylor Echolls [2] believes that acid rain is responsible for serious environmental damage around the world, and is most common in the northeastern United States, Eastern Europe, and increasingly in parts of China and India. According to the Environmental Protection Agency (EPA), acid rain can be particularly harmful to the young growth of many plant species and wildlife. He also notes that acid rain is a serious environmental hazard, and if left unchecked in countries with weak emission laws, it can negatively affect animal and plant life, as well as the structure of buildings, for generations.

According to G.E. Zaikov [3], it is necessary to save nature from acidification. As the author asserts: to do this, it will be necessary to sharply reduce emissions of sulfur and nitrogen oxides into the atmosphere, but primarily sulfur dioxide, since it is sulfuric acid and its salts that cause 70-80% of the acidity of rains that fall at large distances from the site of industrial emissions. The source [4] notes that the frequency of acid rainfall in India has been increasing over the past 40 years. The country's industry is responsible for huge emissions of sulfur dioxide. Emissions of this compound and nitrogen dioxide in India are expected to grow at least until 2030. In addition, local farmers, due to excessive use of fertilizers and pesticides, add ammonia and chemically active nitrogen compounds to the atmosphere, which further increases the acidity of precipitation. In general, according to experts, sulfur dioxide emissions in the western parts of the world are decreasing today, and the situation with acid rain is improving there. At the same time, in the east, in the regions of South and Central Asia, the situation is worsening due to the growth of the industrial sector and an increase in population density.

The author's research [5] notes that health protection and the fight against the most dangerous diseases is one of the global tasks of humanity, since it is central to the preservation of life on Earth. Among the factors that shape the health of the population, a decisive role is played not only by a healthy lifestyle, the state of the environment, heredity and the level of health care, but also by the cultural and spiritual potential of society. The core of each civilization is spiritual culture in all its uniqueness. Man-made civilization creates a real threat not only to the physical, but also to the spiritual and moral degradation of man. It brings serious diseases, has a detrimental effect on the human body, especially on the health of the younger generation.



It should be noted that acid rain causes the following negative consequences:

- human diseases;
- destruction of agricultural crops;
- pollution of water bodies;
- reduction of forest areas.

METHODOLOGY

Experts believe that acid rain is most often observed after a long period of hot and dry weather. That is, typical summer thunderstorms and showers that come after the scorching sun and a long period of clear weather contain a high amount of aggressive acids. A single case, of course, is not capable of radically changing the environmental situation, but regular precipitation and the cumulative effect make themselves felt.

Any rainwater has a certain level of acidity. In a normal situation, this indicator corresponds to a neutral pH level of 5.6-5.7 or slightly higher. Slight acidity is explained by the content of carbon dioxide in the air, but it is considered so low that it does not cause any harm to living organisms. The pH indicator varies in different bodies of water, but in an undisturbed natural environment, the range of these changes is strictly limited. Natural waters and soils have buffering capabilities; they are able to neutralize a certain part of the acid and preserve the environment. However, it is obvious that the buffering capabilities of nature are not unlimited. Thus, the causes of acid rain are associated exclusively with human activity and cannot be explained by natural causes.

Acid rain causes enormous damage to forests. Forests dry out, and dieback develops over large areas. Acid increases the mobility of aluminum in soils, which is toxic to small roots, and this leads to the suppression of foliage and needles, and brittleness of branches. Coniferous trees suffer especially because needles are replaced less often than leaves, and therefore accumulate more harmful substances over the same period.

The Earth and plants suffer the most from acid rain: soil productivity decreases, the supply of nutrients decreases, and the composition of soil microorganisms changes. Acid rain causes increasing damage to agricultural crops: plant covering tissues are damaged, cellular metabolism changes, plants slow down their growth and development, their resistance to diseases and parasites decreases, and their yields fall.

It should be noted that acid precipitation has a specific feature, in particular, it has a transboundary nature, caused by the transfer of acid-forming emissions by air currents over long distances - hundreds and even thousands of kilometers. This is largely due to the once adopted "high chimney policy" as an effective means against ground-level air pollution. Almost all countries are simultaneously "exporters" of their own and "importers" of others' emissions. The "wet" part of the emissions (aerosols) is exported, the dry part of the pollution falls in the immediate vicinity of the emission source or at an insignificant distance from it. The exchange of acid-forming and other air polluting emissions is characteristic of all countries of Western Europe and North America. Great Britain, Germany, France send more oxidized sulfur to their neighbors than they receive from them. Norway, Sweden, Finland receive more oxidized sulfur from their neighbors than they emit through their own borders (up to 70% of acid rain in these countries is the result of "export" from Great Britain and Germany). Transboundary transport of acid precipitation is one of the reasons for the conflictual relations between the United States and Canada.



