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ISSN 2959-6157

The pollution and the ecological influence of chemical and industrial waste

Rui Liu[1, *]

[1]High School Attached to Northeast Normal University, Changchun, China

*Corresponding author: ricky_liu@hsannu.com

Abstract:

Pollution from chemical and industrial wastes has far-reaching effects on ecosystems. Harmful substances such as heavy metals, persistent organic pollutants (e.g., polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs)), acid and alkali waste streams and other harmful substances enter the coastal and marine environments through rivers, sewage pipelines and other pathways, posing a serious threat to marine ecosystems and human health. Not only do these pollutants tend to accumulate in sediments, but they are also gradually amplified through the food chain, eventually reaching high concentrations in top predators and leading to biomagnification effects. In addition, ocean acidification and discharge of highly alkaline waste streams further affect carbonate-dependent marine organisms and disrupt the marine ecological balance. Understanding the environmental behavior of these pollutants and their ecological impacts is essential for developing effective pollution control and ecological protection measures.

Keywords: Chemical waste; Industrial waste; Heavy metals.

1. Introduction

The coastal area is an extremely rich-ecological-diversity area, which has important ecological, economic and social value. It is not only a habitat and breeding ground for many Marine life, but also it provides support of fishing resources, tourism and transportation. The prevalence of social inequality (Social inequality is widespread in all parts of the world and manifests itself in income disparities, differences in social status, and unequal distribution of resources. Poor communities and vulnerable groups are often short of the necessary resources and strength to cope with environmental pollution, and face greater health risks and life pressures.

Chemical waste is a secondary product of industrial production, usually containing a variety of toxic and harmful substances, such as heavy metals, persistent organic pollutants, waste liquid of acid and alkali. Because of its close relationship with land, offshore areas are often the main recipients of these wastes. That's the necessary of research this.

The pollution of chemical and industrial waste to the paralic environment has become the global issue. Wastes enter coastal waters through rivers, sewage pipelines and other ways, which is threating to marine ecosystems and humans' health. Understanding the environmental behavior of these pollutants and

their ecological impacts is essential for developing effective management and protection measures.

2. The varieties and the environmental behaviors of chemical and industrial wasteSection Headings

This leads to re-suspension of sediments and contributes to the re-entry of heavy metals into water bodies [1]. The sources of persistent organic pollutants (POPs) such as polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) are mainly industrial activities including combustion processes, chemical manufacturing, and waste disposal.PCBs are widely used in electrical equipment, whereas PAHs are mainly derived from incomplete combustion of organic substances such as fossil fuels. Due to their stable molecular structure, PCBs and PAHs are highly resistant to environmental degradation, and their degradation process is very slow, relying mainly on microorganisms, which can also be accelerated by physical factors such as ultraviolet light.PCBs may be degraded by reductive dechlorination processes in sediments, while specific bacteria can degrade PAHs. However, high-molecular-weight PAHs are extremely slow to degrade, and some degradation products are as toxic as the original pollutants. are as toxic as the original contaminants. Due to their hydrophobic nature, these contaminants tend to accumulate in sediments and soils and bioaccumulate in the food chain, posing a long-term risk to wildlife and humans.PCBs and PAHs can also be transported through the global environment, contaminating areas far from the source of the contamination, such as the Arctic, with serious ecosystem impacts [2]. Acidic waste streams lead to a decrease in seawater pH and increase ocean acidification. Organisms such as corals and shellfish that depend on carbonates to form their shells find it difficult to survive in acidic environments and their shells become more fragile, affecting their normal development [3][4]. The discharge of alkaline waste streams raises the pH of seawater and may increase the toxicity of certain substances. For example, ammonia toxicity has significant effects on fish and invertebrates in high pH environments [4][5]. Ocean acidification has significant effects on carbonate-dependent marine organisms, and populations of organisms such as corals and sea urchins may be significantly reduced, which in turn affects marine ecosystems [3][4]. Biological metabolism is also impaired in highly alkaline water, with direct effects on the gills and skin of fish in particular [5]. The environmental behavior and toxicity of other toxic and hazardous substances such as chloride and cyanide are also of concern. Cyanide is widely found in industrial activities such as mining, metallurgy, and chemical manufacturing, and when it enters the environment, cyanide tends to form unstable complexes with heavy metal ions and rapidly dissociates into more toxic cyanide ions (CN-) and hydrogen cyanide (HCN) in water. Cyanide is extremely toxic to aquatic organisms, especially freshwater fish, with 24-hour LC50s ranging from 40-1200 μg/L, with the most sensitive species, such as the Atlantic salmon, having an LC50 of only 40 μg/L. Although chloride is not as toxic as cyanide, high concentrations of chloride can cause salinization of water and soil, affecting aquatic organisms and plant growth. Excessive discharge of chloride may lead to changes in biological communities in fresh and marine waters when industrial wastewater is not properly treated [6][7]. Cyanide causes damage to organisms by inhibiting key enzymes in the cellular respiratory chain (e.g., cytochrome oxidase), resulting in the inability of cells to utilize oxygen, which in turn triggers acute toxicity or even death. Furthermore, cyanide degradation relies on photolysis and microbial decomposition, but its persistence in the environment makes it still one of the major pollutants [6][7].

