Harmfulness, Detection and Treatment of EDCs in Water Environment

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Abstract: Endocrine disrupting chemicals (EDCs) showed variety and widely distributed in the environment. The presence of EDCs was the most typical in water bodies. EDCs in water accumulated in human and other organism to a certain extent would harmfully interfere the normal functioning of the nervous system, immune system and endocrine system. This paper reviewed the existing form of EDCs, the harmfulness of EDCs, the detection methods and treating methods for EDCs in water environment. In view of the current situation of EDCs pollution in the water body, the specific measures for the future treatment of EDCs were established.

Introduction

EDs（Endocrine disruptors）was a kind of micro-pollutants which primarily existed in chemicals, with potential interference with the endocrine system. EDCs (endocrine disrupting chemicals) was the main existing role of EDs which interfering organisms within the normal hormone producing, releasing, transporting and secreting. EDCs were mainly included in synthetic chemicals and natural chemicals. The synthetic chemicals mainly existed in pesticides, flame retardants, plasticizers, industrial solvents etc. The natural chemicals mainly existed in plants, fungus and in animals' excrement. As the chemicals polluted the water bodies seriously, EDCs became a normal but a kind of the most harmful pollutants in water nowadays.

Harmfulness of EDCs

The toxic effects of EDCs on human body were obvious. It caused a series of adverse reactions on the human bodies' endocrine system, and disrupted the body's normal humoral regulation, nervous regulation and immune regulation. EDCs were mainly absorbed by the human body through three ways: skin absorption, nasal absorption and digestive tract absorption[1]. Reports indicated that lactating women with the skin exposed in the presence of EDCs, their milk contained EDCs, and the concentration of EDCs increased in their bodies with the increasing of the EDCs concentration increased in the environment. Studies showed that the skin of the human bodies exposure in the EDCs would be immediately detected EDCs in the exhaled air. The chemical structures of EDCs did not change but only the concentration would decrease with the time goes on

slowly[2]. Nasal inhalation was the most common way to contact EDCs in the general population. The America EPA (Environmental Protection Agency) found that due to the high water partition coefficient of EDCs, EDCs would accumulated in breast milk with the lactating women exposure to the air containing EDCs[3-5]. EDCs absorption of the digestive tract was mainly through drinking water and food into the human body. Because of the existence of EDCs in surface water, at present in China water treatment EDCs was not yet to endocrine disrupters as emphasis, it rapidly enters into the circulatory system in human bodies.

Detection of EDCs

Chromatographic technique was a main technique to detect EDCs in water. After preconcentration and other preprocess, water samples needed to be detected by chromatography[6]. Gas chromatography, liquid chromatography, gas or liquid chromatography-mass spectrometry and high performance liquid chromatography were used to detect EDCs in now studies.

Gas Chromatography and Gas Chromatography-Mass Spectrometry

GC (Gas Chromatography) was a typical EDCs analysis method for the separation and analysis of the chemical substances which were easy to be gasified and cannot be decomposed. GC was often used to analyze the purity of some substance, or to separate the components from the mixture[7]. Gas chromatography-mass spectrometry (GC-MS) was in the gas phase chromatography combined with mass spectrometry analysis. This could be quickly and efficiently to separate the mixture and analysis of a variety of components[8,9]. The combination was more effective than a single analysis, especially for the detection of EDCs in water.

Liquid Chromatography and Liquid Chromatography-Mass Spectrometry

LC (Chromatography Liquid) was similar to the principle of GC, but the substance to be detected does not need to be gasified. It simply needed to maintain the liquid phase. HPLC (High Performance Liquid Chromatography) was on the basis of LC[10]. High pressure made the samples through the highly efficient adsorption material so as to achieve the purpose of efficient detection[11]. HPLC in the trace substances detection and analysis kept the champion position. It was widely used in the fields of medicine, chemical industry and environmental monitoring etc. LC-MS (Liquid Chromatography–Mass Spectrometry) was similar to GC-MS, which was used in combination with HPLC and MS.

Other detection techniques

Other detection techniques including photocatalytic degradation, inductively coupled plasma-mass spectrometry, enzyme linked immunosorbent assay, capillary electrophoresis technology, fluorescent molecular sensor technology, biological identification-chemical analysis, etc[12]. Rebecca Wittrig used LC / MS / MS to monitor X-ray contrast agent and EDCs in wastewater and got a good result. This combined method using a triple quadrupole Technology (triple Q. Technology) to link with MS, composed of a plurality of detection of the reaction system, monitored the effect far more than GC-MS.