Toxic substances formed over cities are carried along with air masses over long distances. Of course, their concentration decreases over time, as polluting particles are dispersed, but they eventually fall to the ground along with precipitation. Neighboring countries suffer from transboundary transfer of air masses, which often causes mutual claims and conflicts. For example, Scandinavian countries such as Sweden and Norway are hostages of their geographical location, since it is they who receive a significant amount of nitrogen and sulfur oxides produced in the United Kingdom, France, and Germany along with the dominant westerly winds.

Acid precipitation often falls in the countries of Northern Europe, for which we should thank our neighbors from Western Europe. A similar situation is observed in the European part of Russia, where, according to experts, about 40% of sulfur falling with precipitation comes from Poland, Ukraine, Germany, and other European countries. Canada also suffers from acid precipitation, the cause of which is air masses from the United States. The saddest thing is that all these undesirable processes will negatively affect the health of the population living in these areas.

Acid rain pollutes water bodies and soils with nitric and sulfuric acid, cadmium compounds, aluminum and other heavy metals. As a result, crop yields fall and forests die. Acid rainfall has an extremely negative impact on public health. Toxic metals enter drinking water and poison the human body with various ailments. People with chronic respiratory diseases who are in the acid rain zone will feel worse. Plants, fish and animals that are in areas where such precipitation constantly occurs are very dangerous for people. Substances found in acid rain cause serious incurable pathologies in humans. First of all, acid rain affects the population, who are forced to consume drinking water and food contaminated with toxic metals - mercury, lead and cadmium. With regular consumption of such food by the population, mercury, lead, aluminum and other heavy metal compounds penetrate the human body. They disrupt the functioning of the cardiovascular, nervous systems, liver, kidneys, and cause intoxication and genetic mutations.

Based on the source Gloster.com, information is presented, which schematically illustrates the process of acid rain formation and its negative consequences (Fig. 1). As can be seen from the figure, ultimately, due to acid precipitation, poisoning and death of aquatic flora and fauna occurs. People who consume products from rivers and seas in these regions will be susceptible to various diseases, including cancer.

Aerosol particles of acid rain pose a major threat to public health. Large particles are retained in the upper respiratory tract. Small droplets (less than 2 μm) consisting of a mixture of nitric and sulfuric acids are capable of penetrating into the most remote areas of the lungs. Carcinogenic heavy metals (mercury, lead and cadmium) can enter the human body along with these aerosols. For example, during the tragic London fog of 1952, more than 4,000 deaths were attributed to the increased content of sulfur oxides and sulfate particles in the humid air.

