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"Sustainable Water Treatment: Innovative Technologies"

Edited by Zainura Zainon Noor and Noor Salehan Mohammad Sabli (Universiti Teknologi Malaysia, Johor, Malaysia), Taylor and Francis Group LLC, Boca Raton, USA, 2017, 184 pages, ISBN: 978-1-138-03324-5, $143.96, £91.20

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Introduction

"Sustainable Water Treatment: Innovative Technologies" is a compilation of papers previously published elsewhere presented as 10 chapters. These have been edited by Zainura Zainon Noor, whose research is heavily involved in green technologies in water treatment while she also leads the Green Technology Research Group and the Institute of Water and Environmental Management, and Noor Salehan Mohammad Sabli, a PhD student under the supervision of Zainura Zainon Noor focusing on developing a water footprint framework for the calculation of water usage in crude palm oil production. The book presents ongoing research in technologies utilised for industrial water treatment. It describes innovative approaches such as streams previously considered waste being utilised as intermediates in the production of high value chemicals. It would therefore appeal to researchers with an interest in the area of wastewater treatment as well as industries with research capabilities looking to apply innovative technologies to address wastewater issues.

The book is divided into three sections. Section I presents research on biological processes used to treat wastewater with a focus on palm oil effluent either from the process of production or the point of end use. Section II describes membrane bioreactor technologies. Section III presents advanced chemical-physical processes for industrial wastewater treatment. The chapters vary from presenting research with testing and results on enzymatic hydrolysis of waste cooking palm oil to a technology review of membrane bioreactors.

Innovative Biological Processes for the Recovery of Value-Added Products from Wastewater

Section I presents research on biological processes used to treat wastewater with a focus on palm oil effluent whether from palm oil mills or from cooking palm oil that finds its way to wastewater. Of great interest is the paper by Qistina Ahmad Kamal and Nor Azimah Mohd Zain that presents bioremediation of palm oil mill effluent (POME) for itaconic acid production. Itaconic acid, known as methylene butanedioic acid or methylene succinic acid, is an unsaturated dicarboxylic acid which has high potential as a replacement for acrylic or methacrylic acid in polymers. It functions as plastic, adhesive, elastomer and coating in its polymerised forms such as methyl, ethyl or vinyl ester. New findings suggest it can be used in the making of artificial glass, bioactive compounds in agriculture and pharmaceuticals. It is produced by the filamentous fungi *Aspergillus terreus* and *Aspergillus itaconicus* and its synthesis is

