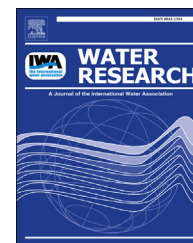


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Current state of sludge production, management, treatment and disposal in China



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ABSTRACT

Large amount of sludge has been a great trouble and raised significant concerns in China. This paper reviewed the current situation of sludge production, management, treatment and disposal in China. Total sludge production in China had an average annual growth of 13% from 2007 to 2013, and 6.25 million tons dry solids was produced in 2013. Per Capita sludge production in China is lower than that in developed countries. However, sludge management is poor in China. Administrative agents of sludge are not in accordance with each other. Laws and regulations of sludge management are incomplete and sometimes unrealistic. As to sludge treatment and disposal, many technical routes have been applied in China. Thickening, conditioning, and dewatering are three most used treatment methods, while application ratios of stabilization and drying are low in China. More than 80% of sludge is disposed by improper dumping in China. Regarding proper disposal, sanitary landfill is the commonest, followed by land application, incineration and building materials. According to the overall situation of China, “thickening-anaerobic digestion-dewatering-land application” is the priority technical route of sludge treatment and disposal. Good changes, current challenges and future perspectives of this technical route in China were analyzed and discussed in details.

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1. Introduction

Sludge is the by-product of wastewater treatment process (Bodzek et al., 1997; Feng et al., 2014; Zhang et al., 2009a). In China, with the development of industrialization and urbanization, large amount of sewage has been generated (Yang et al., 2014). In addition, wastewater treatment ratio has been higher and higher. Therefore, large amount of sludge has been produced in China (Dong et al., 2013; Yang et al., 2011). Sludge has many toxic substances such as pathogens, heavy metals and some organic contaminants, which can cause serious environment pollution (Dong et al., 2013; Shehu et al., 2012; Zhang et al., 2009b). Nowadays, sludge has been a great challenge in China, so it is essential to manage, treat and dispose sludge properly.

Currently, management systems of sludge are multitudinous including administrative agents, laws and regulations. Moreover, sludge treatment usually consists of thickening, conditioning, dewatering, stabilization and drying, with various physical, chemical and biological technologies (Kelessidis and Stasinakis, 2012; Yu et al., 2013; Zhang et al., 2007). Many sludge disposal methods have also been applied such as sanitary landfill, incineration, land application and building materials (Cai et al., 2007; Hale et al., 2012; Wang et al., 2012).

Although most of above mentioned sludge treatment and disposal methods have been applied in China, China pays more attentions to wastewater treatment than sludge treatment and disposal all the time. Recently, some pollution events of sludge were reported in China. In Beijing and Nanjing, two big cities of China, some wastewater treatment plants (WWTPs) dumped sludge in the suburbs. These events have led to great public dissatisfaction. Accordingly, in China, the situation of sludge production, management, treatment and disposal is needed to gain insight for solving this problem. However, so far, a clear view on the current status of sludge treatment and disposal as well as management in China is lacking. Relevant studies were old, fragmentary, or even inconsistent (He et al., 2007; Lin and Zhou, 2005; Fu et al., 2004).

The main objective of this study was to comprehensively review the current status of sludge production, management, treatment and disposal in China based on recent available data. According to the overall situation of China, future option for technical route of sludge treatment and disposal was discussed. Good changes, current challenges and future

perspectives of this route were also analyzed. For this purpose, data were obtained from statistical yearbook, literature, government reports or official websites, professional organizations and field reports.

2. Sludge production

2.1. Overview

As shown in Fig. 1(a), the daily wastewater treatment capacity and number of WWTPs in China have increased rapidly from 2007 to 2013, which suggested that more and more sewage was generated and treated. Accordingly, as shown in Fig. 1(b), from 2007 to 2013, the total sludge production in China increased significantly and had an average annual growth of 13%. In 2013, 6.25 million tons dry solids (DS) was produced. Moreover, Per Capita sludge production in China was about 4.6 kg DS in 2013, which was much lower than that in developed countries (Kelessidis and Stasinakis, 2012). This phenomenon might be due to different wastewater treatment processes, more developed economy and less population in developed countries.

2.2. Geographic distribution

The mainland China has 31 provinces and can be divided into seven administrative areas including Central, East, North, Northeast, Northwest, South and Southwest. Total sludge production, Per Capita sludge production and Per Capita GDP of these areas in 2013 were illustrated in Fig. 2 (NBSC, 2013b; CUWA, 2013). The status of sludge production in each province was reported in Table 1 in details. It should be motioned that province-level municipality and autonomous zone are all treated as province in this study.

In China, generally speaking, more sludge was generated in the eastern part than the western part (Fig. 2). Population density, industrialization and urbanization in the eastern part were higher than that in the western part (Yang et al., 2014), which led to larger sewage production. Besides, the sewage treatment rate of the eastern part was higher than that of the western part. In China, there was no obvious difference of wastewater treatment process in different areas, so total sludge production usually increased with sewage amount and sewage treatment rate. Similarly, total sludge production in

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