  Water Science & Technology | 78.1 | 2018

Editorial: Algal technologies for wastewater treatment and resource recovery

PROMISING FEATURES OF ALGAL TECHNOLOGIES

Over 80% of the globally produced wastewater receives none or hardly any treatment before it is disposed into the environment (WWAP 2017). Therefore, it is urgent to develop new wastewater treatment technologies that are sustainable in the broad sense of the word, i.e. not only produce high quality effluents, but also minimise energy expenses, recover energy and nutrients, and apply technology that is appropriate in relation to the availability of skilled personnel.

The requirements of such a technology could be summarised by a number of characteristics. Firstly, the effluent quality should be better than commonly achieved by e.g. waste stabilisation ponds, especially if nutrient removal is required. With natural systems such as ponds or wetlands extremely large areas are required, which in many circumstances makes these technologies not practically feasible. If the local market conditions are favourable for nutrient recovery, nitrogen and particularly phosphorus recovery are important. Rapidly growing algae cultures are very efficient to capture nutrients from water. However, the areal footprint of wastewater treatment systems is an important cost factor, especially in urbanising areas where land is scarce and/or expensive. As the required area for mechanised systems such as activated sludge is typically around 0.5 m^2 per capita, algae-based technologies preferably should be only marginally more area demanding.

The low global coverage of wastewater treatment indicates that many treatment technologies are too complex, too expensive and/or lack robustness. The technological complexity therefore should be kept to a minimum. A thorough understanding of the biological processes and ecological engineering of microbial communities is required, and relatively simple reactors are likely to be preferred over multi-step processes that encompass many different unit operations.

'Wastewater treatment' is increasingly transformed into 'resource recovery', including recovery of the energy and nutrients contained in wastewaters. Algal-based systems may have strong advantages in this respect, as no artificial aeration is required to provide oxygen, and the algal biomass could be used to produce biofuels, biogas, biofertilisers or in special cases even valuable biopharmaceuticals. Further process improvements are necessary to make some of these products feasible in terms of economics and net energy production or consumption.

As water scarcity in the world is increasing, so will the need for reuse of treated wastewater in agriculture or for other non-potable uses. Disinfection of the wastewater is therefore of great importance. Many research papers have been published about pathogen removal in natural systems such as ponds and wetlands, but the more controlled conditions in a photo-bioreactor potentially could be used to achieve a much more rapid removal of pathogens. Such a characteristic probably is a condition for widespread application of modern algal technologies for production of irrigation water. The global fight against climate change also requires wastewater treatment technologies with a minimum CO_2 footprint. The low energy demand of microalgae-based wastewater treatment, along with the ability of microalgae to capture CO_2 from the aerobic heterotrophic oxidation of organic matter, rank algal systems among the most sustainable technologies for water reclamation.

THE INTERDISCIPLINARY BASIS OF ALGAL REACTOR TECHNOLOGY

In order to exchange and discuss the latest achievements towards the realisation of the above described technology, scientists, algaeneers and practitioners gathered for the 1st IWA International Conference on Algal Technologies for Wastewater Treatment and Resource Recovery at the premises of IHE Delft in the Netherlands, on 16–17 March 2017. The objective of the meeting was to bring two perspectives together, i.e. the perspective of treating wastewater (with algae) and the perspective of growing algae (on wastewater). Representatives from both fields benefited from the interdisciplinary discussions. Wastewater treatment engineers benefited from knowledge about the use of algae to produce biofuels, food/fodder supplements or green pharmaceuticals. Likewise, wastewater as a cheap source of carbon and nutrients was

doi: 10.2166/wst.2018.323

shown to be promising for the production of algae-based commodities.

THIS SPECIAL ISSUE

This special issue compiles the main outcomes of the recent efforts to improve the design of waste stabilisation ponds and confirms the superior performance of high rate algal ponds as a result of process intensification. Anaerobic digestion devoted to biogas production continues to be the preferred strategy for the energy valorisation of the algal biomass, co-digestion with multiple high C/N ratio substrates gathering significant attention over the past years. The potential of algal biomass as a biosorbent for heavy metal removal (Cu, Ni, F) maintains its share in the research field of water bioremediation, while research on nutrient removal has focused on providing new insights on the mechanism of nitrogen and phosphorus removal from wastewater in algal–bacterial systems. Finally, it is worth noticing that breakthroughs in complementary fields of research such as nanotechnology or lighting technology are gradually being implemented in algal biotechnology, with new products such as nanoparticles for water disinfection or photobioreactors illuminated by low intensity LED panels.

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