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Review

Current state of sewage treatment in China

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ABSTRACT

The study reported and analyzed the current state of wastewater treatment plants (WWTPs) in urban China from the aspects of scale, treatment processes, sludge handling, geographical distribution, and discharge standards. By 2012, there were 3340 WWTPs in operation in China with a capacity of 1.42×10^8 m^3/d. The number of medium-scale WWTPs ($1–10 \times 10^4$ m^3/d) counted for 75% of total WWTPs. On average, the chemical oxygen demand (COD) removal efficiencies of small-scale, medium-scale, large-scale and super-large-scale WWTPs were 81, 85.5, 87.5 and 86.5%, respectively. Generally speaking, the nutrients removal instead of COD removal was of concern. As to the different processes, oxidation ditch, anaerobic–anoxic–oxic (A^2/O) and sequencing batch reactor (SBR) were the mainstream technologies in China. These technologies had minor difference in terms of overall COD removal efficiency. The sludge treatment in WWTPs was basically "thickening-coagulation-mechanical dehydration" and the major disposal method was sanitary landfill in China. The distributions of WWTPs and their utilization showed significant regional characteristics. The sewage treatment capacity of China concentrated on the coastal areas and middle reaches of Yangtze River, which were the economically developed zones. Besides, most WWTPs enforced the Class 1 or Class 2 discharge standards, but few realized wastewater reuse. Finally, existing problems were discussed, including low removal efficiency of nitrogen and phosphorus, emerging contaminants, low reuse of reclaimed water, poor sludge treatment and disposal, low execution standard of effluent, and emissions of greenhouse gas from WWTPs. Suggestions regarding potential technical and administrative measures were given.

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1. Introduction

Nowadays, water pollution is a severe problem, especially in developing countries like China (Qu and Fan, 2010; Wu et al., 1999). There are many factors that have resulted in widespread water pollution, including 1.3 billion population of China, rapid economic growth, industrialization, urbanization and inadequate investment in infrastructures. Over the past several decades, China's surface water and ground water have been severely contaminated by industrial and municipal wastewater, agricultural activities and household wastes (Liu and Diamond, 2005; Hu and Cheng, 2013). By 2012, the national wastewater emissions were 68.5 billion tons, and increased by 3.7% over the last year. Specifically, the chemical oxygen demand (COD) emissions were 24.2 million tons, and the ammonia nitrogen emissions were 2.5 million tons. Pollutants removal is the main object in this situation (Zhang, 2011). For the seriousness of water pollution, it is necessary to analyze the current state of sewage treatment in China.

In recent years, with the fast development of economy and growing environmental protection consciousness of government and citizens, the sewage treatment capacity of China has been established quickly. According to the Ministry of Housing and Urban-Rural Development of the People's Republic of China, by 2012, there were 3340 wastewater treatment plants (WWTPs) in cities, and the sewage treatment capacity was about 1.42×10^8 m^3/d, which increased 6×10^6 m^3/d over last year. Based on those data, China has the world's second-largest sewage treatment capacity after the United States. Wastewater treatment generally consists of primary, secondary, and sometimes an advanced treatment process, with different biological, physical, and chemical technologies (Batt et al., 2007). At present, many sewage treatment processes are used in WWTPs in China, including conventional activated sludge treatment, anaerobic–anoxic–oxic (A^2/O), anaerobic–oxic (A/O), sequencing batch reactor (SBR), oxidation ditch, etc. The treatment efficiency of WWTP is not only related to the process, but also depends on the scale of WWTP. According to the treatment capacity, WWTPs can be divided into small-scale, medium-scale, large-scale and super-large-scale. Since the amounts of wastewater are determined by the population density and economic level, there are larger amounts of wastewater in the coastal area and big cities of China than other zones (Qiu et al., 2010). So the geographical distribution of WWTPs is also worth consideration. Besides, the rapid construction of WWTPs in China is almost finished and it is time to summarize and analysis the situation. However, there are few systematic researches on the current state of sewage treatment in China.

The study reported and analyzed the current state of WWTPs in urban China from the aspects of scale, treatment processes, sludge handling, geographical distribution, and discharge standards. The newest available nationwide statistical data were those of 2012. Data used in this paper are from China statistical yearbook; government reports or official websites from environmental protection agencies, water supply agencies, and urban infrastructures agencies; professional literatures; field reports; and interviews with industrial and academic experts (National Bureau of Statistics of the People's Republic of China, 2012, 2008–2013; China Urban Water Association, 2012; Ministry of Environmental Protection of the People's Republic of China, 2008–2013, 2013a,b; Ministry of Housing and Urban-Rural Development of the People's Republic of China, 2010–2013). Note that all information referred to mainland China and municipal sewage only, excluding the industrial wastewater.

2. Scale of WWTPs

As the most important means of water environment protection, the construction of WWTPs has been paid more and

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