Treatment methods of EDCs

Coagulation-Sedimentation-Filtration

Coagulation meant to invest ferric salt, aluminum salt and other types of coagulants to increase the concentration of make water of anionic, cationic or anionic and cationic polymers. It would

disrupt the stability of the suspended solids in water and condense small particles into large ones to remove by sedimentation[13]. After sedimentation, the water through the quartz sand filter layer, impurities in the water were further intercepted. Coagulation-sedimentation-filtration method was the most traditional and conventional water treatment technology[14]. In a certain extent, EDCs had been certain removed. But compared to other pollutants quantities, EDCs was water soluble and less existed, this conventional treating method was limited especially on EDCs removal.

Activated Carbon Adsorption

The adsorption of activated carbon included physical and chemical processes. Physical adsorption process relied on the porous structure of activated carbon making the huge surface area. The pore wall carbon molecules would exert an attractive force on materials[15]. Chemical process was not only only caused by the carbon element, but also some adsorbed chemical groups, including hydroxyl, carboxyl and a series of active free radicals would remove the pollutants' molecules. Due to the excellent adsorption capacity of activated carbon, the removal efficiency of EDCs was good.

Oxidation

Oxidation technology was widely used in water treatment and the technology was mature. The oxidation treating EDCs in water mainly included chemical oxidation, photocatalytic oxidation, ultrasonic enhancement and so on. The most widely used oxidation method was chemical oxidation. To the easily oxidized EDCs molecules, the long chains were decomposed into short chains. That would be easy to remove[16]. Common oxidants used in recent years were chlorine, chlorine dioxide, hydrogen peroxide, potassium permanganate and ozone. Based on oxidation technology, advanced oxidation technologies had emerged which had good removal effects on EDCs[17].

Biotreatment

The biotreatment method mainly used the metabolism function of microorganism to degrade the EDCs in water body. In water treatment, activated sludge process and biofilm process were main ways. Biodegradation was in line with the goal of green chemistry. After the microbial metabolism, the EDCs degradated in water or trapped into microorganism. This process didn't need additional chemicals and not produce secondary pollution. But in the water environment, EDCs showed various kinds and low concentrations. So the sludge contents needed a longer period of time to domesticate that would get better effects.

Membrane Technology

The membrane treatment technology with good effects, high efficiency and strong controllability in the processing has become an important method. The common membrane technologies included microfiltration, nanofiltration, ultrafiltration and reverse osmosis. The membrane technology for EDCs has a good removal effect. And smaller the aperture was, the better the water quality would get. However, in water treatment, increasing pore size of the film was easy to plug and needed to clean, so the operating costs would be raised.

Other Methods

The SDWA (safe drinking water act) recommended a treating method called POU/POE (Point-of-Use/ Point-of-Entry Treatments). This kind processing method was for small scale water circulation system[18]. No matter to the water quality or the water quantity, this method had a good effect to the EDCs removal.

Conclusions

With the rapid development of economy, the varieties and contents of EDCs in water became

more and more. In the economic construction of new technologies, new processes and new materials, new pollutants were brought out. To define whether the new materials were EDCs needed a complex screening and testing process. Terrence Collins has proposed to chemical substances of toxicological extreme: cell death, structure of DNA damage or mutation, epigenetic alteration of gene expression. For the production and use of chemical substances, to the best use was the aim, but also to the negative effects by the alert was the aim too.

The following several points could be carried out for EDCs research: firstly, the basic knowledge of EDCs needed to consolidate in order to establish a complete system. At present, the research on EDCs was fragmentary and unitary, and the knowledge system of EDCs had not yet formed, which made the negative impact in the spotlight. This is just the relationship between a point and a point, the link was not close. Secondly, EDCs detection method needed to be improved. Now screening and detection methods used in many countries although in a certain extent can located the good position of EDCs, but this method needed to spend a lot of time and effort, and required continuous on fish, amphibian and mammalian animals in vitro and in vivo to determine the correctness. Thirdly, EDCs exposure needed to be reduced. In this way the incidence of diseases was reduced. For humans and wild lives, EDCs exposure had a serious negative impact. On the other hand, the lack understanding of the EDCs was also an important reason for this adverse impact. What's more, to establish a scientific risk assessment method was necessary. At present, there was not a way to assess the chemical substances and health risk assessment method to be widely recognized.

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