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Mini Review

Heavy Metal Pollution in China Yellow River: What do we know?

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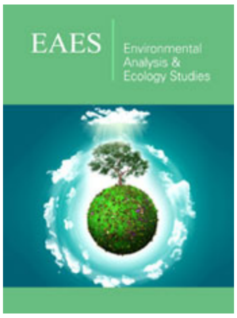

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Abstract

Heavy metal is one of the most severe pollutants, which threats to human and environment worldwide. Even in the current era of growing technology, the concentration of heavy metals in water sources is still not meet the recommended limits. The water contaminated by Lead (Pb), Zinc (Zn) and Copper (Cu) is becoming a major health concern for public and health care professionals. This paper reviews the current progression of heavy metal pollution in China Yellow River and supply several strategies for its efficacy purification.

Introduction

The human society development is controlled by environment through two channels, health and level of income [1]. It is great concern on the negative impact of polluted environment, especially polluted soil and water on human health. Environmental pollutants can cause health problems like respiratory disease, heart disease, and some types of cancer. People with low incomes are more likely to live in polluted areas and have unsafe drinking water. Specially, children and pregnant women are at higher risk of health problem related to pollution. All types of pollution are result of negative market externalities since the free market is hard to efficiently allocate the resources. The combined health and non-health cost of outdoor air and water pollution for China's economy comes to around $US100 billion a year, which is around 5.85% of the country's GDP [2]. According to China official data, more than two-thirds (70%) of groundwater samples taken from around the country earlier this year were too polluted to be fit for human use.

With the developing industry of mining, smelting and metal treatment, heavy metal pollution becomes one of the most serious challenges for water purification in China, as well as all over the world. Heavy metal pollution not only affects the water bodies, but also the production and quality of crops, and threatens the health and life of animals and human beings by way of the food chain. Most severe is that this kind of pollution is covert, long-term and non-reversible [2]. Heavy mental ions in the polluted water are most severe pollution resource, and they are majorly derived from various chemical engineering processes including electronics, mining, machinery manufacturing, battery fabrication, etc. [3]. How to clean the heavy metals from the polluted water in order to avoid their entrance into the food chain, however, is important for protecting the health of animals and human beings. As such, technologies aiming at the effective removal of these ions have received extensive interests from this field. This review would compile the references, which have mostly been published in wastewater purification, to try to provide an improved comprehension, progress and prospect of the heavy metal pollution in China as well as all over the world.

Heavy Metal Pollution

The geological background level of heavy metal is low [4]: such as, in the water of the Yangtze River Basin during 1990-1992, the concentration of Cd, Cu, Mn, Pb, and Zn are 0.080, 7.91, 2.59, 15.7 and 18.7ug/L respectively. Generally, concentrations of heavy metals was at lower water level conditions several dozen years ago. Because of the activity of human being, a high anthropogenic emission of heavy metals enters into the biosphere. Emission, wastewater and waste solid are the origin of heavy metal pollution to water. Wastewater irrigation is very common worldwide. In China, 60-80% of the wastewater is due to industrial effluents and the compositions are complicated.

Heavy Metals in Food and Their Transfer Through the Food Web

Polluted water have led to the heavy metal pollution of foods for human and animals. A case reported that disease was caused by ecological environment [5]. There were 20 families with totally 154 persons in the study village, but 31 of them died of cancer during the last three decades. By analysis of the heavy metal in the water source, the contents of several heavy metal ions were higher than the standard. Among them, Pb, Zn and Cu ions show a more ecotoxicological effect on the environments and were the main reason for cancer in the studied village.

Heavy Metals Clearance in Water

How to clean the heavy metals in the water and to avoid their entrance into the food chain is a hot topic throughout the world. Conventional technologies for the treatment of heavy metal ion-containing wastewater includes chemical precipitation [6], membrane separation [7], ionic exchange [8] and adsorption [9]. Among them, Adsorb-based separation would be an effective technique to remediate heavy metal pollutions in wastewater due to its unique advantages such as high efficiency, low cost and more friendly to environment. Fortunately, studies on adsorption for heavy metals is widely spread throughout the world. It indicates competitive efficiency when applied different types of adsorbents to treat a large volume of wastewater, including activated carbon [10], functionalized cellulose [11], polymers [12], MOFs [13]. One group developed a green synthetic strategy to acquire a polythiophene (PTh)/MnO2 composite in the aqueous medium [14]. The produced core-shell composite, which featured abundant sulfurs and hydroxyls, provided a platform for the effective heavy metal ion capture, resulting in a rapid adsorption equilibrium with 30min, and in novel adsorption capacities of ~82, 30, 60mg g^{-1} for Pb^{2+}, Zn^{2+} and Cu^{2+}, respectively. This design principle contributed to address challenges concerning heavy metal selective capture in the environmental field.

Adsorption has been proved to be a useful method for the treatment of wastewater contaminated by metal ions. However, most of reports use commercial adsorption resins for the removal of heavy metal ions. The matrix of resins was usually of polyarylic or styrene-divinyl benzene ester, and the adsorption mechanism primarily relied on the hydrophobic force such as van de Walls force in the aqueous solution, which may lead to the low adsorption selectivity. We developed an efficient purification method through synthesis of novel structure on the basis of the Friedel-Crafts catalyzed and amination reaction [15]. The results indicated the modified adsorbent performed significantly higher purity and adsorption compared to commercial ones due to its more pores, higher surface area and stronger hydrogen-bonding interaction.

On the other side, the wastewaters very in terms of the pollutant composition depending on the origin of the industry. There are also water that contain as well as nutrients and heavy metals, such as storm wastewater and municipal wastewater. In that cases where a complex water composition and several of the pollutants need to be removed, it is interesting to find a single adsorbent that has potential to be utilized for treatment of that kind of wastewater due to the ability of removal of nutrients and heavy metals. Besides the relying on the interaction of the target compounds with the functional groups on the surface of the adsorbents, we also attempted to study the adsorption and regeneration of Ni^{2+}, Cd^{2+}, PO_3^{-4}, NO^{3-} using the same adsorbent, carbonated hydroxyapatite modified nanocellulose [16]. This modified adsorbent has a composition and structure analogous to the bone apatite and showed higher bioactivity than pure hydroxyapatite. The results showed this modified adsorbent was very effective for Ni^{2+}, Cd^{2+} and PO_3^{-4} removal from aqueous solution, which adsorption efficiency was >90%.

Prospective

Humans should be careful with heavy metal polluted water and food worldwide. To improve food from areas non-polluted by heavy metals and drink safe water would be a way to avoid these heavy metals from being transferred to humans via food chain. In China, the Yellow River basin has east-west extent of about 1,900 kilometers and a north-south extent of about 1,100km. Its total drainage area is about 795,000 square kilometers. As modern economic development has increased through the basin, however, pollution from industrial sources and agricultural runoff has also increased. In addition, the greater demand for limited water resources has caused shortages, which makes the utilization of Yellow River becomes more important. Besides the selection and modification of adsorbent materials for heavy metal removal, the optimal operation conditions of adsorption process is the next key factor on the purification efficacy, which would be systemically reviewed in the near future.

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