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Seasonal changes in the invertebrate community of granular activated carbon filters and control technologies

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ABSTRACT

Invertebrate colonization of granular activated carbon (GAC) filters in the waterworks is one of the most frequently occurring and least studied biological problems of water processing in China. A survey of invertebrate colonization of GAC filters was carried out weekly from October 2010 to December 2011 at a reservoir water treatment works in South China. Twenty-six kinds of invertebrates were observed. The abundance was as high as 5600 ind. m^{-3} with a mean of 860 ind. m^{-3}. Large variations in abundance were observed among different seasons and before and after GAC filtration. The dominant organisms were rotifers and copepods. The average invertebrate abundance in the filtrate was 12–18.7 times of that in the pre-filtered water. Results showed that the GAC filters were colonized by invertebrates which may lead to a higher output of organisms in the filtrate than in the pre-filtered water. The invertebrate abundance in the GAC filters was statistically correlated with the water temperature. Seasonal patterns were observed. The invertebrate abundance grew faster in the spring and summer. Copepods were dominant in the summer while rotifers dominated in all other seasons of the year. There was a transition of small invertebrates (rotifers) gradually being substituted by larger invertebrates (copepods) from spring to summer. Control measures such as backwashing with chloric water, drying filter beds and soaking with saliferous water were implemented in the waterworks to reduce invertebrate abundances in the GAC filters. The results showed that soaking with saliferous water (99%, reduction in percent) was best but drying the filter beds (84%) was more economical. Soaking filter beds with 20 g/L saliferous water for one day can be implemented in case of emergency. In order to keep invertebrate abundance in the acceptable range, some of these measures should be adopted.

1. Introduction

One of the most pervasive problems afflicting people throughout the world is inadequate access to clean water (Shannon et al., 2008). The significance of multicellular organisms in drinking water is attracting increasing scientific attention as we are starting to better understand their capacity to act as vectors of waterborne pathogens (Bichai et al.,

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2010). Previous results have shown that nematodes and other invertebrates may protect pathogenic microorganisms from disinfection during surface water treatment (Bichai et al., 2008, 2009, 2010). Furthermore, the bacteria associated with the invertebrates are potential pathogens for human beings (Wolmarans et al., 2005), although there is no evidence of a significant effect on microbial safety yet. The estimated number of bacteria that could be associated with a single invertebrate (as based on average invertebrate numbers) could range from 10 to 4000 bacteria per organism, most of them were isolated from the intestines of invertebrates (Wolmarans et al., 2005). Invertebrates such as rotifers and crustaceans are likely to be found in all drinking water distribution systems and at some stages of full-scale water treatment works (Van Lieverloo et al., 2012), but mostly in granular material filter effluents (Castaldelli et al., 2005; Schreiber et al., 1997). Although most of the invertebrates that pass through the water filter and taps are not easily observed, a few larger invertebrates are visible to the naked eye and lead to consumer complaints (Van Lieverloo et al., 2002).

The occurrence of macroscopically visible organisms in the drinking water such as oligochaetes, for example, is certainly an aesthetic problem to say the least. For example, during 1999, the water supplier in Gauteng, South Africa handled 68 consumer complaints of which 19 were due to invertebrates (Shaddock, 2005) and approximately several dozen times of consumer complaints every year in Netherlands (Van Lieverloo et al., 1997). Although there is no direct hygienic relevance to the invertebrates detected in the GAC filtrate, a high abundance of invertebrates in the stagnant pipes can lead to the regrowth of microbes within the distribution system (Schreiber et al., 1997). Tan et al. (2000) reported that *Lecane inermis*, which infected the urinary system of a person in China was common in the drinking water system.