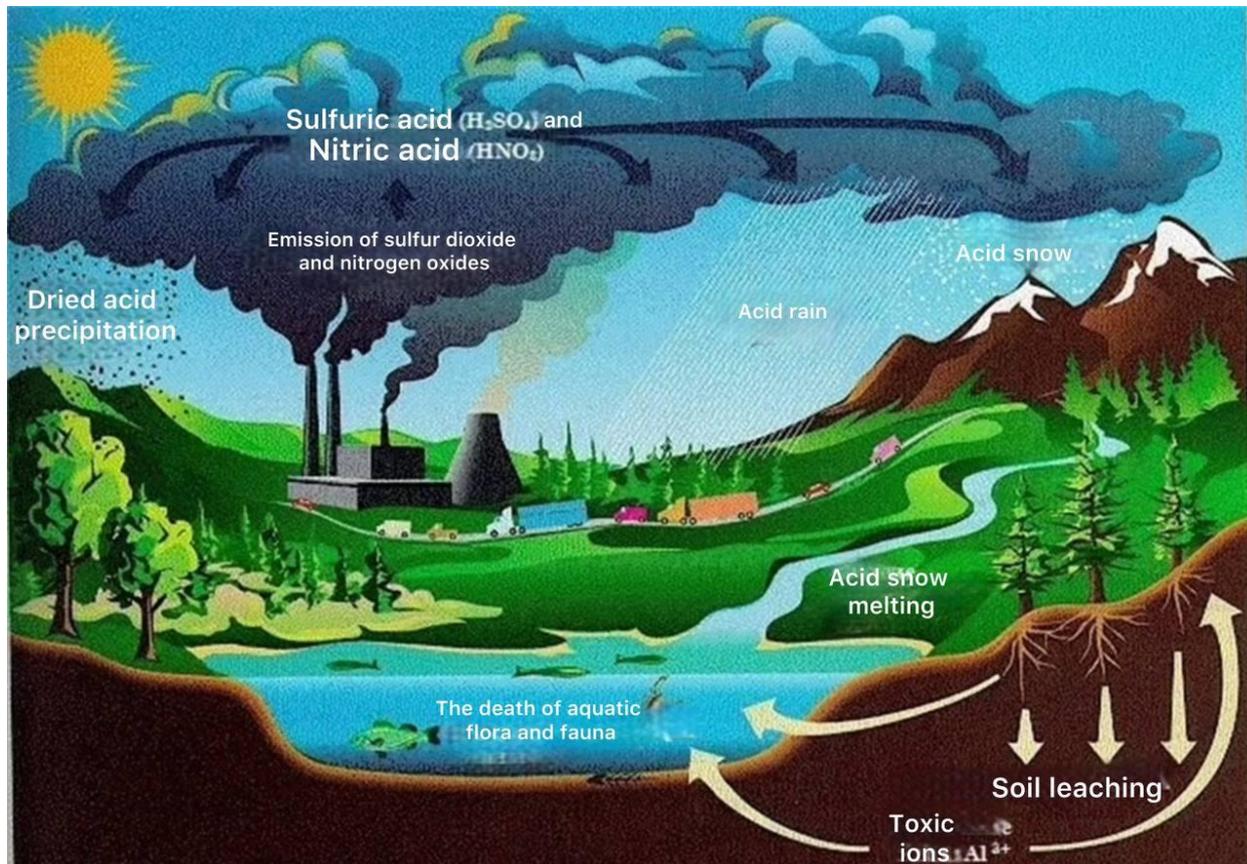


Figure 1. Illustration of the process of acid rain formation.

It has been found that the discharge of industrial wastewater into rivers and seas leads to an increase in the concentration of toxic ions of heavy metals, such as cadmium, mercury and lead. A significant portion of these are absorbed or adsorbed by certain substances, and this is sometimes called a self-purification process. However, in closed basins, heavy metals can reach dangerously high concentrations, which can negatively affect public health.

A tragic example of a water body being contaminated with a toxic metal – a mercury mixture – occurred in Minamata Bay in Japan. Industrial wastewater containing methyl mercury acetate was discharged into the bay. As a result, mercury entered the food chain. It was absorbed by algae, which were eaten by shellfish, the shellfish were eaten by fish, and the fish were eaten by locals. The mercury content in the fish was so high that it led to birth defects and deaths. This disease was called Minamata disease.

Special studies have convincingly shown that air pollution is the cause of acute and chronic respiratory diseases in children and adults, and the cause of premature death in the elderly. In some large cities around the world, they are now even forced to temporarily close traffic on those highways where air pollution reaches its extreme level. In Tokyo, oxygen masks have been introduced into the uniform of traffic police officers, since it is impossible to stand at a city intersection for even an hour without getting seriously poisoned. In Beijing, local weather forecasts, in addition to data on temperature, humidity, etc., necessarily contain information on the current level of certain PM2.5 microparticles in the air, which enter the city's airspace with



exhaust gases from vehicles and from heating systems (in Beijing, they mainly operate on coal) and characterize the state of smog in the capital. There is a very real old story about London medical students who had previously dissected the corpses of city dwellers with soot-blackened lungs, and, when they went to practice in the countryside, decided that they had discovered a new disease when they saw normal “pink lungs” on dissection. Acid rain not only harms human health and wildlife, but also destroys architectural monuments. Durable, hard marble, a mixture of calcium oxides (CaO and CO₂), reacts with a solution of sulfuric acid and turns into gypsum (CaSO₄). Temperature changes, rain and wind destroy this soft material. Historical monuments of Greece and Rome, having stood for thousands of years, have been crumbling before our eyes in recent years. The same fate threatens the Taj Mahal, a masterpiece of Indian architecture from the Great Mughal period, and the Tower of London and Westminster Abbey. The layer of Portland limestone on St. Paul's Cathedral in Rome has been corroded by 2.5 cm. In Holland, the statues on St. John's Cathedral are melting like candy. The royal palace on Dam Square in Amsterdam is eaten away by black deposits. More than 100 thousand valuable stained glass windows decorating cathedrals in Chartres, Conterbury, Cologne, Erfurt, Prague, Bern, and other European cities may be completely lost in the next 15-20 years.

CONCLUSIONS

It is necessary to note that air pollution is carried out by people themselves. There is no need to think that someone else is to blame for this problem, and it does not depend on you specifically. This is not entirely true. Of course, one person is not capable of making emissions of toxic and chemical substances into the atmosphere in large quantities. However, regular use of vehicles leads to the fact that you regularly emit exhaust gases into the atmosphere, and this subsequently becomes the cause of acid rain.

In my opinion, one of the ways to solve the problem of acid rain is to reduce harmful industrial emissions into the environment. This will give much more significant results than it seems at first glance. Along with this, it is necessary to improve the technology of cleaning from pollution. All enterprises must use cleaning filters and structures. The most long-term, expensive, but also the most promising solution to the problem is the creation of environmentally friendly enterprises in the future. All modern technologies should be used taking into account the assessment of the impact of activities on the environment.

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