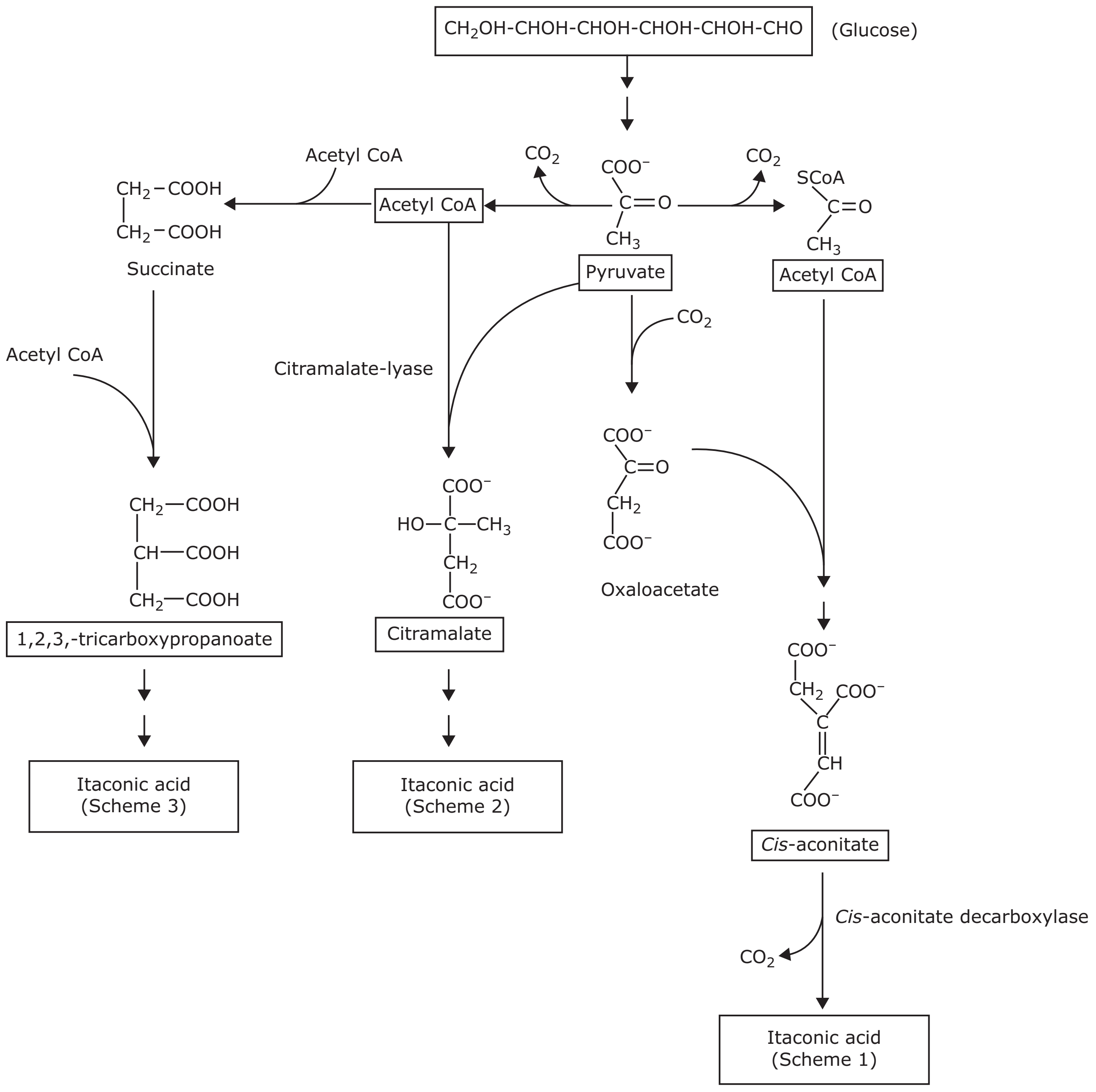

Fig. 1. Pathway of itaconic acid synthesis (1). Reproduced/amended with permission from American Society for Microbiology

uneconomical as the substrate cost is high relative to the low yield it produces (**Figure 1**).

The researchers use *Aspergillus terreus* to produce itaconic acid using POME as an alternative low cost substrate. The investigation is around the potential for maximising yields by immobilising the biology in poly(vinyl alcohol) (PVA)-alginate beads. The results have not been promising as POME does not have a higher yield than a glucose or sucrose substrate. Translation of these results to a larger scale is also not considered.

Membrane Bioreactor Technologies

Section II contains recent research on membrane bioreactors (MBR). The work described ranges from the use of MBR for removal of micropollutants in spent caustic water, to integration of MBR with other treatment systems and the outlook on future MBR technologies. The review paper written by Rabialtu Sulilah Ibrahim, Adhi Yuniarto and Siti Nurhayati Kamaruddin on the outlook of MBR technologies presents the benefits of MBR against conventional activated sludge processes in terms of cost, footprint, power usage and effluent quality achieved. Advanced MBR technologies such as a combination of MBR with a bio-electrochemical cell to reduce membrane fouling are presented. Other examples include a submerged membrane electro-bioreactor combining biological, electrokinetic and membrane filtration. The paper also discusses the growth of the MBR market presenting figures such as US$888 million by 2017 at a rate claimed to be faster than other membrane systems.

