Research Progress of Tap Water Treatment Process

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Abstract. With the rapid decrease of available water resources, to satisfy the needs of human life, it is urgent to treat and purify the water resources of waterworks so that the purified water can satisfy people’s needs. This article mainly elaborates on the current research progress of tap water treatment technology and advanced treatment technology. Provide some basis for the application of social enterprises and scientific research workers.

1. Introduction

Water is the basis of human existence, but with the acceleration of industrialization, the pollution of water resources worldwide is becoming more and more serious. Usually, the pollutants in drinking water mainly include organic matter and ammonia nitrogen [1]. At present, the commonly used water treatment processes are mainly coagulation, precipitation, filtration, and chlorine disinfection, but they cannot effectively remove ammonia nitrogen and organic matter [2-3]. And chlorine disinfection can produce harmful by-products [4]. Drinking unclean water can seriously endanger public health and even affect the kidney and urogenital system [5-6]. Under the situation of a significant reduction in clean water resources, it is urgent to treat the water resources of waterworks through an efficient water treatment process so that they can use it for domestic water.

2. The current treatment process of waterworks

2.1. Membrane separation technology

Membrane technology has become one of the key technologies for treating polluted water [7]. The application of membrane technology in the field of water purification treatment is a global development trend, including various coupling technologies, such as reverse osmosis and forward osmosis coupling to reduce energy consumption and water production costs; reverse osmosis and membrane distillation technology coupling to achieve zero emissions. And membrane technology has been widely used in sewage treatment [8-9]. Membrane separation technology mainly includes microfiltration membrane (MF) and ultrafiltration membrane (UF) technology [10], reverse osmosis (RO) technology, but reverse osmosis technology has a higher cost of filtration [11]. In contrast, reverse osmosis and nanofiltration technology can filter secondary treatment water to save costs [12].
Oh et al. used microfiltration combined with activated carbon adsorption to treat surface water, namely the raw water of the water plant. The results show that organic matter and microorganisms can be simultaneously removed by the adsorption and filtration mechanism[13]. Haas et al. used a combination of dam filtration and ultrafiltration treatment, which can make drinking water production more effective and economically feasible and can completely remove bacteria and turbidity[14]. Albergamo et al. found that after filtering the river embankment and then performing reverse osmosis treatment, it can remove biologically active pollutants and produce drinking water without the toxic effects studied, including 2,6-dichlorobenzamide, bentazon, and acesulfame[15]. The ultrafiltration membrane technology is becoming more and more mature. The membrane pollution can cause the membrane flux to reduce, and auxiliary equipment needs to be maintained, resulting in higher operation and maintenance costs.

2.2. Activated carbon treatment technology

At present, an in-depth treatment of water resources in waterworks mainly uses activated carbon and other technologies. Activated carbon treatment technology is convenient and straightforward, economical, and reusable. The commonly used granular activated carbon (GAC) helps to remove compounds in drinking water to achieve the purpose of water purification[16]. GAC filtration can remove the bad color, smell, taste, and organic compounds caused by water treatment, and also can remove pesticides and other heterogeneous organisms. During GAC filtration, adsorption, and biodegradation co-occur[17]. Siwila et al. used gravity-driven wooden filters combined with granular activated carbon to treat drinking water and found that the removal rate of bacteria can reach more than 99%, and also can remove organic matter, heavy metals, color, smell, and peculiar smell[18]. And Moona et al. found that the existing biological activated carbon filter maintains 90% of the filter media. While the new GAC promotes adsorption, biodegradation continues to be helpful for removing natural organic matter[19]. Sawana et al. used cerium dioxide modified activated carbon to purify arsenic in drinking water. It found that CeO2 coated powdered activated carbon can effectively remove arsenic in drinking water through specific adsorption and condensation attraction. The removal ability of As(III) and As(V) was close to 12 mg/g. And removal was not affected by factors such as pH and salinity[20]. And GAC adsorption can well control the controlled disinfection by-product (DBP)[21]. Liu et al. found that the adsorption of GAC can remove the organic matter of soluble microbial products in 60% of water and reduce the formation potential of disinfection by-products by more than 70%. GAC is a more effective way to control the DBP derived from wastewater in water supply[22]. Activated carbon treatment technology can effectively avoid the potential harm caused by chlorine disinfection in conventional water treatment processes. However, activated carbon treatment technology has the disadvantages of secondary pollution risk and inconvenient recovery. And analyze the membrane separation and activated carbon treatment technology currently used in waterworks, as shown in Table 1.

