Preface

Green technologies for sustainable water

Water pollution has long been a great challenge to the environment, bio-system, and human health. Wastewater treatment, reuse, recycling and resource recovery have been developed to protect the environment. In recent years, the research hotspot of water environmental protection has gradually shifted from the well-known conventional technologies to eco-friendly, cost-effective, and sustainable technologies also known as green technologies which could perform outstanding advantages. Several practical treatment processes have been proposed and applied in practice; however, the green technologies are currently the most attractive for pollution control, especially water and wastewater remediation. The green technologies refer to a group of practical methodologies and materials based, among others, non-toxic chemical processes, clean energies, and environmental monitoring to mitigate or correct the negative impact induced by human activities (Fig. 1).

The 2nd Green Technologies for Sustainable Water Conference (GTSW 2019) was successfully held in Ho Chi Minh city, Vietnam on December 1–4, 2019. It was jointly organized by Ho Chi Minh City University of Technology (HCMUT), Vietnam National University – Ho Chi Minh (VNU-HCM), University of Technology Sydney and other universities/organizations. The aim of GTSW 2019 was to provide a special forum for exchanging experiences, knowledge, and innovative ideas for all aspect of green technologies with seven main theme including (1) water and wastewater treatment by green technologies; (2) Wastewater treatment and reuse; (3) Membrane processes; (4) Resources recovery from wastewater; (5) Nanotechnology for biological waste treatment; (6) Bio-processes and bio-products; (7) Disruptive technologies and applications for water resource treatment and management. The outcomes of GTSW 2019 was an opportunity to discuss and assess the latest approaches, innovative technologies, policies and new directions in infrastructure development, pollution prevention and eco-friendly processes and to promote cooperation and networking amongst practitioners and researchers involved in addressing Green Technologies for Sustainable Water.

Fig. 2 presents some emerging green technologies of this SI. In light of using green technologies, the first paper focused on combining microalgae and bacteria in activated sludge with different ratios. Thanks to the substantial amount of lipids in cell structure of microalgae, its biomass is a promising feedstock for biofuel production not just traditional crops. Microalgae is known for its ability in assimilating high load of nutrient and producing biomass in short amount of time. As such, this yielded a growth in COD removal by 37.5–45.7% at 3:1 and 1:1, respectively. The 3:1 ratio was reported to achieve organic/nu- trient removal and biomass production for low COD:N wastewater with satisfactory removal of TN (86%), TP (79%) and COD (99%) and total biomass concentration of 1.12 g/L. This paper confirmed the fundamental role in nutrient assimilation of algae, while the activated sludge assisted in TN assimilation, denitrification and COD removal.

With a similar focus on nitrogen removal and microbial activities, the second paper discussed systemic nitrogen alteration pathways along the reactor's height, and microbial groups and correlated genes. The paper pointed out that anaerobic-anoxic-oxic and oxidation are still commonly used in mainstream wastewater treatment, and these technologies cannot live up to the concept of sustainable development. Therefore, the studies suggested the utilization of both annamox and anaerobic digestion to directly treat municipal wastewater despite high organic content. This study aimed to comprehend the process mechanism of incorporating AnMBR with two-stage PN/A followed by autotrophic nitrogen removal and create a reference for its practical usage. Consequently, the paper reported that the majority of the nitrogen removal occurred at the bottom of the UASB tank, with a removal efficiency of 75.9% ± 0.6%, in which the impact of annamox was more than 98%. *Ca. Brocadia* was the main anammox bacteria and was enriched at the bottom; *Dokdonella* and *Thermomonas* were identified as the denitrifiers for nitrite production and found in the whole reactor.

Removing phosphorus from wastewater using more sustainable technologies is also a great concern. Using white hard clam (*Metetrix lyrata*) shells and *Paspalum atratum* as a substrate and plant in a lab-scale horizontal sub-surface flow constructed wetlands were studied. These materials is commonly cultivated in the coastal regions of Vietnam, which are relatively cheap and can be used for multiple purposes. The results found that media sorption was the main pathway for P removal (77.5%), followed by (14.5%), and plant uptake (5.4%). This suggested the potential in using white hard clam as a media in horizontal sub-surface flow constructed wetlands to increase P removal.