Advanced Chemical-Physical Processes for Industrial Wastewater Treatment

In Section III technologies are presented for the treatment of wastewater from industries such as pharmaceuticals and fabrics production. VOCs are described by their predominant anthropogenic sources such as chemicals production as well as biological sources such as isoprene from plants. Current technologies for the treatment of VOC in wastewater are discussed. Nonthermal plasma by gas discharge when applying an electric potential between two electrodes was tested for effectiveness in VOC destruction (**Figure 2**).

Due to the high density of water, nonthermal plasma application would require an electric field several orders of magnitude larger than a gas system would require. An integrated air stripping and nonthermal plasma system was therefore used to determine effectiveness of treating wastewater containing toluene and xylene. Increasing voltage achieved an increased removal efficiency for toluene with 12.32 kV resulting in 59.8% removal and 15.68 kV resulting in 92% removal. Water, carbon dioxide, carbon monoxide and nitrous oxide gases were detected and identified as byproducts of toluene and xylene decomposition.

Conclusion

The book contains a good range of technologies for the treatment of wastewater. It provides solutions that find application within several industries and merit more research to determine their effectiveness and most importantly their scalability. It would make a good starting point for industry based research but would not be appropriate for readers without some background knowledge in wastewater treatment.

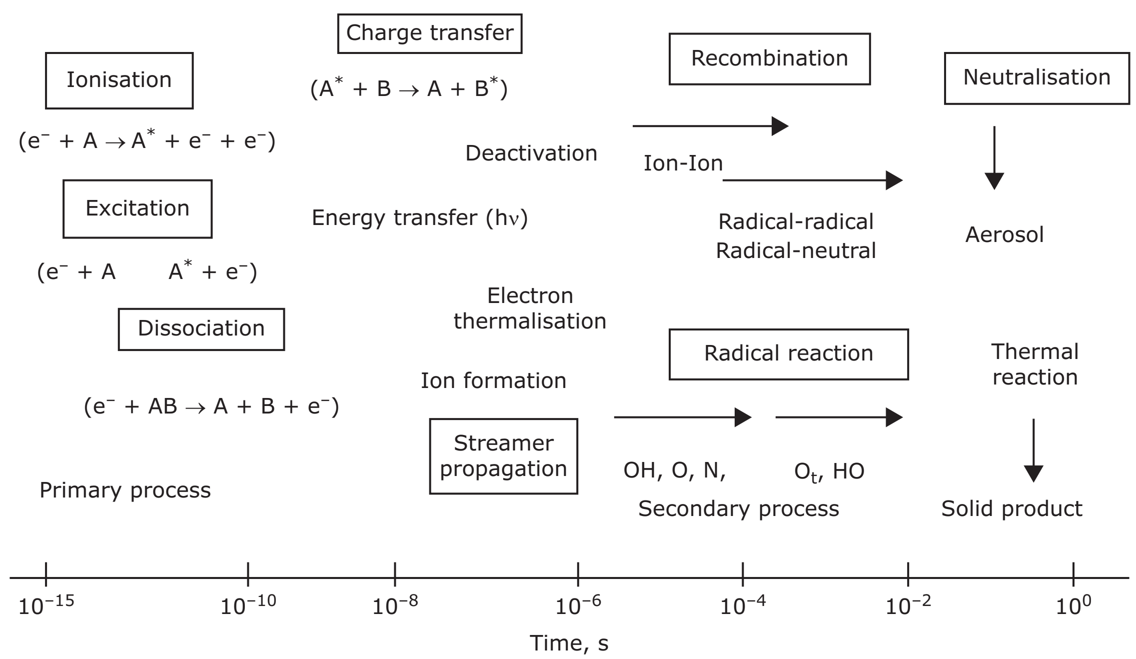

Fig. 2. Timescale for different reactions in plasma. Reprinted from (2), Copyright (2002), with permission from Elsevier

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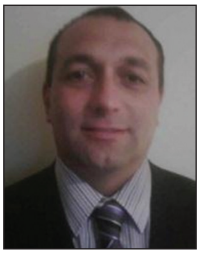

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