| Treatment process                          | Remove pollutants          | Removal       | References |
|-------------------------------------------|----------------------------|---------------|------------|
| Microfiltration-activated carbon          | UV260                      | 90.3%         | [13]       |
| Dam filtration and ultrafiltration        | Bacteria and turbidity     | 100%          | [14]       |
| Wooden filter-GAC                         | Bacteria, turbidity, and TSS| >99%          | [18]       |
| Ceria modified activated carbon           | Fe, Pb, Ni, Al, and Zn     | >90%          | [20]       |
| GAC                                       | As(III) and As(V)          | 12 mg/g       | [22]       |
|                                           | Soluble microbial product organic matter | 60%          |            |

2.3. Biological treatment process

Biofilm water treatment technology is a kind of water treatment technology that has been developed rapidly in recent years. It has the advantages of small footprint and convenient management. It has been widely used in the treatment process of waterworks[23]. This kind of biofilm has a long service
life, and can effectively block microorganisms in the water and improve the safety of domestic water. However, its stability is susceptible to factors such as ambient temperature, dissolved oxygen, and toxic substances[24-25]. Rittmann based on the membrane bioreactor (MBfR) of H2 can convert NO3- to N2, ClO4- to H2O and Cl-, and can effectively remove many pollutants[26]. Gilbert et al used a moving bed biofilm reactor to treat wastewater and found that denitrification can be effectively carried out[27]. The lack of treatment of heavy metals and other toxic substances in water bodies by the biofilm method for water purification is one of the defects in its application to the actual purification of water sources.

3. Advanced treatment process of waterworks

Andersson et al found that the chlorination and chlorination treatment of pilot water commonly used in Sweden produces low levels of adsorbable organic halogen (AOX). Compared with traditional treatments, brominated DBP is rich in variety, but the main is chlorinated DBP[28]. Since Br-DBPs are more toxic than Cl-DBPs, the potential increase in Br-DBPs has a significant impact on the associated health risks. In response to the genotoxicity caused by disinfection by-products caused by chlorine disinfection. Lundqvist et al reduced the genotoxicity caused by disinfection through each treatment step of the innovative water treatment technologies (suspended ion exchange, ozone, online coagulation, ceramic microfiltration membrane, and granular activated carbon combined treatment). Oxidative stress (Nrf2 activity) caused by a large amount of chlorination in conventional methods, the activity of chlorinated water after suspension ion exchange has reduced by 70%. And through subsequent ozone treatment, Nrf2 activity is further reduced after chlorination[29]. Besides, it is more interesting that Carrasco-Turigas et al through boiling and filtering tap water found that filtering and boiling can reduce 97% trihalomethane (THM4) and reduce 3-chloro-4 (dichloromethyl)-5-Hydroxy-2(5H)-furanone (MX) reduced to below the legal limit[30]. Rodriguez controlled the by-products of disinfection by spray aeration combined with activated carbon process. The results showed that reduced 58% trihalomethane (THM) and reduced 48% haloacetic acid (HAA5)[31]. The advanced treatment process is mainly to purify drinking water through a combination process. At the same time, it is also necessary to develop new technologies to promote the diversification of purifying drinking water treatment options, thereby providing options and basis for further cost reduction.

4. Conclusions

There are more and more treatment processes for purifying tap water, but each has its advantages and disadvantages. Therefore, in practical applications, we need to select the treatment process following the actual situation to achieve the purpose of purifying tap water, thereby contributing to the safe and reliable drinking water that humans can drink. The advanced treatment process is essential for the purification of tap water. The development of new, efficient, sustainable, and diversified treatment processes is a research focus in the future.

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