Environ Sci Pollut Res (2017) 24:5095–5097
DOI 10.1007/s11356-016-8331-4

EDITORIAL

Solution to water resource scarcity: water reclamation and reuse

Yu Tian[1] · Hongying Hu[2] · Jun Zhang[1]

Received: 21 December 2016 / Accepted: 22 December 2016 / Published online: 9 January 2017

With scarcity of locally available water supplies in many regions of the world, impacts from severe droughts, rising energy prices, the need to mitigate greenhouse gas emissions, and requirements for environmental restoration, water resource crisis is one of the top obstacles restricting the world's sustainable development. Water reclamation and reuse are becoming an increasingly important component of water resource management worldwide and have been considered as a promising way to mitigate the global water resource risks. During the recent 10 years, significant advances have been made in water reuse management (in particular new approaches in reuse regulations and risk management); water reuse and its role in mitigating climate change impacts; water and energy nexus in water reuse; and water reuse projects directed to water and food, urban, and industrial applications as well as direct potable reuse.

This special issue on WaterRR includes a selection of papers presented at the10th IWA International Conference on Water Reclamation and Reuse, which was held in the Harbin Institute of Technology of China on July 5–9, 2015. The biennial IWA water reuse conference represents the most advanced technology and policy research level of water reuse, leading the development of water reuse in the world. More than 150 experts and scholars from 25 countries and regions worldwide attended this conference. Eighty-six oral presentations and 36 poster presentations were given during the conference. The topics include, but not limited to:

- Government policies, water reuse planning, and economics
- Risk management and regulations in water reuse
- Water reuse and its role to mitigate climate change impacts
- The role of water reuse for an integrated water resource management in China
- Water and food/irrigation (agricultural irrigation, landscape, and recreational use)
- Urban reuse
- Industrial reuse
- New paradigms in potable reuse and groundwater replenishment
- Reuse in developing countries
- Water and energy in water reuse
- Emerging technologies for water reuse

All the selected papers were subjected to rigorous peer-review process as regular submissions to Environmental Science and Pollution Research according to the specifications on the journal website: www.springer.com/environment/journal/11356. After rigorous peer-review process, nine papers were accepted for publication in the Environmental Science and Pollution Research Special Issue: WaterRR. The brief introduction of articles accepted for SI: WaterRR is given as follows:

Ding et al. evaluated the ammonia removal performance of a hybrid electrooxidation and adsorption reactor (HEAR). The influences of current density, chloride concentration, packing particles, and the performance of HEAR under serial circulation for ammonia removal in HEAR were investigated. Authors found the optimal conditions to achieve high

Responsible editor: Philippe Garrigues

✉ Jun Zhang
hitsunyboy@126.com

Yu Tian
hittianyu@163.com

Hongying Hu
hyhu@tsinghua.edu.cn

[1] School of Municipal and Environmental Engineering, Harbin Institute of Technology, Harbin 150090, China

[2] School of Environment, Tsinghua University, Beijing 100084, China

ammonia removal efficiency, where electrooxidation coupled with adsorption led to simultaneous ammonia removal and zeolite regeneration in HEAR. No decrease of ammonia removal efficiency was observed over several cycles with the electrooxidation treatment. Furthermore, this study demonstrated that ammonia removal in HEAR was due to the comprehensive influences of zeolite's adsorption, desorption, and indirect electrooxidation. HEAR was considered to be a prospective alternative as a tertiary treatment for wastewater effluent with low chloride ions.

Microbial fuel cells (MFCs) can use nitrate as a cathodic electron acceptor for electrochemical denitrification, yet there is little knowledge about how to apply them into current wastewater treatment process to achieve efficient nitrogen removal. In the paper titled "Simultaneous nitrification and denitrification in a novel membrane bioelectrochemical reactor with low membrane fouling tendency", Li et al. proposed to construct a novel membrane bioelectrochemical reactor (MBER) for simultaneous nitrification and denitrification under specific aeration. High effluent quality was obtained in the MBER and denitrification occurred simultaneously with nitrification at the bio-cathode of the MBER, achieving maximal nitrogen removal efficiency. Besides, a better power density and a current density were achieved compared to the control system. Most importantly, the MBER exhibited lower membrane fouling tendency due to reductions of MLVSSs and extracellular polymeric substance (EPS), EPSp/EPSc ratio decrease, and particle size increase of the sludge. Finally, it was suggested that the MBER holds potential for efficient nitrogen removal, electricity production, and membrane fouling mitigation.

In the paper of "Distribution and risk assessment of heavy metals in sewage sludge after ozonation", Zhang et al. investigated the transformation of heavy metals (Cu, Zn, Ni, Pb, Cr, Cd, Mn, and Mg) in sewage sludge (SS) during ozonation. Meanwhile, the risk of heavy metals to environment in ozonated sludge (OS) and SS was also estimated. The high residual rates of heavy metals demonstrated that the heavy metals in SS were mainly existed in the OS after ozonation. The risk assessment indicated that the environmental risk of heavy metals in OS was aggravated compared to SS, except for Mg. It was suggested that the OS should be pretreated before application.

Yu et al. investigated the microbial growth potentials of reclaimed water from MBR after coagulation. Their results showed that the microbial growth potentials in the effluent of the MBR increased evidently after coagulation. The organic matter affecting the bacterial growth might be substances having aromaticity (i.e., UV254 absorbance) but little fluorescence. According to molecular weight (MW) distribution analysis, the coagulation was indeed effective in removing organic matters with large MW. The removal of large MW organic matters might be related to bacterial growth increase. The results indicated that post-treatments are needed after coagulation to maintain the biological stability of reclaimed water.