This special issue focused on the removal of nutrient as well as the removal of micro-pollutants using horizontal sub-surface flow constructed wetlands, which is known as a rather sustainable solution for wastewater treatment. This research focused on phenolic and phthalates compounds that were commonly found in municipal solid waste and landfill leachate. Since there were limited resources of using constructed wetlands to tackle organic microbial pollutants, this paper assessed the removal efficiencies of major organic microbial pollutants found in landfill leachate during long-term operation in a tropical climate. The results showed that the biodegradation led to the removals of DEP, DBP, 2,6-DTBP and BHT whereas DEHP was firstly removed through adsorption and formation of iron-organic complex and then biodegraded during long-term operation. This confirmed the application of constructed wetlands in treating organic microbial pollutants to ensure ecological safety.

In view of sustainable management, many advanced wastewater treatment technologies have been studied to deal with nitrate that was generated from aeration tank via biological nitrification process. Biological denitrification is an efficient method for nitrate removal,

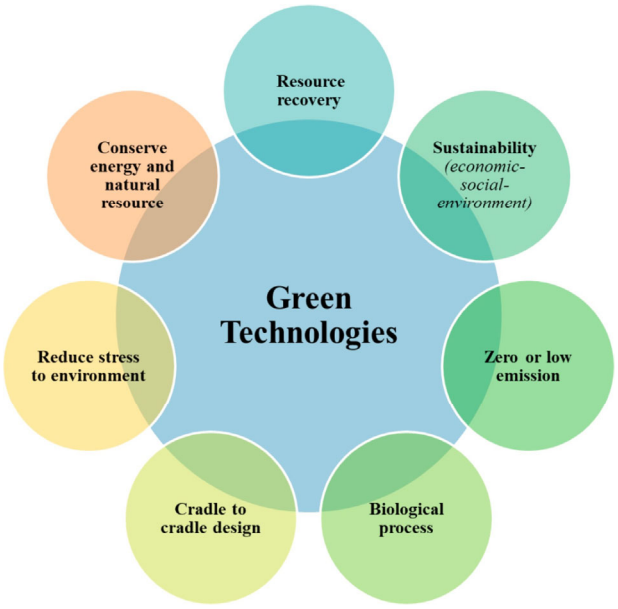

Fig. 1. Principle of Green Technologies for water and wastewater treatment.

