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ENVIRONMENTAL ISSUES OF RADIOACTIVE WASTE

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Abstract: This article examines the environmental issues surrounding radioactive waste amid the spread of radiation across the globe, and the potential dangers of nuclear power in the past and today. It provides information on radioactive waste, which can contaminate soil, water, and air, adversely affecting plants and animals, as well as the ecosystem as a whole. It also highlights the negative consequences of radioactive waste, which, when exposed to radiation, can cause both short-term and long-term health risks.

Keywords: Radioactive waste, ionizing radiation, radiation ecology, natural radionuclides, nuclear industry, radioactive isotopes, high-level, intermediate, and low-level waste.

INTRODUCTION

The environmental problem will be a formidable and difficult challenge in the 21st century. The environmental crisis manifests itself in a variety of ways, posing numerous dangers to humanity and threatening a global environmental catastrophe. Soils are becoming contaminated with harmful substances, particularly radioactive substances and dioxins. Soils are degrading, losing their humus, and desertification and salinization are spreading. Freshwater shortages are growing. Pollution of the ocean, surface water, and groundwater with harmful substances, primarily petroleum-based ones, is increasing. Phytoplankton, the foundation of the ocean food chain and an important source of oxygen, is dying.

Until recently, radiation and radioactive substances were a natural part of the environment. However, at some point, humans took a major step forward and harnessed the power of the atom. Since then, radioactive substances and radiation have been used in a wide variety of activities: from industry and energy production to medicine and agriculture. And as befits any non-trivial human endeavor, all this activity results in the generation of waste in various forms. And not just any waste, but radioactive waste.

LITERARY RESEARCH

Ecology as a science can suggest solutions to the growing crisis. It reveals the laws of relationships that form the basis for the sustainable development of society. At the same time, it is essential that the population consciously understand the importance of improving its relationship with nature and strictly adhering to the rules and principles of proper management of the Earth's resources and wealth. Only by strictly adhering to all precautionary measures will a high level of environmental awareness be formed and developed in society.

The phenomenon of radioactivity has led to significant breakthroughs in medicine and various industries, including energy. However, at the same time, the negative properties of radioactive elements have become increasingly apparent: it has become clear that exposure to radiation on the human body can have tragic consequences. As more information has become available about

the effects of radiation on the human body and the environment, opinions have become more and more contradictory regarding the role radiation should play in various spheres of human activity.

According to A.A. Gorelov [1], the modern environmental crisis is the flip side of scientific and technological progress. Its greatest achievements were the trigger for the crisis and led to catastrophic environmental consequences on the planet. The atomic bomb was created in 1945. In 1954, the world's first nuclear power plant was built in Obninsk. In 1986, the largest man-made disaster in Earth's history occurred at the Chernobyl Nuclear Power Plant, a consequence of an attempt to harness the atom. This accident produced more radioactive substances than the bombings of Hiroshima and Nagasaki. The release of long-lived radionuclides into the biosphere was 66 times greater than that from the Hiroshima explosion. The Chernobyl accident affected more than 7 million people and will affect more – the descendants of those who survived the radioactive contamination.

The website [2] provides information on the difference between conventional and radioactive waste. The latter contain atoms with unstable nuclei (radionuclides). Such nuclei are prone to spontaneous change, emitting ionizing radiation. In everyday life, this is often called radiation, although this is not entirely accurate. There are other types of radiation, such as solar radiation, which have nothing to do with radioactivity.

Referring to the website [3], we can confirm that environmental pollution is widespread: radioactive waste can contaminate soil, water, and air, negatively impacting plants and animals, as well as the ecosystem as a whole. The website also notes that exposure to radioactive materials can cause cancer, birth defects, and other health problems. Radioactive waste must be stored securely for very long periods, which can limit the availability of land for other purposes. It also notes that accidents at nuclear power plants or leaks from storage facilities can lead to the release of radioactive materials into the environment, and the process of extracting usable fuel from spent fuel can lead to the proliferation of nuclear weapons.