3. Impacts of chemical waste on offshore ecosystems

3.1 Effects of chemical waste on the physiology, growth and reproduction of aquatic organisms such as fish, shellfish and plankton

Chemical pollutants such as heavy metals, pesticides and microplastics can affect the behavior and physiological function of fish. For example, copper in chemical wastewater interferes with salmon's sense of smell, which affects their escape response and ability to hunt. Other pollutants, such as petroleum-based compounds, can impair heart function and growth.[8]

Microplastics and other pollutants can have toxic effects on the growth and reproduction of plankton. For example, certain chemicals can pass through the food chain and end up affecting fish and shellfish that feed on plankton. In addition, heavy metal pollution can inhibit plankton reproduction and reduce ecosystem diversity.[9]

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3.2 To investigate the accumulation of chemical waste in sediments and its effects on the structure and function of benthic communities

Heavy metals such as lead, mercury and cadmium are deposited in sediments and ingested by benthic organisms

ISSN 2959-6157

through the food chain, resulting in impaired physiological function and reproductive capacity. The study found that worm-like organisms, such as polychaetes, are able to remobilize pollutants in sediments, further expanding their spread through the ecosystem.[10][11]

Chemical and industrial waste not only affect benthic organisms directly through feeding, but also affect the biodiversity and ecological function of benthic communities by changing the physical structure of sediments. Polluted sediment can alter the habitat of benthic organisms, resulting in changes in community structure and interference with ecological functions such as nutrient cycling.[11]

[10]S. S. Dixit, D. Witcomb, B. J. Eadie, P. F. Landrum and W. Faust, SpringerLink [11] PETER A. JUMARS and ARTHUR R. M. NOWELL, Oxford Academic

3.3 Killer whales are among the most PCB-contaminated creatures on the planet

This long-term exposure weakens their immune system, affects their ability to reproduce, and leads to increased susceptibility to disease. The effects of these chemicals on polar bears are particularly significant, especially as climate change causes them to turn to contaminated food sources, such as seals and seabirds in the sub-Arctic. As climate change intensifies, the movement of pollutants in the ocean and accumulation in the food chain will further threaten the survival of these top predators.[12]Killer whales are among the most contaminated organisms on the planet with polychlorinated biphenyls (PCBs). Because of their position at the top of the food chain, killer whales accumulate large amounts of PCBs in their bodies by feeding on contaminated fish and marine mammals, and these persistent organic pollutants pose a serious threat to the health of killer whales, which can lead to reproductive problems, impaired immune system function, and even affect the survival of their overall populations.

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3.4 Chemicals such as heavy metals and persistent pollutants move up the food chain and eventually reach high concentrations in top predators, causing a biomagnification effect

Long-term exposure can weaken an organism's immune system and cause reproductive problems. Microplastics not only hinder photosynthesis and affect the growth of algae and phytoplankton, but also enter the body of fish and Marine mammals through ingestion, causing oxidative stress and metabolic disorders. This cumulative effect has profound implications for the health and biodiversity of Marine life [13][14][15].Chemicals such as heavy metals and persistent pollutants are cascaded through the food chain and eventually reach high concentrations in top predators, leading to biomagnification. These pollutants are able to accumulate in lower levels of organisms due to their difficult-to-degrade nature and are progressively passed on to higher levels of organisms as they are preyed upon. Top predators, such as large fish, birds and mammals, tend to have much higher concentrations of contaminants in their bodies than lower level organisms due to their position at the top of the food chain. This biomagnification poses a serious threat to the health of top predators and can lead to reproductive, immune and neurological damage and even death.

4. Summary

The coastal zone has important ecological, economic and social values, serving as a habitat and breeding ground for marine organisms while supporting multiple aspects such as fishery resources, tourism and transportation. However, as social inequalities increase, poor communities and vulnerable groups face greater pressure to cope with environmental pollution, especially when chemical wastes emitted from industrial production pose a serious threat to coastal ecosystems. Chemical wastes often contain heavy metals, persistent organic pollutants, acid and alkali waste streams, and other toxic and hazardous substances, which enter coastal waters through pathways such as rivers and sewage pipes, threatening marine ecosystems and human health.

After entering the water body, heavy metal pollution is easily attached to particles and deposited on the seabed, and extreme weather may lead to the resuspension of heavy metals, increasing the risk of water body pollution. And persistent organic pollutants (POPs), such as polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs), tend to accumulate in sediments and food chains due to their difficult degradability, threatening organisms and humans in the long term. The discharge of acid and alkaline waste streams also affects seawater pH, and ocean acidification not only negatively affects organisms that depend on carbonates for survival (e.g., corals and shellfish), but may also alter the toxicity of certain substances, affecting the metabolism and viability of marine organisms. Other toxic substances, such as cyanide, also pose a serious threat to aquatic organisms, especially fish. Understanding the environmental behavior and ecological impacts of these pollutants is essential to developing effective management and conservation measures.

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