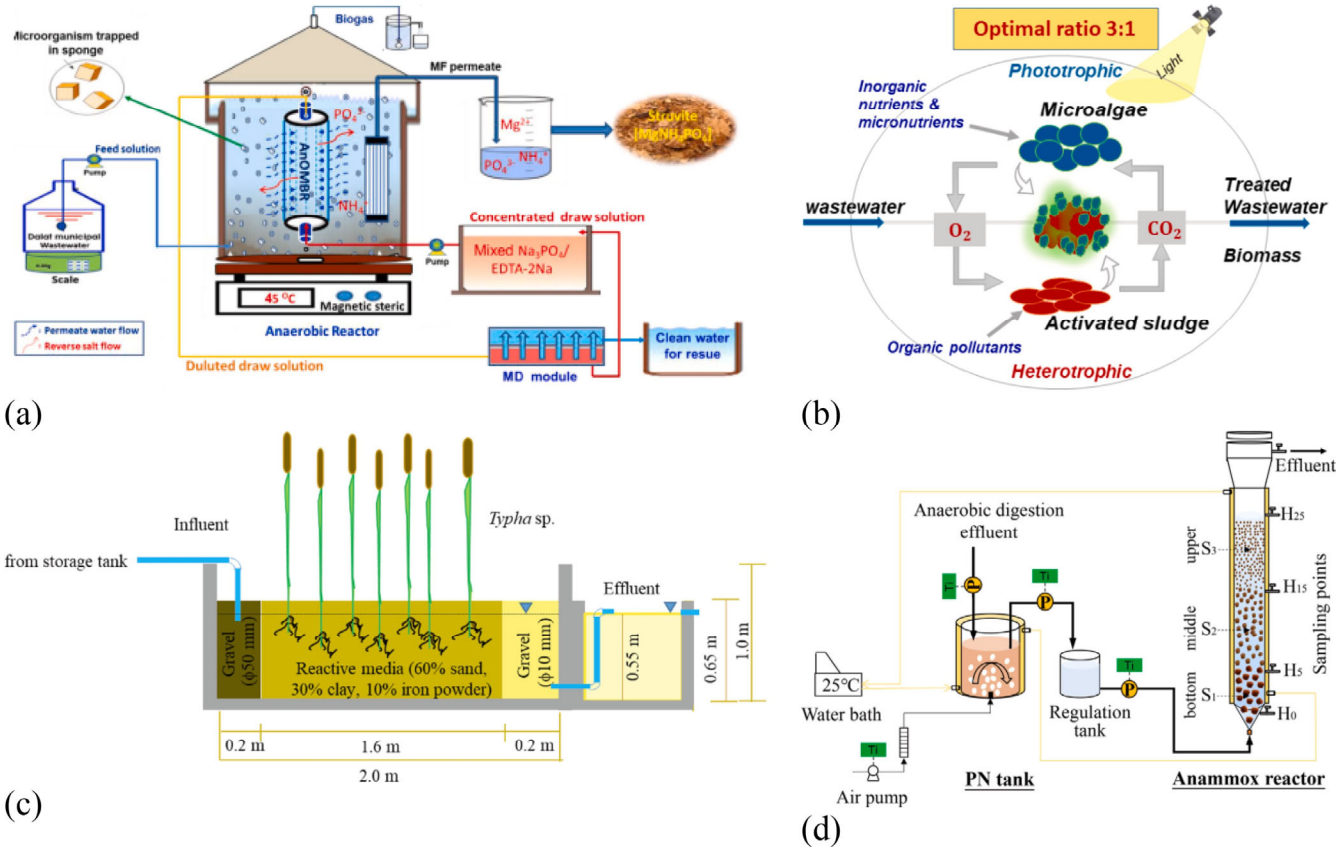

Fig. 2. Novel green technologies for wastewater and water treatment coupling with resource recovery (a) sponge-based moving bed-AnOMBR/MD system, (b) Co-culture of microalgae-activated sludge in PBRs, (c) HSSF-CW with reactive media, (d) PN/A system.

which relies on its pros of high-efficiency, economically sustainable and eco-friendly. Moreover, this technology also served as a promising technology because it is developed via solid carbon source as additional election donor and biofilm carrier for nitrate removal. As a result, the nitrate and COD removal were 97% and 80%, respectively. The statistics provided a further biological basis about applying solid-phase denitrification for simultaneously remove nitrate and organic matter.

To go along the theme of green technologies, understanding the reactor operations and system performance in thermal pyrolysis of municipal solid waste in order to develop an effective municipal solid waste pyrolysis process with a minimal carbon footprint.

As another highlight of GTSW2019, water and nutrient recovery is a

promising area. Therefore, membrane bioreactor emerges can be applied as an innovative technology to advance wastewater reuse with limited space requirement. There are many variations to the membrane bioreactor technologies, one of which is a novel sponge-based moving bed-anaerobic osmosis membrane bioreactor/membrane distillation (AnOMBR/MD) system using mixed Na3PO4/EDTA-2Na as the draw solution. This technology was found to effectively reduce energy consumption by using osmotic pressure difference between draw solute (DS) and feed solution (FS) streams across the FO membrane. However, it is inevitable that membrane fouling occurred. Hence, numerous studies were carried out to mitigate this problem. One of them used a new green bio-flocculent in MBR which could reduce energy consumption to maintain sustainability. This proved to have high capability in improving sludge properties, mitigating membrane fouling and increasing bacterial diversity. Another approach to move toward a more sustainable future, one paper studied rumen-MBR to produce volatile fatty acids from crops residues. This offered a way to reuse a resource that is known for its abundance, inexpensiveness and renewability. Consequently, volatile fatty acids were yielded at an average daily of 438 mgVFA/g substrate, and the yield lasted 35 days, which proved the feasibility of rumen-MBR.