Source [4] notes that radioactive waste is generated at all stages of the nuclear fuel cycle, including uranium ore mining and processing, nuclear fuel fabrication and use, spent fuel reprocessing, and nuclear facility decommissioning. According to the International Atomic Energy Agency, 442 nuclear reactors generating electricity are currently operating in 31 countries. Currently, no country has transitioned to technologies that would fully resolve the problem of spent nuclear fuel management.

O.I. Vasilenko's book [5] systematically lays out the fundamentals of radiation ecology. It describes the physical properties of ionizing radiation, its interaction with matter, various radiation sources, radiation accidents at military and energy facilities, environmental pollution, the medical and biological effects of radiation at various levels, regulation, protective measures, non-ionizing radiation, and the medical hazards of the most significant radionuclides.

The authors' work [6, 7] notes that the use of nuclear energy has created a new form of energy, which, although it first appeared in the USSR, is currently less widely used in Russia compared to a number of countries, including the United States, France, and Japan, and China and India will likely soon join them. It is well known and hardly in doubt that nuclear energy is the most environmentally friendly form of energy, especially compared to coal and oil, which, incidentally, during normal operation emit significantly greater quantities of harmful substances into the atmosphere, including radioactive waste, and simultaneously deplete atmospheric oxygen.

Methodology

Radioactive waste does not pose an eternal threat, not least because its radioactivity decreases over time. Radioactive elements are inherently unstable and decay at their own rate. Nuclear waste is a byproduct of nuclear energy processes, including the operation of nuclear reactors and fuel reprocessing. It includes high-level waste generated by nuclear fission, as well as low-level waste, such as used materials and equipment that have been exposed to radiation. This waste can remain radioactive for millennia, making its disposal and safe storage crucial for humanity.

It's no secret that the human population is constantly exposed to radiation. This radiation is natural (background radiation), originating from space (cosmic rays), as well as natural radionuclides found in the atmosphere, the Earth's crust, water, and biota (an important component of the ecosystem and biosphere).

It's worth noting that, from the very beginning of the development of nuclear technology, the problem of radioactive waste management received special attention. Since 1945, the United States has been disposing of liquid radioactive waste in remote, isolated areas underground, in steel-lined concrete tanks. Some, less radioactive waste, was even dumped into rivers or seas. This practice was abandoned in the 1960s. Today, the nuclear industry has adopted radioactive waste management methods that are the most justified and safest in terms of modern technology and scientific advances.

In Russia, all types of radioactive waste are subject to mandatory disposal. There are two types of disposal depending on the classification of the radioactive waste: near-surface disposal (placement in facilities located at ground level or at a depth of up to 100 meters) and deep disposal (in facilities located at a depth of more than 100 meters). The final disposal system for radioactive waste consists of several safety barriers. After the facility is closed, the storage facility will be guarded 24/7, 365 days a year, and environmental monitoring will be conducted nearby.

The problem with nuclear waste is that it not only poses a threat to human health and the environment but also requires significant resources for its safe management. For example, high-level waste containing radioactive isotopes must be stored under special conditions to prevent their release into the ecosystem. It is important to note that each country addresses this issue differently, depending on its technology, economic capabilities, and political will.