Comparing the number of invertebrates found in raw water samples with those found in drinking, there is a striking rise in all waterworks examined that shows that the biological

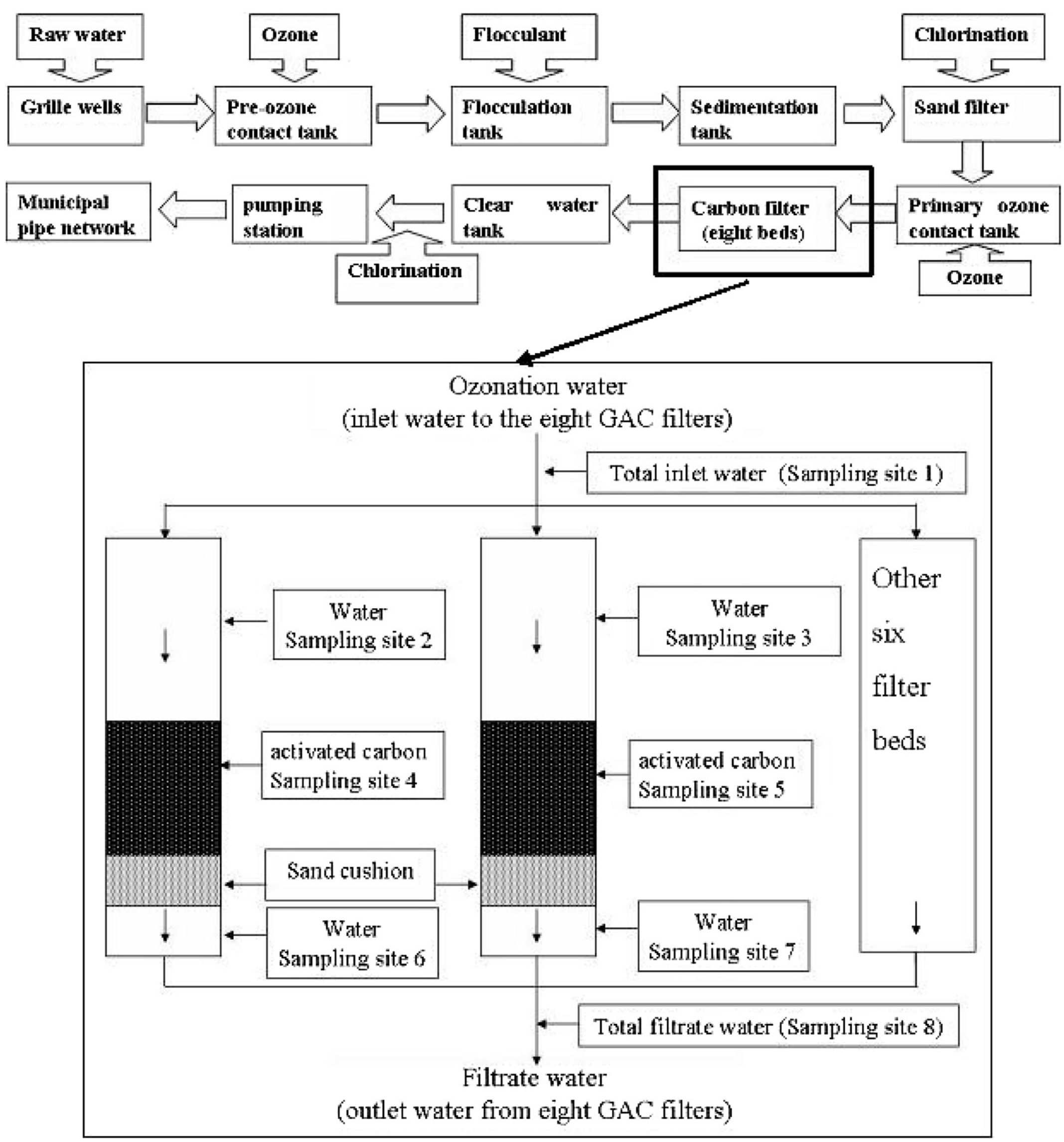

Fig. 1 – The technical process in the water works examined and sampling sites shown.