REMOVAL OF TYPICAL ANTIBIOTICS FROM HOSPITALS WASTEWATER: COMMENTS ON AVAILABLE MATERIALS

УДАЛЕНИЕ ТИПИЧНЫХ АНТИБИОТИКОВ ИЗ СТОЧНЫХ ВОД БОЛЬНИЦ: КОМЕНТАРИИ К ДОСТУПНЫМ МАТЕРИАЛАМ

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This paper presents the fate and removal of antibiotics in hospital wastewater are analysed in depth, and the occurrence and risk of antibiotics in hospital wastewater are demonstrated by different treatment processes and materials.

В этой статье проводится глубокий анализ направления и удаления антибиотиков из сточных вод больницы, а также путем различных методов обработки и обработки материалов, которые доказывают наличие и риски антибиотиков в сточных водах больницы.

Keywords: Antibiotics, Adsorption and degradation, Catalyst materials, Wastewater remediation, Advanced oxidation

Ключевые слова: антибиотики, адсорбция и деградация, материал катализатора, восстановление сточных вод, высококачественное окисление.

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Hospital sewage is mainly the sewage discharged from the wards, clinics, operating rooms, X-ray photography rooms, laundry rooms and laboratories of the hospital. The source and composition of sewage are greatly complicated. Hospital sewage not only contains concentrated blood, tissue waste, drugs and detergents, but also contains numerous viruses, bacteria, parasite eggs and other harmful substances. Some discharge sewage of hospital treatment room also contains radioactive substances. The characteristics of hospital sewage depend on a number of factors, including geographic region, type of antibiotic recommended, type of medical facility, density of hospital beds, type of ward, country, seasonal variation and other factors.

Germany has about 25% of all antibiotics discharged from hospitals, while Switzerland has only about 25%, or 18% of all antibiotics. Prescription drugs account for approximately 20% of all drugs in Europe, 30% in the United Kingdom and 25% in the United States. The contribution, therefore, depends on the study area and the target compound, and is only about 2% or less, as reported by Thomas et al. In some studies, hospitals were found to contribute about a third of the total input, and targeting specific molecules showed higher concentrations than other substances that posed an environmental risk. The contribution of hospitals to trace pollutants in water can be identified by various sampling methods and strategies. These medical institutions and hospitals are relatively important sources of pollutants into which antibiotics, analgesics and therapeutic drugs enter.

Risks of antibiotics. Although the concentration of antibiotics in the soil environment is much lower than that of some traditional organic pollutants, the environmental risks cannot be ignored. Since antibiotics in the environment may be the cause of antibiotic resistance genes in the environment, their residues or metabolites may be harmful to the functioning of humans, animals and ecosystems. Plants and animals grow in soils contaminated with antibiotics, absorb and accumulate antibiotics in the body. For example, the application of enrofloxacin at a concentration of 0.05−5 mg·L−1 to cucumber, lettuce, kidney bean and radish would change the length of primary roots, hypocotyls and cotyledons. Ciprofloxacin at 10 mg·kg−1 could induce oxidative stress in earthworms and affect its mRNA expression, leading to DNA damage. Antibiotics in plants and animals can also be passed through the food chain to the human body, causing potential harm to human health. Antibiotics entering water will accumulate in sediments due to adsorption, and those with weak adhesion ability will enter nearby water bodies due to leaching conditions. Then, it will also be transfer to human bodies through the food chain, endangering human health, or migrate to soil, and enter the surface water and groundwater environment through surface runoff, posing a threat to different environmental media.[1] (Figure 1).

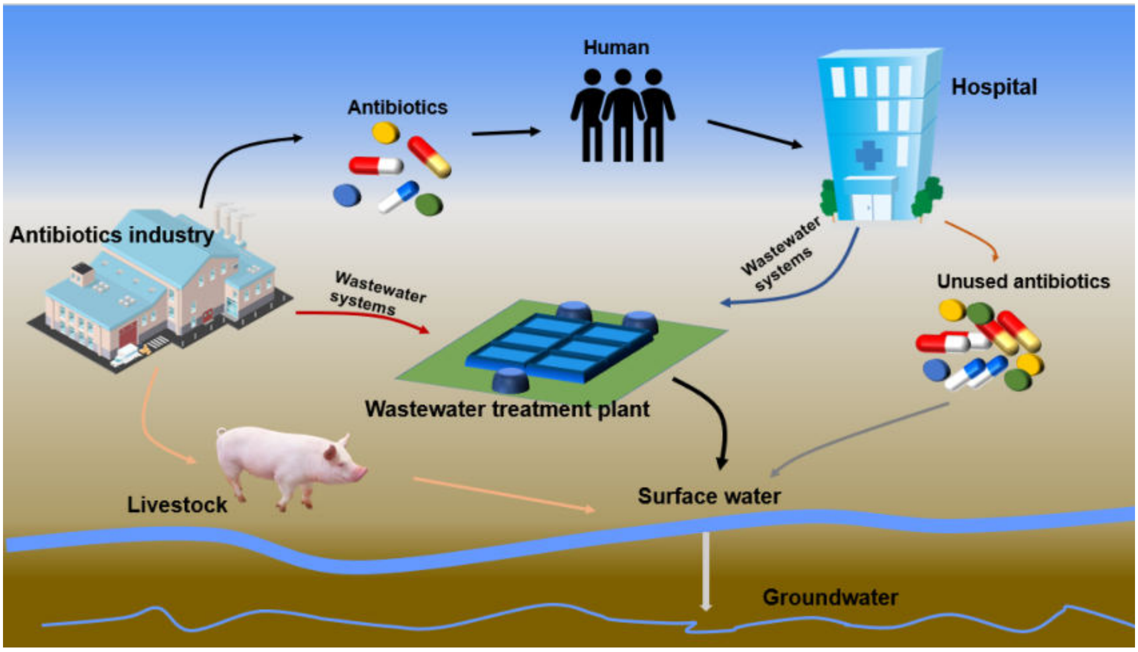

Figure 1 – Potential sources and fate of antibiotics in the water environment and soil