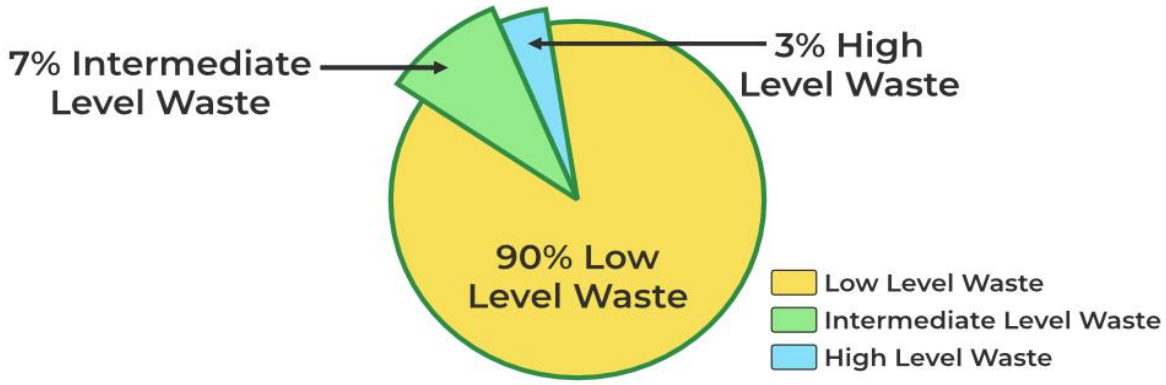

Figure 1. Illustration of the distribution of radioactive waste depending on its radioactivity.

Nuclear waste is divided into several categories, and their distribution based on their radioactivity and source is shown in Figure 1. Nuclear waste categories include:

• High-level waste, generated by nuclear reactors, is the most hazardous and requires special storage and handling conditions. It contains significant amounts of radioactive isotopes and can remain active for thousands of years;

• Intermediate-level waste. This type of waste includes items with higher levels of radioactivity than the intermediate-level waste, such as spent fuel rods from nuclear reactors;

• Low-level waste, on the other hand, is less hazardous but also requires attention and disposal. This waste may include used equipment, protective materials, and other items that have been exposed to radiation. This category includes items that have come into contact with radioactive materials, such as clothing and tools used at nuclear facilities. It should be noted that although low-level waste does not pose the same risk as high-level waste, its accumulation also requires careful planning and management.

Experts believe that human exposure to radioactive waste can be serious and include both short-term and long-term health risks. Some of the potential health effects of exposure to radioactive waste include:

• Acute radiation sickness: Exposure to high doses of radioactive material can cause symptoms such as nausea, vomiting, hair loss, and an increased risk of infection;

• Cancer: Exposure to radioactive material can increase the risk of developing cancer, including leukemia and thyroid cancer;

• Genetic damage: Exposure to radioactive materials can cause DNA mutations that can lead to genetic disorders and birth defects in future generations;

• Reproductive and developmental effects: Exposure to radioactive materials can affect reproductive function and development, leading to infertility, miscarriages, and other problems;

• Immune system damage: Exposure to radioactive materials can damage the immune system, leading to increased susceptibility to infections and other diseases;

• Neurological effects: Exposure to radioactive materials can cause neurological effects, such as headaches, fatigue, and cognitive impairment;

• Mental health problems: Exposure to radioactive materials can also have psychological effects, leading to stress, anxiety, and depression.

It is important to note that the severity of these effects can depend on the type of radioactive material, the duration of exposure, and the overall health of the individual. Proper management and disposal of radioactive waste, as well as adherence to safety precautions at nuclear facilities, can help reduce the risk of exposure and potential health hazards.

Conclusions

Based on the above, it can be concluded that radioactive waste poses a significant environmental threat and can cause significant harm to human populations and other living organisms, as well as to the ecosystem as a whole. The more people participate in solving the environmental problems of radioactive waste, the greater the benefit to society. I believe that if we want to live in an environmentally friendly country, breathe fresh air, and drink clean water, we need to change our attitudes toward radioactive waste.

The future of nuclear waste management remains unclear. Modern technologies allow for more efficient management of radioactive waste, but public perception remains a challenge. Efforts are needed to raise public awareness of nuclear energy and radioactive waste to overcome fears and prejudices. It is also important to continue research into the safe storage and processing of radioactive waste to find sustainable solutions for future generations. Nuclear energy can play a key role in the transition to sustainable energy sources, but to do so, the problem of radioactive waste must be addressed.

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