ABSTRACT

The treated water is an important source for water supplement, particularly in some arid or semi-arid areas. To protect the public health and the environment, the reliability of water treatment has to be guaranteed. Ammonium has been recognized as a typical pollutant in water source, because it can increase the consumption of chloride during water treatment. The ability of the high rate nitrifying trickling filter (NTF) for ammonium removal at low concentrations has been identified. With the increase of the energy crisis, it is important to consider the energy consumption on the NTF design.

This thesis compared the nitrification performance in two NTFs, with different aspect ratios (height: diameter) and the same packing media specific surface area. The effect of some operational parameters on nitrification performance for the two NTFs was also taken into consideration.

A laboratory-scale NTF system, consisting of two filters with different aspect ratios and the same effective media surface area, was constructed in Flinders University, South Australia. The NTFs were operated at the same environmental conditions (e.g. temperature and pH).The influent ammonium concentrations for both NTFs were maintained low. The inorganic nitrogen profiles of short- and long-term observation in both NTFs showed high similarity. The typical operational parameters (e.g. pH, total alkalinity and dissolved oxygen) exerted the similarly effects on the nitrification performance in both NTFs. These results demonstrated that the aspect ratio of the filter had insignificant effect on nitrification performance in the NTF.

The nitrifying bacteria in the NTF also have been known to be able to biodegrade some chemicals of concern (CoC), which are prevalently known as organic contaminants in water sources. These organic contaminants drifting into the environment are mainly because of the inadequate treatment in conventional wastewater treatment plants (WWTPs) and the improper drainage from industries, hospitals or households. Biological treatment process is considered to be an efficient approach for the removal of the organic contaminants. Little is known about the efficiency of a fixed-bed NTF for chemical removal. In order to remove ammonium and the CoC at the same time, the high rate fixed-bed NTF was applied in this study.

This thesis investigated the feasibility of the high-rate NTF for the removal of some CoC. These CoC were from a variety of classifications, including caffeine (stimulant), benzotriazole (detergent additive), N, N-diethyl-m-toluamide (insect repellent), 17α-ethynylestradiol (hormone), acetaminophen (analgesic agent), atrazine (herbicide), trimethoprim (antibiotic) and bisphenol A (plasticizer). A laboratory-scale NTF system, consisting of four parallel NTFs

(0.6 m bed depth and 0.15 m in diameter), was constructed in Flinders University, South Australia. The results showed that biodegradation was the main removal mechanism for all the investigated CoC. The removal efficiency for CoC ranged from 27% (bisphenol A) to 98% (caffeine) after 12 hours recirculation.

This thesis also investigated effect of nitrification rate in the NTF to the removal efficiency for CoC and the effect of CoC challenge to the nitrification performance in the NTF. The results demonstrated that the nitrifying-enhanced NTF was able to improve the removal efficiency for most of the investigated CoC. The largest removal efficiency improvement was observed for acetaminophen.

This research further investigated the effect of exogenous organic carbon (sucrose) to the removal efficiency for CoC in the NTF. The addition of exogenous organic carbon might generate other bacteria species (e.g. heterotrophic bacteria) in the NTF. The removal efficiency for CoC ranged from 20% to 90%. High removal efficiency of >80% was observed for ACE, BPA, TRI and EE2. The addition of sucrose improved the removal efficiency of the NTF for most of the CoC.

This study revealed that the NTF aspect ratio had insignificant influence on the nitrification performance, and this is an important criterion for the NTF design. The feasibility of a high-rate NTF for CoC removal has been confirmed in this study. The enhancement of nitrification rate and addition of exogenous organic carbon might improve the efficiency of NTF for CoC removal.