Available materials involved in antibiotics treatment

Adsorbent

Over the past few decades, researchers have worked on the feasibility of many adsorption materials to remove antibiotics, including activated carbon, carbon nanotubes, clay minerals, ion-exchange resins, and biochar.[53, 54] A special review of antibiotics adsorption removal is necessary because of the need to identify and classify the advantages and disadvantages of various sorbents. This need to use carbon-based, nanocomposite based and clay-based advanced adsorbents to repair antibiotics in aqueous media. The main interactions in which these adsorbents remove antibiotics include surface/pore diffusion, electrostatic interactions, hydrogen bonding, and π-π electron donor-acceptor (EDA) interactions. (Figure 2)

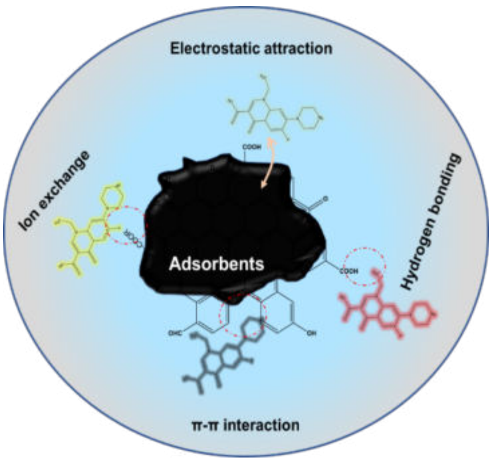

Figure 2 – Adsorption mechanism of antibiotic pollutants by carbon materials.

Catalyst

A great deal of research has been done by scientists to resolve the theory and applications of AOP, and significant progress has been demonstrated. Some basic reaction principles of AOPs have been gradually revealed and new catalysts have been synthesized to overcome the shortcomings of traditional catalysts in AOPs applications. [2] In Fenton oxidation, the pH of the reaction system is the bottleneck issue, and the pH is generally 7−8 in real industrial textile effluents. This means that the pH of the wastewater needs to be adjusted before Fenton oxidation, which will greatly increase the cost of wastewater treatment. Therefore, the current research on Fenton process mainly focuses on the introduction of light, electricity or the development of new green and efficient catalysts to broaden the application range of the process.

Algae

Algae are protists in aquatic ecosystems. Due to its short growth cycle, high sensitivity to water pollutants, initiating stress response mechanism and other characteristics, it can be used as an ecological indicator and removal of pollutants. Algae-based technologies are already widely used to treat wastewater containing antibiotics, offering many benefits including efficient CO2 fixation, low environmental impact, solar-powered activity, and providing potential raw materials for the generation of biofuels or other high-value byproducts. Microalgae biodegradation can occur through two main mechanisms: first, through metabolic degradation, in which antibiotics provide a carbon source and act as electron donors or acceptors for microalgae; Second is through co-metabolism, in which antibiotics are reduced by enzymes, resulting in the formation of non-toxic product compounds. Biodegradation has been shown to be the most effective mechanism for algae-mediated removal of antibiotics.Furthermore, the factors influencing the degradation of antibiotics by algae were demonstrated (Figure 3).

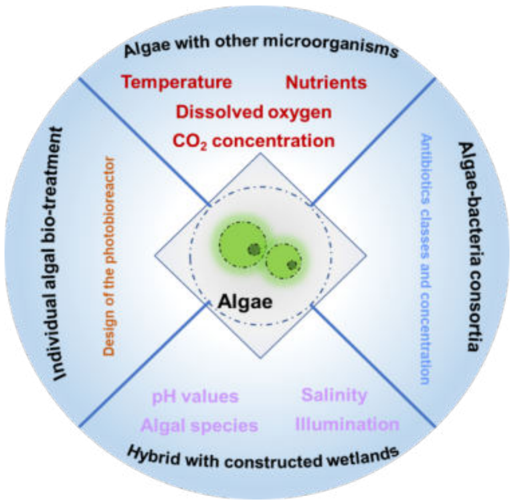

Figure 3 – The factors influencing the degradation of antibiotics by algae

Conclusions and perspective. Hospital sewage has different physical and chemical parameters, biological, inorganic and organic pollutants. As a new pollutant, the harmfulness of antibiotics has attracted more and more attention. However, there are still no clear guidelines on the use of antibiotics and their management of wastewater treatment. Most antibiotic removal technologies and detection methods are suitable for the treatment of wastewater containing high concentrations of antibiotics, such as industrial wastewater and pig wastewater. This review compares and summarizes the treatment methods and related materials of antibiotics in recent years. Many of these approaches still face implementation challenges, such as narrow environmental parameters for optimal function (such as pH), not being effective against all antibiotic classes, and uncertainty about how to apply these technologies to comprehensive wastewater systems. Because of the complex challenge of removing antibiotics from already complex waste substrates, these technologies may need to be used as a range of tools in the toolbox for environmental protection from antibiotic contaminants, rather than as a single solution, because wastewater contains mixtures of many different antibiotic classes with different functionality and activity.

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