In the study of "Causes of large *Potamogeton crispus* L. population increase in Xuanwu Lake", the authors studied the mechanism for the large increase of *Potamogeton crispus* after clay flocculation which controlled algal blooms significantly. Results showed that the transparency and dissolved oxygen content were improved evidently after clay flocculation, while thetotal nitrogen and total phosphorus content decreased significantly. It was found that the ameliorative light intensity and favorable nutrient level after clay flocculation were the key factors in turion sprouting and seedling propagation of *P. crispus*. It was suggested that ecological restoration of macrophytic and algal lakes be conducted by some physical or chemical means to improve transparency, reduce nutrient concentration, and adjust water pH, with the purpose of improving water quality for germination and growth of aquatic plants.

Residual ammonia and pathogenic microorganism restrict the reclamation and reuse of wastewater treatment plant (WWTP) effluent. Zhao et al. developed an electrochemical system for simultaneous ammonia removal and disinfection of actual WWTP effluent. Under the optimal chloride concentration, high removal of ammonia and successful disinfection of *Escherichia coli* in actual effluent were achieved. Higher electric charge was necessary to simultaneously remove *E.coli* and ammonia to meet the reclamation requirement of WWTP effluent. At this charge, no trihalomethanes, chlorate, and perchlorate were found in the system, indicating biological safety and little toxicity threatening of this process to public health. The research results in this study clearly showed the potential of this electrochemical process to serve as a tertiary wastewater treatment for WWTP effluent reclamation.

Due to the adverse impact of nano-ZnO (nZnO) on environment, it is new to apply coagulation process to simultaneous removal of the nanoparticles and heavy metals. In this article, Sun et al. investigated the environmental chemical behavior of ZnO in water, such as dispersion, aggregation, sedimentation, and dissolution of releasing metal ions systematically. Three kinds of nZnO state were found such as compacted sediment, suspended, and released state. Enteromorpha polysaccharides (Ep) were used together with polyaluminum chloride (PAC) in surface water purification. The mechanism analysis on the evolution of flocs size, strength and recovery ability, and fractal structure due to Ep addition indicated that PAC-Ep was efficient in removing nZnO and Zn^{2+} simultaneously. Ep was an efficient coagulant aid in enhancing the performance of coagulation and generating flocs with bigger sizes, faster growth rates, and higher recovery abilities.

Asaithambi et al. investigated and compared the efficiency of the sonication, electrocoagulation, and sono-electrocoagulation processes for removal of pollutants from the industrial effluent of the pulp and paper industry. Their results showed that the sono-electrocoagulation process yielded higher pollutant

removal percentage compared to the sonication and electrocoagulation process alone. The optimal operating parameters in the sono-electrocoagulation process were determined for the electrolyte concentration, current density, effluent pH, COD concentration, inter-electrode distance and electrode combination on the color removal, COD removal, and power consumption. The final conclusion was that the sono-electrocoagulation process could be used as an efficient and environmental friendly technique for complete pollutant removal.

Microbial desalination cells (MDC) is a new approach for synergistic bioenergy generation, desalination, and organic waste treatment without additional power input. However, current MDC systems cause salt accumulation in anodic wastewater and sludge. In this study, Meng et al. developed a microbial capacitive desalination cell (MCDC) with dewatered sludge as anodic substrate to address the salt migration problem and to improve recycling value of sludge by specially designed membrane assemblies. They pointed out that MCDC could achieve the maximum power output and high desalinization rate during stable operation. They also found that the CEM/ACC/Ni assemblies could effectively restrict the increase of anodic conductivity in MCDC and promoted dewatered sludge beneficial use by improving the parameters of dewatered sludge.

Prof. Yu Tian Professor/PhD supervisor, Yangtze River Scholar, China Youth Science & Technology Award and Heilongjiang Province Outstanding Youth Science Fund. Serve as the associate director of China Engineering Construction Standardization Association, and the editorial board members of Water Pollution and Treatment and International Journal of Membrane Science & Technology. The major research fields include the membrane technology for wastewater treatment and reuse, sewage sludge reduction, and resources. Be responsible for more than 30 projects and got 4 Heilongjiang Province Science & Technology Awards. Publish above 60 SCI papers, 5 academic books, and 20 approved patents during the recent 5 years. Approve as the executive chair of 2015 IWA International Conference on Water Reuse.

Prof. Hongying Hu Professor/PhD supervisor, vice dean of graduate school of Tsinghua University, winners of the National Science Fund for Distinguished Young Scholars and National Distinguished Teacher. Serve as the chairman of ISO TC282 SC2, associate editor of Water Research and Member of Management Committee of IWA Water Reuse Specialist Group (WRSG). Engage in the research fields of environmental microbiology and environmental biotechnology, water reuse and water quality security assessment and security technology, technology of water pollution purification, and ecosystem restoration. Professor Hu's group is one of the earliest research teams focusing on the sewage reuse and security researches. Publish more than 100 SCI articles and lead above 20 national projects, including the National Outstanding Youth Fund, Natural Science Foundation of China, Major International Cooperation Project, the National Key Basic Research and Development Program (973 Program) project, and other research projects.

Dr. Jun Zhang PhD, focus on the wastewater further treatment and water reuse. Publish above 30 research papers and apply 5 national patents in the recent years. Participate in numbers of national research projects including the Major Science and Technology Program for Water Pollution Control and Management, 863 key projects, and the National Natural Science Foundation of China. Ph. D thesis was awarded as the outstanding doctoral thesis in 2014 and serves as the executive vice-president of 10th IWA water reuse conference.