Desalination and Water Treatment
www.deswater.com
doi: 10.5004/dwt.2017.20938

(2017) 1–10

Effect of biochar on the migration and biodegradation of nitrogen during river-based groundwater recharge with reclaimed water: an indoor experimental study

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Received 25 January 2017; Accepted 14 May 2017

ABSTRACT

To investigate the effect of biochar on coupling migration–biodegradation of total nitrogen (TN) during river-based groundwater recharge with reclaimed water, lab-scale columns were used to simulate the recharging process. The packing medium of the three columns was mainly composed of biochar amended soil (BCS), silty clay (SC) and sterilized soil (SS). The results showed that the attenuation effect of TN was ordered as BCS > SC > SS, which showed that biochar could improve the decay rate. The migration trends of NH_4^+–N and NO_3^-–N were different because of the biotransformation among organic nitrogen, NH_4^+–N and NO_3^-–N. The main removal mechanism was sorption and biodegradation for NH_4^+–N, whereas it was denitrification for NO_3^-–N because the negative charge prevented sorption of NO_3^-–N into negatively charged aquifer soil. The key removal pathway was biodegradation in the recharge process, especially for the BCS system, because biochar amended improved the removal rate of nitrogen as well as denitrification enzyme activity. The 454 pyrosequencing 16s rRNA gene analysis showed that the ranking of the largest five relative abundances at the phylum level evidently changed and that the phylum related to denitrifying significantly increased with the biochar addition. Except for common and coexisting denitrifying bacteria, such as *Pseudomonas* and *Bacillus*, specific bacterial genera, such as *Caenimonas*, *Helicobacter*, *Halomonas*, *Lactobacillus* and *Flavisolibacter*, and the archaeal genus *Woesearchaeota_DHVEG-6* had previously been detected in the BCS system, which might be involved in nitrogen removal and should be studied in future research. Biochar has an intensification effect on denitrification by changing microbial living environmental factors, such as oxidation–reduction potential, pH and C/N, and providing a better biological attachment condition. These findings might provide a useful method to improve nitrogen biotransformation in groundwater recharge areas and could facilitate the prediction of different types of nitrogen in underground aquifers.

Keywords: Nitrogen migration and biodegradation; Biochar; Reclaimed water; Groundwater recharge; Microbial community and diversity; Indoor test

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Presented at the 9th International Conference on Challenges in Environmental Science & Engineering (CESE-2016), 6–10 November 2016, Kaohsiung, Taiwan.