In this context, this SI is mainly intended to knit together the efforts made by research fraternity in this domain and provide the state-of-art research and technological developments, which enables to define the research need.

The content of this SI is as follows:

I. Biological and physio-chemical treatment processes
   1. Co-culture of microalgae-activated sludge for wastewater treatment and biomass production: Exploring their role under different inoculation ratios
   2. Insight into using up-flow anaerobic sludge blanket-anammox to remove nitrogen from an anaerobic membrane reactor during mainstream wastewater treatment
   3. White hard clam (*Meretrix lyrata*) shells media to improve phosphorus removal in lab-scale horizontal sub-surface flow constructed wetlands: performance, removal pathways, and lifespan
   4. Long-term removals of organic micro-pollutants in reactive media of horizontal subsurface flow constructed wetland treating landfill leachate
   5. Simultaneous nitrate and dissolved organic matter removal from wastewater treatment plant effluent in a solid-phase denitrification biofilm reactor
   6. Slow pyrolysis of municipal solid waste (MSW): A review

II. Membrane bioreactors
   7. Water and nutrient recovery by a novel moving sponge – Anaerobic osmotic membrane bioreactor – Membrane distillation (AnOMBR-MD) closed-loop system
   8. Application of a specific membrane fouling control enhancer in membrane bioreactor for real municipal wastewater treatment: Sludge characteristics and microbial community
   9. Derivation of volatile fatty acid from crop residues digestion using a rumen membrane bioreactor: a feasibility study

The guest editors of this special issue would like to thank Prof. Ashok Pandey, Editor-in-Chief of Bioresource Technology who has contributed greatly to the success of the GTSW 2019 conference and provided us an opportunity to publish the peer reviewed papers pre- sented at this conference in such a renowned BITE special issue. Our sincere thanks are also due to Dr. Adam Fraser (Senior Publisher), Mr. Leonard Daniel (Journal Manager), Ms. Hannah Zhang (Special Issue Manager) and the entire production team of *Bioresource Technology* and Elsevier for their cooperation in bringing out this special issue. Our deep appreciation to all the authors and reviewers for their remarkable contributions. Last but not least, we are very grateful to the organizers, staffs and sponsors of GTSW2019. Their endeavor for the sucess of the GTSW 2019 is highy appreciated.

We hope that the articles published in this SI will be widely read, critically discussed and the green technologies could be potentially applied in the real practice.

Huu Hao Ngo*
Centre for Technology in Water and Wastewater, School of Civil and Environmental Engineering, University of Technology Sydney, Sydney, NWS 2007, Australia

Xuan-Thanh Bui
Key Laboratory of Advanced Waste Treatment Technology, Vietnam National University Ho Chi Minh (VNU-HCM), Linh Trung Ward, Thu Duc District, Ho Chi Minh City 700000, Viet Nam
Faculty of Environment and Natural Resources, Ho Chi Minh City University of Technology (HCMUT), Ho Chi Minh City 700000, Viet Nam

Long D. Nghiem
Centre for Technology in Water and Wastewater, School of Civil and Environmental Engineering, University of Technology Sydney, Sydney, NWS 2007, Australia

Wenshan Guo
Centre for Technology in Water and Wastewater, School of Civil and Environmental Engineering, University of Technology Sydney, Sydney, NWS 2007, Australia
E-mail address: ngohuuhao121@gmail.com (H. Hao Ngo),

* Corresponding author.